

April 13, 1926.

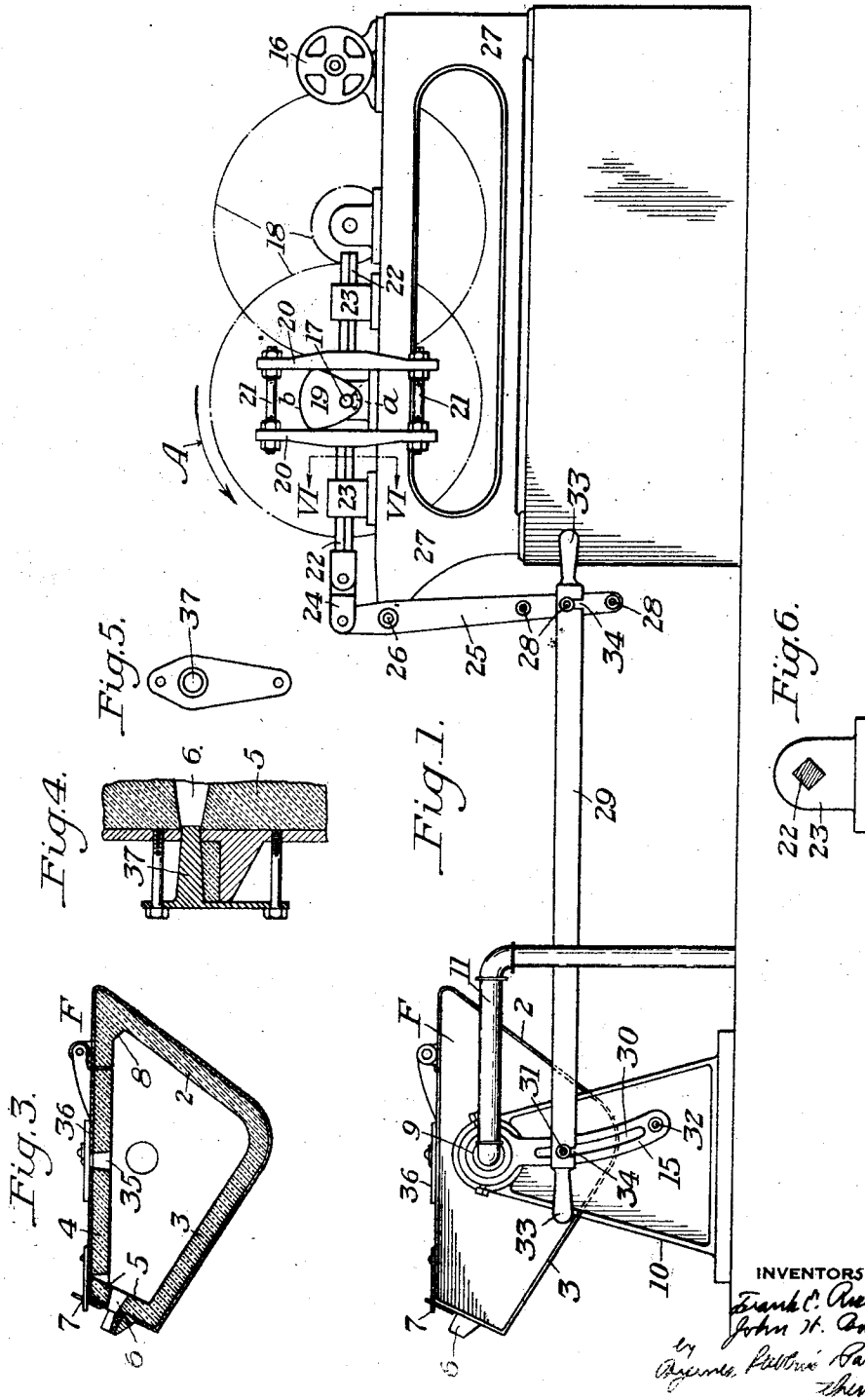
1,580,533

F. E. RICHARDSON ET AL

METHOD AND APPARATUS FOR PUDDLING IRON

Filed April 23, 1924

3 Sheets-Sheet 1



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Fig. 2.

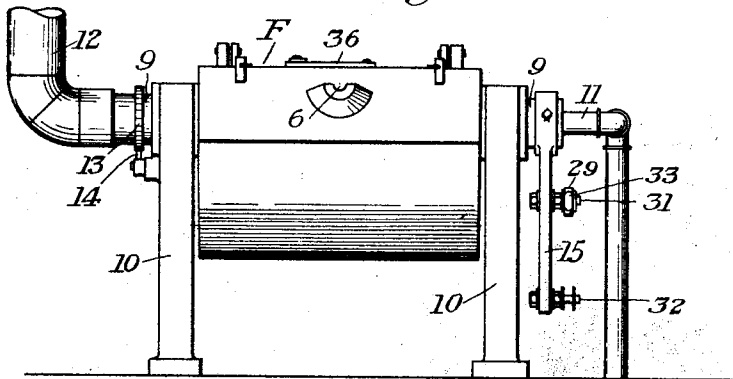


Fig. 7.

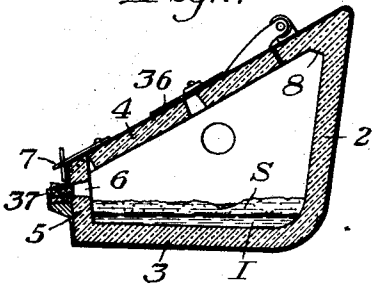


Fig. 8.

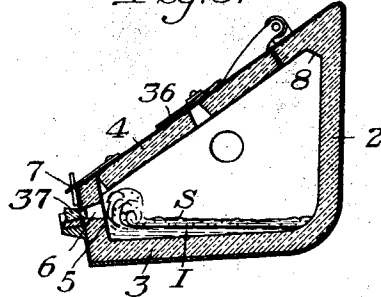


Fig. 9.

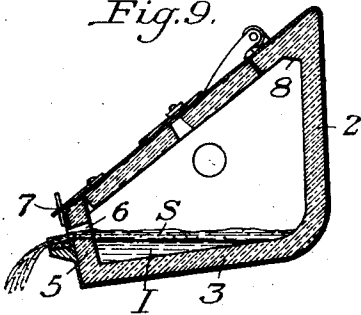
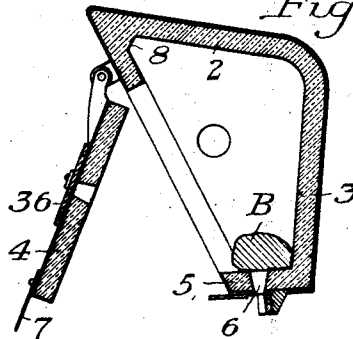


Fig. 10.



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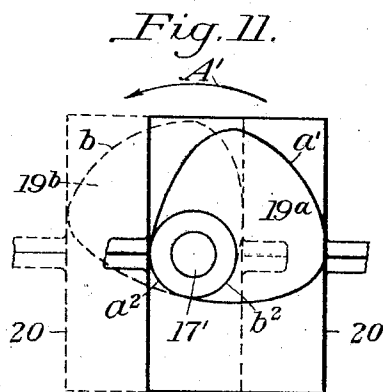
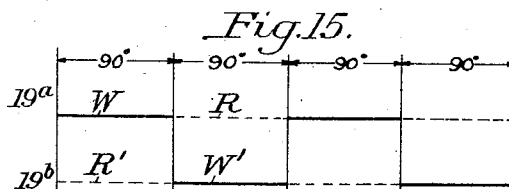


*Fig. 12.*

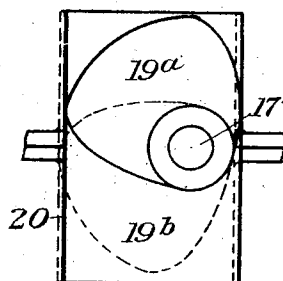


*Fig. 13.*

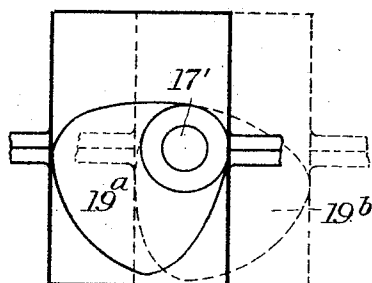


*Fig. 14.*

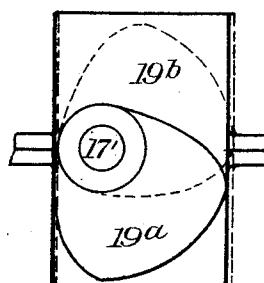


*Fig. 16.*

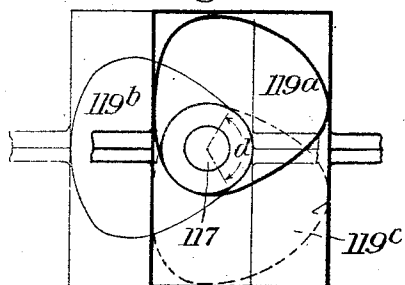
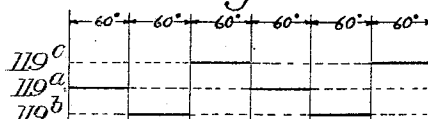


*Fig. 17.*



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1,580,533

# UNITED STATES PATENT OFFICE.

FRANK E. RICHARDSON, OF SEWICKLEY, AND JOHN H. BARR, OF PITTSBURGH, PENNSYLVANIA, ASSIGNORS TO PITTSBURGH FORGE AND IRON COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

## METHOD AND APPARATUS FOR PUDDLING IRON.

Application filed April 23, 1924. Serial No. 708,395.

*To all whom it may concern:*

Be it known that we, FRANK E. RICHARDSON and JOHN H. BARR, citizens of the United States, residing, respectively, at Sewickley and Pittsburgh, county of Allegheny, and State of Pennsylvania, have invented certain new and useful Improvements in Methods and Apparatus for Puddling Iron, of which the following is a full, clear, and exact description.

The present invention relates broadly to the manufacture of wrought metals, and more particularly to a method and apparatus adapted to take the place of the usual hand methods employed in the manufacture of wrought iron.

While at the present time mechanical processes have been used to a considerable extent in the manufacture of wrought iron, it is generally conceded that the hand puddled iron is of better quality. It is one of the objects of the present invention to provide a method and apparatus adapted to incorporate the advantages obtained by the hand rabbling by bringing all of the metal both into intimate contact with the flame within the furnace and with the slag bath.

In the accompanying drawings there are shown, for purposes of illustration, certain embodiments of the present invention, it being understood that the drawings do not define the limits of our invention, and that changes in the construction and operation therein disclosed may be made without departing either from the spirit or the scope of our invention, and more particularly the broader claims thereof.

In the drawings:—

Figure 1 is a side elevation of a furnace constructed in accordance with the present invention, together with its operating means;

Figure 2 is an end elevation of the furnace illustrated in Figure 1.

Figure 3 is a vertical sectional view through the furnace;

Figure 4 is a detail view, on an enlarged scale, illustrating the closure for the pouring spout;

Figure 5 is a front view of the closure shown in Figure 4;

Figure 6 is a transverse sectional view, on an enlarged scale, on the line VI—VI of

Figure 1 looking in the direction of the arrows; 55

Figure 7 is a view similar to Figure 3, illustrating the furnace in a different position;

Figure 8 is a view similar to Figure 3, illustrating the furnace in still another position; 60

Figure 9 is a view similar to Figure 3, showing the furnace in position to permit discharge of the slag therefrom;

Figure 10 is a view similar to Figure 3, illustrating the furnace in position to permit removal of the ball; 65

Figures 11 to 14 are diagrammatic views illustrating successive positions of a slightly modified form of actuating mechanism; 70

Figure 15 is a diagrammatic view illustrating the periods of rest and periods of work of the respective operating cams;

Figure 16 is a view similar to Figure 11, illustrating a slightly modified form of actuating mechanism, and 75

Figure 17 is a view similar to Figure 15, illustrating the respective periods of work and rest of the cams shown in Figure 16.

In carrying out the puddling reaction, it is admittedly of considerable importance to bring every particle of the molten iron into intimate contact, not only with the reducing bath of slag, but also with the flame. This contact with the flame is of special importance after the metal begins to come to nature. The difficulties involved in the mechanical handling of iron have been very largely responsible for the continued practice of puddling by hand. 80 90

In accordance with the present invention there is provided a furnace which is shaped in such manner as to insure intimate contact with the reducing bath during the refining operation, and also insuring such turning of the metal that every particle thereof is brought into reducing relationship with the flame employed. The operating mechanism provided for the furnace is of such construction that the full advantages of the furnace configuration are made available. 95 100

In carrying out the present invention, there may be provided a furnace F having angularly disposed hearth portions 2 and 3. As is customary in the art, the furnace may comprise a metallic outer shell carrying a 105

refractory inner lining having the proper characteristics. The furnace is preferably so shaped that the portion of the casing which supports the hearth portion 2 extends inwardly and over a part of this hearth portion to form a pivotal mounting for the cover 4. The casing is also so shaped that at the termination of the hearth portion 3 there is an abrupt upwardly extending portion 5 carrying a discharge outlet and spout 6 and provided with a suitable catch 7 for holding the cover in closed position. In lining the furnace, the lining is preferably so shaped as to provide an abruptly upwardly extending portion 8 similar to the portion 5 for the reasons hereinafter more fully pointed out.

The furnace is provided with trunnions 9 journaled in suitable bearings 10 and preferably hollow so that a fuel supply line 11 may extend into the furnace coincident with its axis of oscillation at one end and a flue 12 cooperate with the other end. Carried by one of the trunnions is a ratchet wheel 13 with which a ratchet 14 is adapted to cooperate to hold the furnace in different inclined positions during different periods of operation thereof as may be desired. Carried by the other trunnion is an operating lever 15, by means of which the furnace may be mechanically oscillated for imparting the desired movement to the contents thereof.

The operating mechanism for the furnace may comprise a motor 16, the armature shaft of which is adapted to drive a cam shaft 17 through a reducing gear train 18. The cam shaft 17 carries a cam 19 operatively positioned to engage cross-heads 20 adjustably connected by bolts 21. Each of the cross-heads preferably carries a guiding rod 22 which may be of angular cross section, as clearly indicated in detail in Figure 6, and adapted to cooperate with suitably shaped bearings 23, whereby rotation of the cross-heads is prevented. The outer end of one of the rods 22 is pivotally connected to a link 24, which in turn is pivotally connected to the upper end of an operating lever 25 having a pivotal mounting 26 on the supporting frame 27. The operating lever 25 may be provided with a series of pins 28 projecting therefrom and located at different distances from the pivotal mounting of the lever. Any one of these pins may be operatively connected at will with a pitman 29 which has its opposite end operatively connected to the lever 15. The lever 15 may be formed with a curved slot 30 having adjustably mounted therein an actuating pin 31 adapted to be adjusted to any desired position in the slot without appreciably affecting the normal position of the furnace. The lever 15 may also be provided with a fixed actuating pin 32 for cooperation with the pitman. By reason of this construction, it

will be apparent that as the point of connection of the pitman is moved outwardly at one end from the pivotal mounting 26, or at its other end from the axis of rotation of the furnace, the length of stroke of the pitman will be increased, and consequently the angular movement of the furnace correspondingly increased. This feature is of considerable importance, as it enables the operator to vary the movement of the furnace at different times as may be required by the character of the material undergoing treatment. To facilitate this change of connection, the pitman may be provided with an operating handle 33 at each end thereof and with open slots 34 for cooperation with the respective pins.

The cam 19 for actuating the furnace is preferably constructed so as to provide alternate periods of work and rest. In the form illustrated in Figure 1, the cam is of such configuration that it will work through substantially 90° of rotation, and rest during 90° of rotation, the periods of rest and work alternating in such manner that there is a period of rest at the end of the stroke in each direction. Assuming the cam to be rotating in the direction of the arrow A in Figure 1, this operation may be obtained by having the portion of the cam within the angle  $\alpha$  concentric with the axis of rotation of the shaft 17.

In operation, the furnace may be charged with the desired amount of molten iron through the charge opening 35. Thereafter, a molten bath of slag may be added through the same opening, or the materials may be added in the reverse order. After both the slag and the metal have been charged into the furnace, the charging opening 35 may have a suitable closure 36 applied thereto. The discharge spout 6 may also be closed at this time by a removable closure 37. The fuel issuing from the supply line 11 may be lighted, and the operating mechanism set in motion to oscillate the furnace. It will be understood that normally the furnace occupies the position illustrated in Figure 3. As the cam rotates in the direction of the arrow A, the pitman will be moved to the right, thereby tilting the furnace into the position illustrated in Figure 7. After the completion of slightly less than 45° of rotation from the position shown in Figure 1, the cam will bring the furnace into the position shown in Figure 7, in which the hearth portion 3 is in substantial parallelism with a horizontal plane. At this time, the body of molten iron I, will be spread in a thin layer over a comparatively large area, whereby the oxidizing slag S, which tends to float on the surface of the bath, will be brought into more intimate relationship with the iron of the bath than would be possible if the bath were relatively deep and of small area. At

the beginning of the puddling operation, if may be desirable to so limit the stroke of the pitman that the furnace is not tilted beyond the position shown in Figure 7. This rather mild agitation of the metal would correspond in all substantial respects to that which it receives at the beginning of the hand puddling process. However, as the metal begins to come to nature, it may be desired to increase the throw of the pitman to thereby insure turning of the metal to bring the bottom particles on top in such manner that intimate contact thereof with the flame is insured. Where the adjustment of the pitman is such as to produce this operation, the furnace may be tilted into the position shown in Figure 8. In this position the flow of the metal and slag will bring them against the abrupt portion 5, whereby they will tend to splash or curl upwardly and then fall backwardly. This operation will produce turning of the metal and a thorough intermingling thereof with the slag.

After the furnace has been brought either into the position shown in Figure 7 or that shown in Figure 8, the cam will have rotated to such a point that the concentric portion thereof within the angle  $a$  will be in contact with one of the crossheads 20, while the concentric portion  $b$  will be in contact with the other crosshead. During the next  $90^\circ$  of rotation, therefore, the furnace will be permitted to remain in this position until the bath and the slag assume a substantially quiescent condition. Thereafter, the next  $45^\circ$  of rotation will be effective for bringing the furnace back substantially to the position shown in Figure 3. The next  $45^\circ$  will bring the furnace to the other extreme, in which the hearth portion 2 will either be in substantial parallelism with a horizontal plane, or in which it will incline downwardly, as illustrated in connection with the hearth portion 3 in Figure 8, to cause the bath and the slag to impinge against the abrupt portion 8 to produce turning as desired. Thereafter, for the next  $90^\circ$  of rotation, the parts will remain in the position to which they have been moved.

The foregoing operation may be repeated as long as desired to properly effect removal of the carbon from the metal and bring it to nature preparatory to balling. At this time, the parts of the actuating mechanism will be adjusted in such manner as to lengthen the stroke of the pitman so that the furnace may be thrown substantially into the position shown in Figure 9. The furnace may be held in this position by the ratchet mechanism 13 and 14, and the actuating mechanism either stopped or disconnected. The closure 37 will be removed and the slag drawn off, as clearly shown in this figure. After this operation, the actuating mecha-

nism may be adjusted to shorten the stroke of the pitman, and thereby gently rock the furnace about its axis of rotation to work the metal in the curved portion between the angularly disposed hearth portions, and thereby ball the same. When the proper ball has been produced, the furnace may be turned to the position shown in Figure 10, the cover released, and the ball B removed from the furnace as desired and carried to a squeezer or other mechanism.

It will be apparent that even though the actuating mechanism is of such character that it is only working approximately half of the time, it is necessary to provide an operating motor of sufficient horsepower to efficiently produce the operations desired. In large plants, these characteristics may be taken advantage of by utilizing a single motor to drive a plurality of furnaces by extending the cam shaft 17 and providing additional cams thereon.

In Figures 11 to 14, both inclusive, there is illustrated a modified embodiment, in which the shaft 17' carries a cam  $19^a$  and a cam  $19^b$ ; these cams each being of the construction before described, and being arranged with their axes at  $90^\circ$ . With this construction, and with the parts rotating in the direction of the arrow  $A'$  in Figure 11, the cam  $19^b$  will continue to move the dotted crosshead to the left until one of the crossheads occupies a position of tangency to the portion  $b'$  of the cam, and until the other crosshead occupies a position of tangency to the portion  $b^2$  of this cam, while in like manner, the cam  $19^a$  will continue to rest until the crossheads indicated in full lines move out of this condition of tangency from the portions  $a'$  and  $a^2$  respectively. Thereafter, the crossheads indicated by dotted lines will remain substantially stationary through the next  $90^\circ$  of rotation, while the crossheads indicated in full lines will be moved to the left. The positions occupied by the parts after the rotation through  $90^\circ$  from that shown in Figure 11 are indicated in Figure 12, in which the cam  $19^a$  has not quite completed its working stroke, and in which the cam  $19^b$  has not completed its idle stroke or period of rest.  $90^\circ$  of rotation from that shown in Figure 12 will bring the parts into the position illustrated in Figure 13, while the next  $90^\circ$  will bring the parts into the position illustrated in Figure 14. In Figure 15 the periods of work and of rest of the cams are diagrammatically represented, the cam  $19^a$  being shown as commencing with a period of work indicated by the reference character W, followed by a period of rest R, etc. The cam  $19^b$ , however, is shown as having a period of rest  $R'$  coinciding with respect to the angular rotation with the period of work W of the cam  $19^a$ , followed by a period of work  $W'$  coinciding

with the period of rest R of the cam 19<sup>a</sup>. It will be apparent that in this manner the operating motor continuously works, but that the periods of work do not overlap, so that a single motor may advantageously be used for operating two furnaces.

In Figure 16 this same inherent operation of the cam is taken advantage of for the operation of three furnaces by providing the shaft 117 with cams 119<sup>a</sup>, 119<sup>b</sup> and 119<sup>c</sup> having their axes at 120° to each other. The cams in this case, however, will have a modified shape such that the portion included between the sides of the angle  $\alpha$  on each of the cams will represent 120° instead of 90°, as was the case with the angle  $\alpha$  shown in Figure 1. In this manner, each of the cams will be effective during 60° for producing movement of its respective crosshead, during the next 120° for holding a crosshead stationary, during the next 60° for returning the crosshead, and during the next 120° for holding the crosshead stationary in the new position. This condition is illustrated diagrammatically in Figure 17, in which the cam 119<sup>c</sup>, illustrated in dotted lines in Figure 16 as just about ready to commence its period of idleness, is indicated as being idle for 120°, the cam 119<sup>a</sup>, illustrated in heavy lines in Figure 16 as just about ready to commence its period of work, is indicated as working for 60°, and in which the cam 119<sup>b</sup>, illustrated in light full lines in Figure 16 as about in the center of its period of idleness, is indicated as being idle for 60° and then working for 60°. It will be understood that these periods of idleness are indicated in Figure 17 by dotted lines, while the periods of work are indicated by heavy lines, the cams being so arranged that the period of work of one cam immediately succeeds that of another in such manner that the effect is the same as though a single cam were provided for continuous operation.

The advantages of the present invention arise from the provision of a furnace having angularly disposed hearth portions of such nature that they may be alternately brought into operation for distributing the bath in a thin layer, together with operating mechanism for producing such a movement of the furnace.

Further advantages arise from the provision of the abruptly extending portions at the termination of each of the hearth portions, whereby the bath may be turned periodically to bring all portions into intimate contact with the flame and slag, together with operating mechanism whereby the desired movement for producing this operation may be obtained.

Still further advantages arise from the construction of the operating mechanism such that periods of work are followed by periods of rest, and such that an adjustment

to produce different characteristic operations of the furnace may be obtained.

We claim:

1. Puddling apparatus, comprising a furnace having angularly disposed hearth portions, all of which are normally out of parallelism to a horizontal plane, and means for oscillating said furnace to bring such portions alternately into a position of substantial parallelism to a horizontal plane.

2. Puddling apparatus, comprising a furnace having two substantially flat angularly disposed hearth portions, forming a hearth substantially V-shaped in one cross section, and means for oscillating said furnace to bring such portions alternately into a position to receive the bath of molten metal within the furnace.

3. Puddling apparatus, comprising a furnace having angularly disposed hearth portions, all of which are normally out of parallelism to a horizontal plane, and means for oscillating said furnace to bring such portions alternately into a position of substantial parallelism to a horizontal plane, said means being adjustable for varying the amount of oscillation of the furnace.

4. Puddling apparatus, comprising a furnace having its hearth formed of two substantially flat angularly disposed downwardly inclined hearth portions, and means for oscillating said furnace to bring such portions alternately into a position to receive the bath of molten metal within the furnace, said means being adjustable for varying the amount of oscillation of the furnace.

5. Puddling apparatus, comprising a furnace having angularly disposed hearth portions, and means for oscillating said furnace to bring such portions alternately into a position of substantial parallelism to a horizontal plane, said means being effective for holding such portions alternately in the position to which they have been moved for a predetermined period of operation.

6. Puddling apparatus, comprising a furnace having angularly disposed hearth portions, and means for oscillating said furnace to bring such portions alternately into a position of substantial parallelism to a horizontal plane, said means being adjustable for varying the amount of oscillation of the furnace and being effective for holding such portions alternately in the position to which they have been moved for a predetermined period of operation.

7. Puddling apparatus, comprising a furnace having angularly disposed intersecting hearth portions each terminating in abrupt ends, and means for oscillating said furnace to bring such portions alternately into a position of substantial parallelism to a horizontal plane and cause the contents of the furnace to impinge against said ends.

8. Puddling apparatus, comprising a fur-

nace having its hearth formed of two substantially flat angularly disposed downwardly inclined hearth portions terminating in abrupt ends, and means for oscillating said furnace to bring such portions alternately into a position of substantial parallelism to a horizontal plane and cause the contents of the furnace to impinge against said ends.

9. Puddling apparatus, comprising a furnace having a hearth portion, and operating means connected to said furnace for alternately causing the bath within the furnace to pass from one end thereof to the other, said means being effective for holding the furnace substantially stationary in each extreme position thereof throughout a predetermined period of operation of the furnace.

10. Puddling apparatus, comprising a furnace having a hearth portion, and operating means connected to said furnace for alternately causing the bath within the furnace to pass from one end thereof to the other, said means being effective for holding the furnace substantially stationary in each extreme position thereof throughout a predetermined period of operation of the furnace and having an adjustable connection with

the furnace for varying the amount of movement thereof.

11. Operating mechanism for a puddling furnace, comprising an operating cam effective for moving the furnace to one extreme position, holding the furnace in such position, thereafter moving the furnace to another extreme position, and holding the furnace in such position.

12. The method of puddling, comprising the steps of alternately transferring a molten bath from a thin layer on one hearth portion to a similar layer on another hearth portion, and permitting the bath to assume a quiescent condition between successive transfers.

13. The method of puddling, comprising the steps of alternately transferring a molten bath from a thin layer on one hearth portion to a similar layer on another hearth portion, permitting the bath to assume a quiescent condition between successive transfers, and effecting a turning of the metal between successive transfers thereof.

In testimony whereof we have hereunto set our hands.

FRANK E. RICHARDSON.  
JOHN H. BARR.