No. 629,903 Patented Aug. 1, 1899.

J. M. HARTMAN.

APPARATUS FOR CASTING PIG METAL.

(Application filed May 24, 1898.)

(No Model.) 5 Sheets—Sheet 1

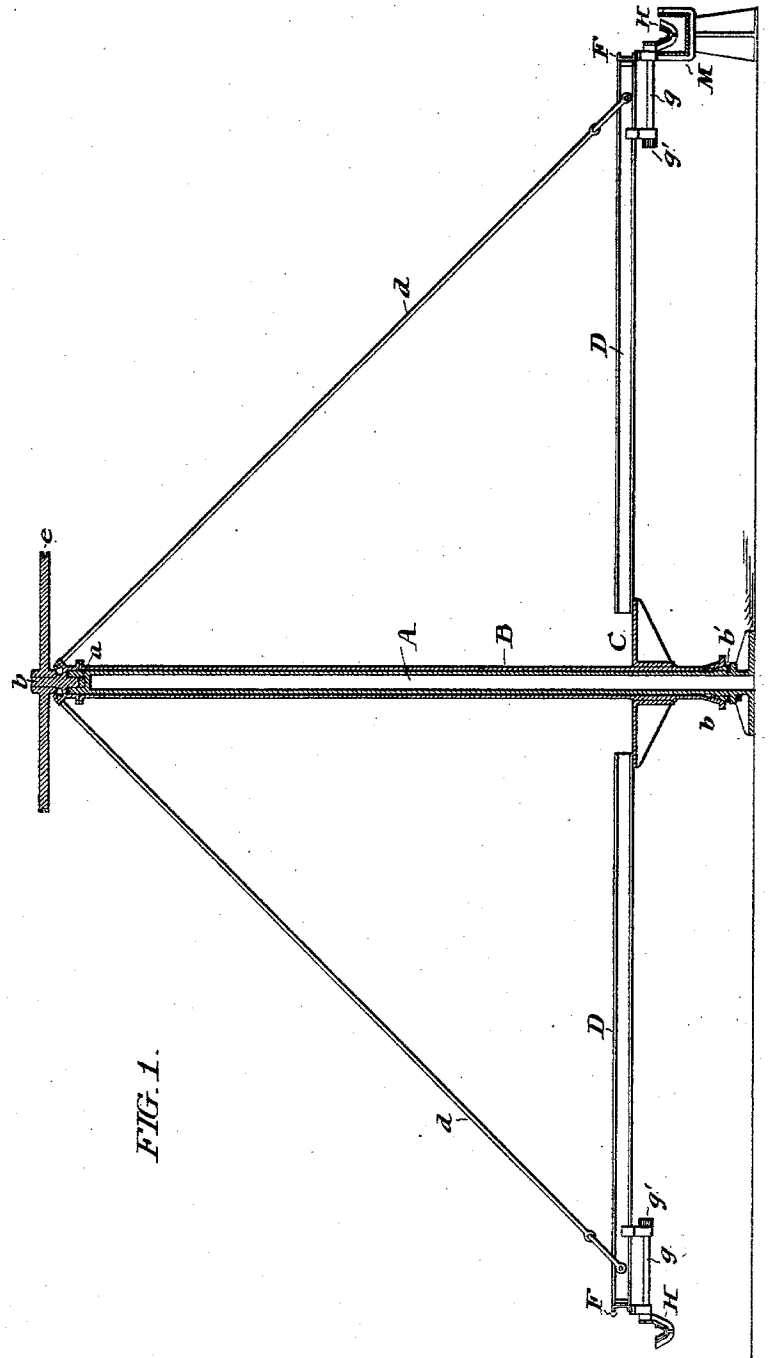


FIG. 1.

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F. Herbert Jenkins

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(No Model.) 5 Sheets—Sheet 2.

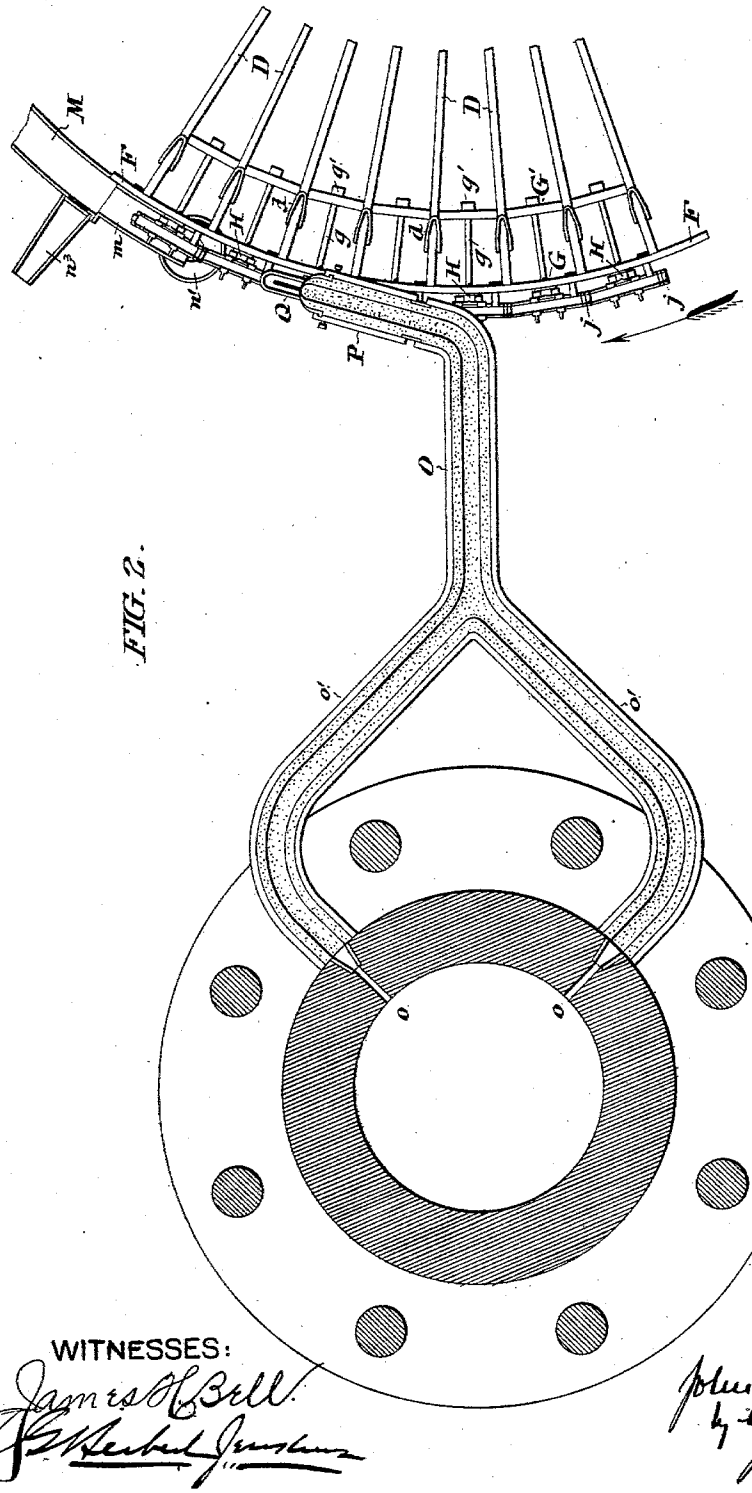


FIG. 2.

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(No Model.) 5 Sheets—Sheet 3.

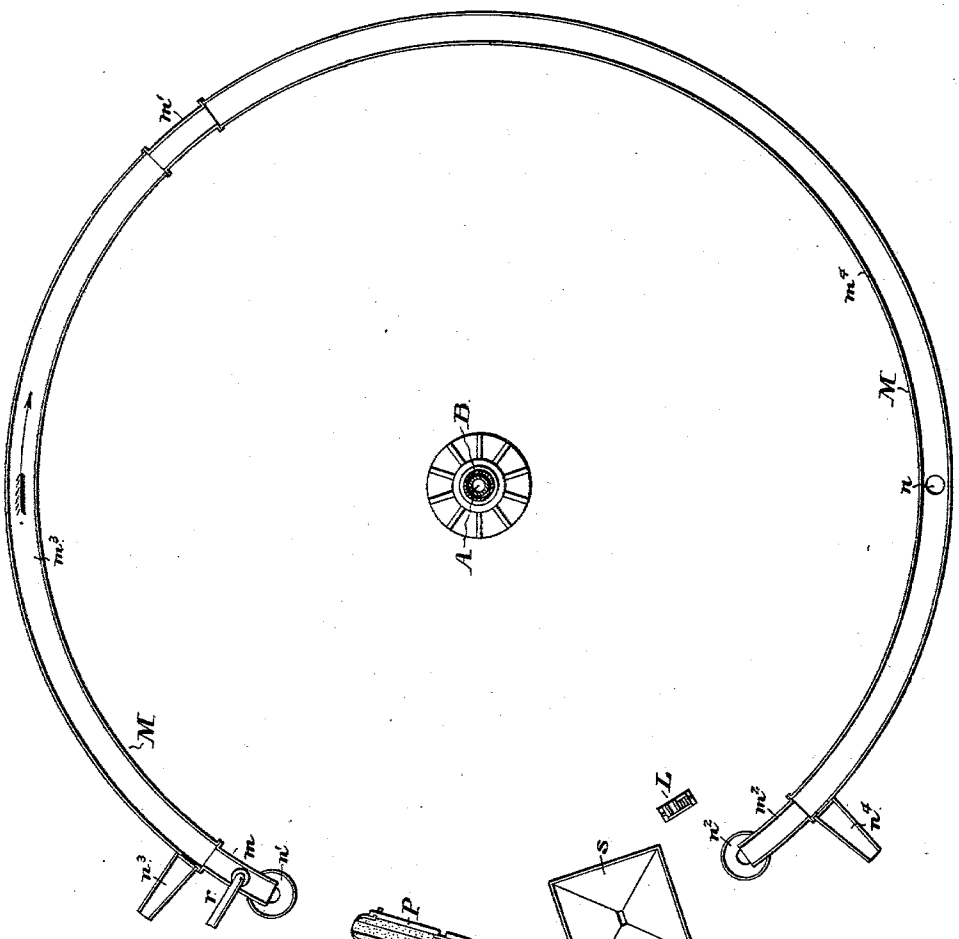


FIG. 3.

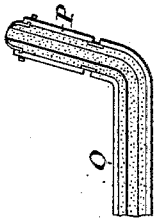


FIG. 4.

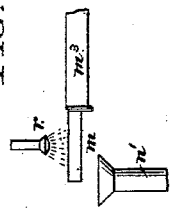
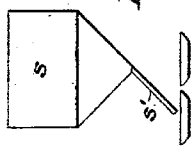


FIG. 6.



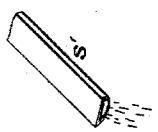


FIG. 5.

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(No Model.) 5 Sheets—Sheet 4

FIG. 9.

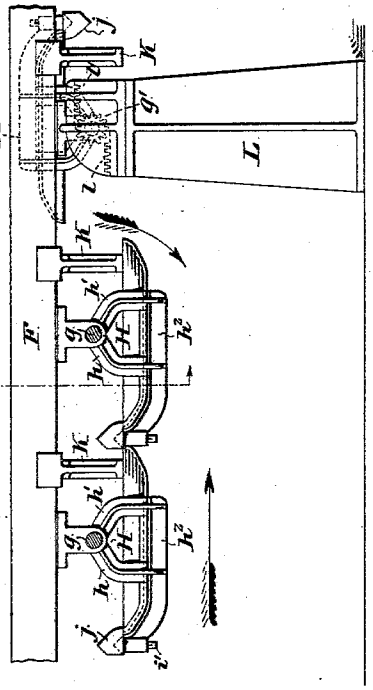


FIG. 10.

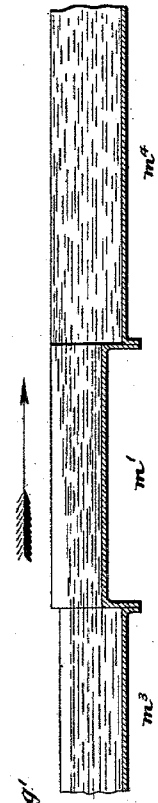


FIG. 7.

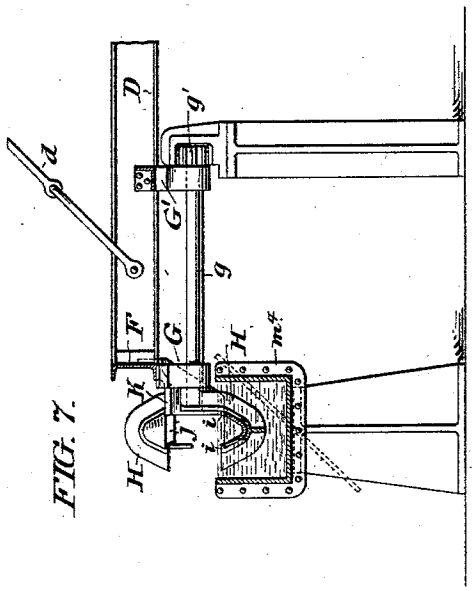
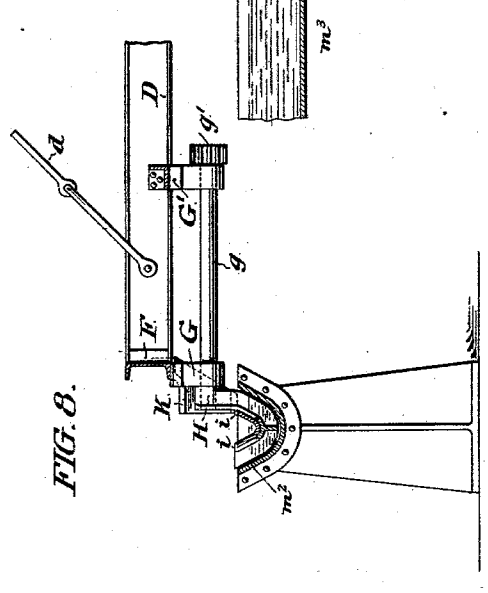


FIG. 8.



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No. 629,903. Patented Aug. 1, 1899.

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APPARATUS FOR CASTING PIG METAL.

(Application filed May 24, 1898.)

(No Model.) 5 Sheets—Sheet 5.

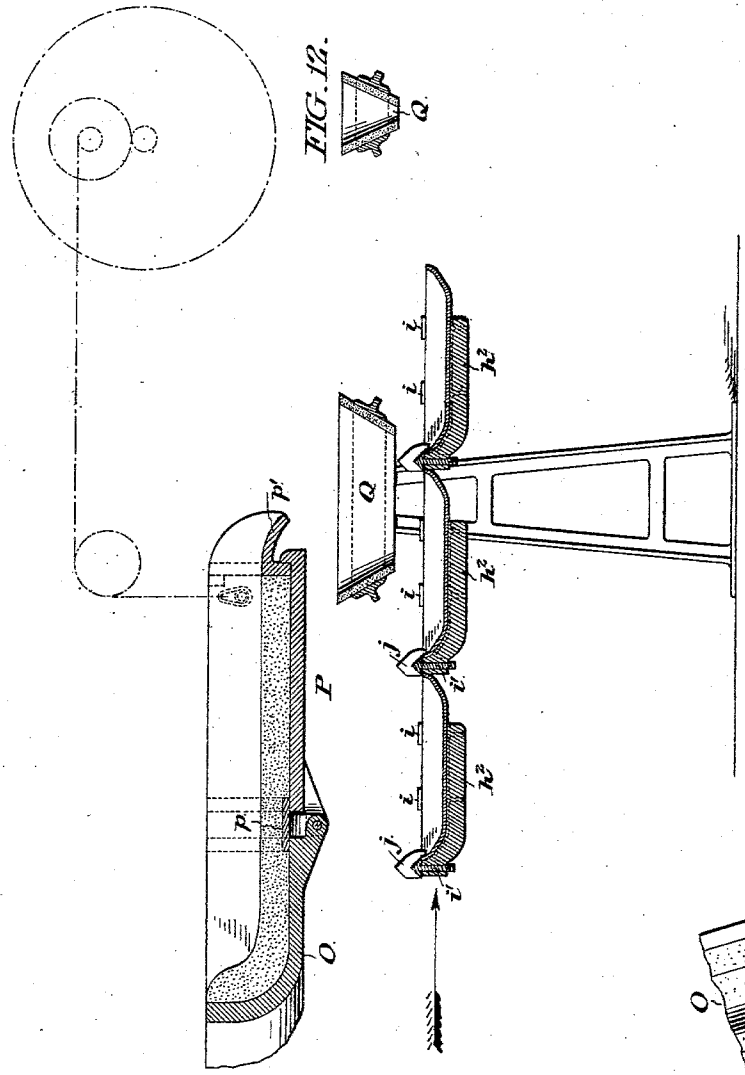


FIG. 11.

FIG. 12.

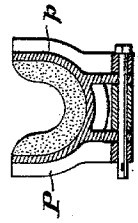


FIG. 14.

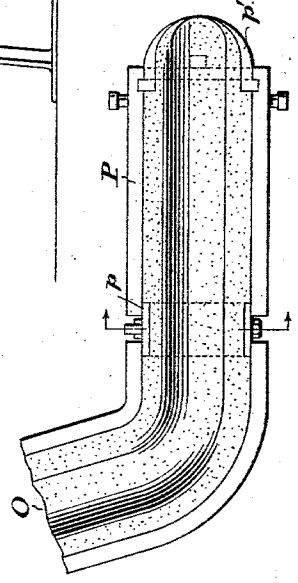


FIG. 13.

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UNITED STATES PATENT OFFICE.

JOHN M. HARTMAN, OF PHILADELPHIA, PENNSYLVANIA.

APPARATUS FOR CASTING PIG METAL.

SPECIFICATION forming part of Letters Patent No. 629,903, dated August 1, 1899.

Application filed May 24, 1898. Serial No. 681,596. (No model.)

To all whom it may concern:

Be it known that I, JOHN M. HARTMAN, of Philadelphia, in the State of Pennsylvania, have invented certain new and useful Apparatus for Casting Pig Metal, whereof the following is a specification, reference being had to the accompanying drawings.

The object of my improvements is to provide a means for overcoming the well-known disadvantages incident to the old method of casting pig-iron. Among these disadvantages are the imperfection and irregularity of the pigs, the waste, the possibility of explosion, and the amount of manual labor and time required. In place of this old method I substitute a continuous and mechanically-even method of casting by means of the regular traverse of a series of molds, into which the metal is successively poured, in which it is systematically cooled, and from which the pig is delivered to a suitable receptacle. Many efforts have been made heretofore to devise a continuous casting device of this general character. My invention differs from these in many respects, which will be hereinafter pointed out, and is much more desirable, simple, and economical in its operation.

In the accompanying drawings, Figure 1 is a vertical cross-section through the revolving table, around the periphery of which the molds are carried. Fig. 2 is a plan view of a portion of the revolving table, together with the gutter by which the molten metal is delivered to the molds, the furnace itself being shown in cross-section. Fig. 3 is a plan view of the annular trough through which the molds around the periphery of the revolving table pass. Certain other adjacent parts are also indicated in this plan. Figs. 4, 5, and 6 are details of certain small parts appearing in Fig. 3. Fig. 7 is a partial vertical section and elevation of the periphery of the table, trough, and accompanying parts. Fig. 8 is a similar view of the corresponding parts in a different circumferential position. Fig. 9 is a side elevation of a portion of the periphery of the table with accompanying parts. Fig. 10 is a longitudinal section in assumed straight projection through the center of a portion of the annular trough. Fig. 11 is a vertical section of the pouring apparatus, showing a number of the molds in similar section. Fig. 12 is a similar section of the funnel shown in Fig. 11 at right angles thereto. Fig. 13 is a plan view of the discharge end of the gutter. Fig. 14 is a cross-section of the same.

A, Fig. 1, is an upright tubular post with a step-bearing a at its top, upon which is pivoted a revolving axle b, fitted to the upper end of a large depending sleeve B, which surrounds and revolves upon the post A. The lower edge of this sleeve has a second conical adjustable bearing b' near the bottom of the post. Surrounding the sleeve, near its lower end, is a disk C, to which are secured the inner ends of a series of I-beams D, which radiate from it horizontally in all directions. The outer extremity of each of these beams is supported by a stay or tie rod d, yoked to its outer end and passed up and fastened to a rim at the upper end of the sleeve B. Upon the axle b, at the top of the sleeve, is a sheave e, through which rotation is imparted to the sleeve and its surrounding radiating beams. The outer ends of these beams are united by means of a peripheral beam F. The entire circular structure thus formed by the disk C, the radial beams D, and the peripheral beam F, forming a large wheel, will be hereinafter spoken of as the "revolving table."

Between each of the radial beams and near their outer extremities are mounted a pair of depending bearings G G', Fig. 7, of which the outermost, G, depends centrally from the peripheral beam F. The innermost, G', spans the space between the beams a little nearer the center of the table and depends to the same level as the bearing G. Within each pair of bearings revolves the shaft g, which carries at its inner extremity a pinion g'. The outer extremity of each of these shafts carries a mold-frame H, the shape of which is best seen in Figs. 7, 8, and 9 of the drawings. This mold-frame is, roughly speaking, an open-work metal basket suspended at one side. From the point of suspension two ribs h h' divide and pass around under the space which the mold (which is somewhat boat-shaped) is to occupy. At their center and lower points these ribs are connected by a longitudinal beam h^2, forming a sort of keel. In one direction this longitudinal beam does not pass beyond the ribs, which it connects. In the

other direction it passes backward and upward a short distance. Within each of the mold-frames thus formed there rests an iron mold having the configuration of the ordinary commercial pig. This configuration is well known, and I have elsewhere referred to it by using the term "boat-shaped," which will serve sufficiently to identify the shape meant. Each of these molds is made of a single plate of rolled wrought-iron or steel by being struck up or die-forged therefrom. A mold constructed from rolled wrought-iron or steel possesses a fibrous as distinguished from a crystalline structure, which for the purposes of my invention is important. Likewise for the purposes of cooling, which I am about to describe, it is necessary that the mold shall be made of comparatively thin plates of wrought-iron or steel. I have found that three-eighths of an inch is a desirable thickness for my purposes, and when I speak in the claims of a "comparatively thin plate" I refer to a plate which does not vary greatly from the thickness which I have given. These molds fit snugly within the mold-frames and are detachably secured therein, by which I mean that they rest in their frames securely enough to be held in place under all the ordinary exigencies of operation and yet are capable of being detached and removed from their frames without the aid of tools or other special parts and without stopping the machine. As I have shown the construction in the drawings, the removable molds are slipped into the frame at the open end, being retained in their place by small overhanging lugs *i i*, Figs. 7 and 8, formed upon the inner edge of the transverse ribs *h h'*. In order to further retain the molds in place even when the mold-frame is revolving with the shaft from which it depends, the longitudinal beam h^2, which has been likened to a keel, carries at its extremity a boss, through which runs an upright pin *i''*, which may be keyed in place at its lower end and which at its upper extremity carries a flanged bridge-piece *j*, formed with a central ridge and with overhanging lips at one end of each flange, under which the end of the mold fits snugly. The length of the molds is such that they entirely fill the space from frame to frame, so that the free end of the mold (which from the direction of rotation may be termed the "forward" end) abuts against the transverse piece *j* of the frame carrying the mold immediately in front of it. A depending stop K is fastened to the peripheral beam F in such relation to the mold-frame that the lower edge prevents the swing of the mold upward in the forward direction. At one point in the travel of the mold-frame as the table swings around the pinion *g'* comes in contact with a rack *l*, mounted on a fixed standard L, by means of which the mold-frame is swung around rear end first to an inverted position, so as to discharge its contents. Immediately, however, a second inverted rack *l'*, mounted upon the same standard L, engages the opposite side of the pinion *g'* and returns the mold-frame to its normal position.

Surrounding the edge of all but a comparatively small portion of the revolving table is an annular water-trough M, Fig. 3, in such position that the mold-frames travel within it during that portion of their rotation which is coincident with the trough. The water-trough occupies the greater part but not all of a circle. This construction I shall hereinafter refer to as a "partial annular water-trough."

It will be noticed that the ribs *h h'* of the mold-frames are made with large flaring webs. (Seen in Figs. 7 and 8.) The short portions of the trough M, which in Fig. 3 are lettered, respectively, *m*, *m'*, and m^2, are somewhat contracted and present in inner cross-section a shape closely corresponding to that of the outer edges of the webs of the ribs of the mold-frames. One of these contracted portions occupies either end of the trough, its shape being shown in section in Fig. 8. The remaining portions m^3 m^4 of the annular trough are of larger size, their cross-section being shown in Fig. 7. Water may be supplied to the trough at any convenient point or points, such as *n*. Below either end of the trough funnels *n' n²* carry off the escape, while overflows n^3 n^4 are provided, respectively, for the troughs m^3 m^4. These overflows are at different levels. n^3 is at the lower level, whereby the level of the water in the portion m^3 of the trough is maintained sufficiently low to reach only to the bottom of the series of molds passing through it, while the overflow n^4 is higher, maintaining the water in the portion m^4 of the trough at a level high enough to completely immerse the molds. The travel of the webs of the mold-frames in the direction of the arrow Fig. 3 acts somewhat as a continuous pump, particularly at the contracted portions *m m'* m^2, where the webs fit the trough somewhat closely. The exact tightness of this fit must be a matter of adjustment, depending upon the extent and position of the water-supply. At *m*, where the pumping effect is away from the open end, there is very little escape into the funnel *n'*. Through *m'* there should be sufficient escape to supply a liberal amount of water to the trough m^3 without, however, allowing it to rise much above the level of its overflow. Fig. 10 shows in longitudinal section the portion *m'* with the adjacent portions of m^3 and m^4, indicating approximately the water-levels therein. At m^2 there will necessarily be a large escape due to the pumping effect, to offset which the supply of water to the trough must be sufficiently abundant.

In Fig. 2 is shown in cross-section the base of a furnace having two iron notches *o*. The gutter O of the furnace bifurcates a short distance from the furnace, one of the branches *o' o'* leading to each of the iron notches. The entire gutter so formed is lined with sand.

The discharge end of the trough is turned so as to be tangent to the circle formed by the series of molds carried by the revolving table. To effectually control the flow of molten metal, the discharge end of the trough is provided with a hinged spout P, as seen in Fig. 11, the end of which may be raised or lowered by a drum and chain with gearing, regulating the flow of metal. The joint of this hinged spout is protected by a shield *p*, Figs. 13 and 14, which covers the gap occasioned by the hinge. This shield retains the sand in the trough and prevents leakage, while not interfering with flexibility. The lip of the spout is flanged, as seen at *p'*, in order to prevent the overrunning of the sand when the spout is lowered. Between the spout and the molds a funnel Q directs the flow of the molten metal, delivering it in the center line of the molds, and also prevents splattering.

The operation of the apparatus which I have described is as follows: The molten metal is discharged through either one of the iron notches into a branch of the gutter O. It is extremely desirable to have two points of possible discharge, as in case of unduly-rapid flow from or the chilling up of the one which is being used the other one may be opened, the first being stopped without interfering with the continuity of the casting operation. The rate of flow may be further accurately regulated by the hinged discharge-spout of the gutter. From this the metal is caused to flow evenly through the funnel Q into the molds which are passing successively beneath it by reason of the constant revolution of the table which carries them. By reason of the longitudinal succession of the molds with reference to the point of discharge the molten metal is fed evenly into the molds along their longest central line from end to end, so that the flow of metal does not persist continuously at any one point, but is gradual along the entire length of each mold. The transverse pieces *j* act as barriers to prevent the slopping over of the metal from one mold to another as the rotation proceeds, their central ridge accomplishing the even shedding of the metal into one or the other of two adjacent molds passing beneath the spout, and their flanged extremities preventing waste of the metal.

Cast-metal molds which have heretofore been used in continuous processes for casting pigs are highly objectionable and, owing to their crystalline structure, crack readily, especially if they are immersed in water when they are hot. The comparatively thin molds which I employ, of soft wrought-iron or low carbon steel, being soft and ductile, are not cracked even by such immersion; but as they are comparatively thin any continuous flow of molten metal at one point may melt through the mold. It is for this reason that the metal is fed successively along the length of the mold, and for the same reason the mold must be cooled as quickly as possible. Immediately, therefore, after filling the rotation of the table brings the mold beneath a fine spray of water *r*, chilling the ingot on the top, and at the same time as the mold-frame enters the trough *m* the water therein begins to chill the bottom of the mold and of its ingot. The mold passes through the entire length of the trough m^3, where the water is maintained at a uniform level of about two inches above the bottom of the ingot. After the bottom of the ingot is chilled the mold enters the trough m^4, where the entire ingot is immersed in water. The gradual cooling from the bottom of the mold up thus effected is a point of greatest importance. The sudden immersion of a molten ingot into water causes accidents and dangerous explosions, as is well known. By my device of a trough with water at varying levels I am able to gradually accomplish the chilling quickly enough to carry on a continuous operation, and yet not so quickly as to be dangerous to the workmen employed. After traversing the entire length of the trough the mold leaves the water and is instantly inverted by the rack-and-pinion mechanism, which has been above described, discharging the solid ingot into any convenient receptacle which may be there placed to receive it. An incline, the position of which is indicated by the dotted lines, Fig. 7, may be used to direct the fall of the ingot into its receptacle. Immediately the mold-frame is again righted in position by the pinion engaging the second rack. The mold next passes under a box *s*, from the lower end of which proceeds a discharge-trough *s'*. This box is filled with plumbago or other suitable carbonaceous material which is dusted into the mold in order to prevent the ingot from sticking. The plumbago-spout *s'* has a curved lower section, as seen in Fig. 5, directing the thicker coat of dust into the center of the mold. The relation of these parts is further shown in Fig. 6. A proper device may be provided for regulating the flow of the plumbago so as to measure off the requisite quantity. After dusting the frame holding the mold passes forward beneath the iron spout and is again filled with the molten metal, from which point the operation repeats itself. During all its course the molds are firmly held in position by the lugs and lip, which have been described. Should, however, undue heat melt or destroy one of the molds, it is a short and easy operation to slip another one into the mold-frame in place of the one destroyed.

It will be observed that the mold-frames by reason of their ribbed construction are sufficiently stiff and stable to prevent the mold which they contain from warping under the influence of the heat, so that the mold will always cool back into its proper shape.

The molds being comparatively light are inexpensive and, if destroyed, are readily replaced, the destruction of the mold having no effect upon the mold-frame. The point of discharge of the molten metal from the

spout is so arranged with reference to the rest of the device that even if overflow does occur or breaking of the mold into which pouring is going on the metal merely runs off on the ground without interfering with any of the machinery and also without possibility of falling into water, which is much worse. This advantage is obtained by making the water-trough in the shape of a partial annulus and conducting the pouring of the metal over that portion of the annulus where the trough is lacking. I have spoken of the advantage of delivering the metal longitudinally along the center of the mold as the latter advances. Coincident with this is the fact that the advance of the mold is in the same direction as the flow of metal from the spout, from which it results that the flow instead of plowing up the plumbago or other dust which has been sprinkled into the bottom of the mold tends to hold it down, thus saving the bottom.

The gradual immersion in the water, cooling first the bottom of the mold and ingot and afterward advancing so as to cover it, is of the highest importance. The central support of the table frees the entire periphery of the wheel from encumbrance with rollers or other machinery. This not only affords plenty of room for the water-trough, but is important for the reason that if any accident occurs at any part of the rotating system the hot metal does not injure anything except possibly the trough, and then merely falls upon the ground.

Having thus described my invention, I claim—

1. In an apparatus for casting pig metal, a series of molds made of a single plate of comparatively thin wrought-iron or steel; a series of mold-frames, consisting of metallic strips, conforming internally substantially to the shape of the mold, each of which contains one of said molds detachably secured therein; a spout from which molten metal may be fed; and a traversing device by which said mold-frames with the molds which they contain are carried in continuous series beneath said spout, substantially as described.

2. In an apparatus for casting pig metal, a series of molds each made of a single plate of comparatively thin rolled wrought-iron or steel; a spout from which molten metal is fed; a horizontal traversing device by which said molds are carried in continuous series beneath said spout; a trough of water or other cooling liquid in the path of said molds, and through which their further traverse carries them without variation of horizontal position; means for maintaining the water in that portion of the trough which the molds first enter at a lower level than that at which it is maintained in the rest of the trough, whereby during that portion of the traverse of the molds through the trough which first succeeds their reception of metal the bottoms of the molds only are immersed, while subsequently the entire molds with their contents are immersed, substantially as described.

3. In an apparatus for casting pig metal, the combination of a horizontal revolving table; a series of molds carried by the periphery of said table, and depending therefrom; a partial annular water-trough coextensive with all but a part of said revolving table; means for maintaining water in said trough at a level above the bottom of the molds; means for permitting free entry of the molds into the trough in a horizontal plane; and a spout from which molten metal is fed into said molds situated over that portion of the table where the trough is lacking, substantially as described.

4. In an apparatus for casting pig metal, a series of molds made of a single plate of comparatively thin wrought-iron or steel; a series of mold-frames, consisting of metallic strips, conforming internally substantially to the shape of the mold, each of which contains one of said molds detachably secured therein; a spout from which molten metal may be fed; a traversing device by which said mold-frames with the molds which they contain are carried in continuous series beneath said spout; and a trough of water or other cooling liquid in the path of said molds into which they pass after receiving metal from the spout, substantially as described.

5. In an apparatus for casting pig metal, the combination of a horizontal revolving table; a partial annular water-trough coincident with all but a part of the periphery of the revolving table; a series of mold-frames carried by the periphery of the revolving table and depending therefrom to a point below the level of the water in the trough; a series of molds each made of a single plate of comparatively thin rolled wrought-iron or steel, one of which fits within and is detachably secured to each of said mold-frames; a spout from which molten metal is fed into said molds situated over that portion of the periphery of the table where the trough is lacking; and means for maintaining the water in that portion of the trough which the molds first enter at a lower level than that at which it is maintained in the rest of the trough, whereby during that portion of the traverse of the molds through the trough which first succeeds their reception of the metal the bottoms of the molds only are immersed, while subsequently the mold and its entire contents are immersed, substantially as described.

6. In an apparatus for casting pig metal, the combination of a revolving table; a series of short shafts mounted radially thereto around the periphery of the table; pinions upon the inner ends of said shafts; a series of mold-frames with overhanging lugs upon their inner edges and carried upon the outer end of each of said shafts; a series of molds one of which is carried in and detachably secured to each mold-frame by the overhanging lug,

said overhanging lug being absent at one end of each mold-frame whereby the mold may be slipped in and out from that end; a spout for molten metal under which said molds pass in continuous succession; and two fixed racks which in the course of the rotation of the table successively engage each pinion, one above and the other below the pinion, the first inverting the mold and the second righting it by a reverse motion, substantially as described.

7. In an apparatus for casting pig metal, the combination of a revolving table; a series of short shafts mounted radially thereto around the periphery of the table; pinions upon the inner ends of said shafts; a series of mold-frames carried one upon the outer end of each of the shafts; overhanging lugs upon the inner edges of the mold-frames; a series of mold-frames one of which may be slipped in beneath the lugs of each mold-frame; a spout for molten metal under which the revolution of the table carries the mold-frames with their molds in continuous succession; and two fixed racks which successively engage each of the pinions, the first inverting and the second righting each mold in regular succession, substantially as described.

8. In an apparatus for casting pig metal, the combination of a horizontal traversing device; a series of depending molds carried thereby; a water-trough with open extremities within the path of said mold, through which the molds are successively carried by the traversing device, the open extremities of said trough having a conformation corresponding approximately to that of the molds; and means for continuously supplying water to said trough, substantially as described.

9. In an apparatus for casting pig metal, the combination of a horizontal traversing device; a series of depending mold-frames carried thereby and provided with projecting webs; molds carried by said mold-frames; a water-trough with open extremities within the path of said mold-frames, through which the mold-frames are successively carried by the traversing device, the open extremities of said trough having a conformation corresponding approximately to that of the webs of the mold-frames; and means for continuously supplying water to said trough, substantially as described.

10. In an apparatus for casting pig metal, the combination of a horizontal traversing device; a series of depending molds carried thereby; a water-trough divided into two parts within the path of said molds, and through which the molds are successively carried by the traversing device, the two portions of said trough being divided by a partial partition having a conformation corresponding approximately to that of the molds; and means for continuously maintaining a supply of water in both portions of said trough and at different levels, substantially as described.

11. In an apparatus for casting pig metal, the combination of a series of molds; a gutter for the delivery of molten metal; a hinged spout forming the discharge end of said gutter; a shield protecting the hinged joint between the gutter and the spout forbidding the passage of the molten metal therethrough, said shield and also the gutter and spout being covered with a sand lining; and a traversing device whereby the molds are carried in continuous succession beneath the delivery end of said spout, substantially as described.

12. In an apparatus for casting pig metal, the combination of a blast-furnace having two iron notches; a bifurcated gutter, one branch of which extends to each of the iron notches so that the delivery from each of the notches occurs from the same spout; a series of metal molds; and a traversing device whereby the said molds are carried beneath said spout in regularly-timed succession, substantially as described.

JOHN M. HARTMAN.

Witnesses:
JAMES H. BELL,
G. HERBERT JENKINS.