May 5, 1936. J. D. PUGH 2,039,738

METALLURGICAL FURNACE

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FIG. 1.

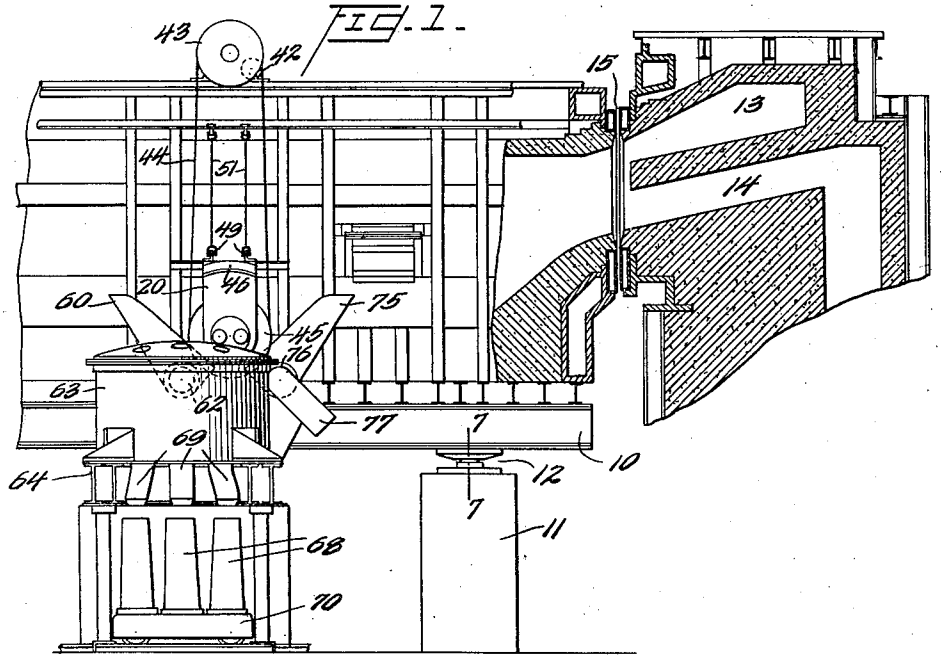
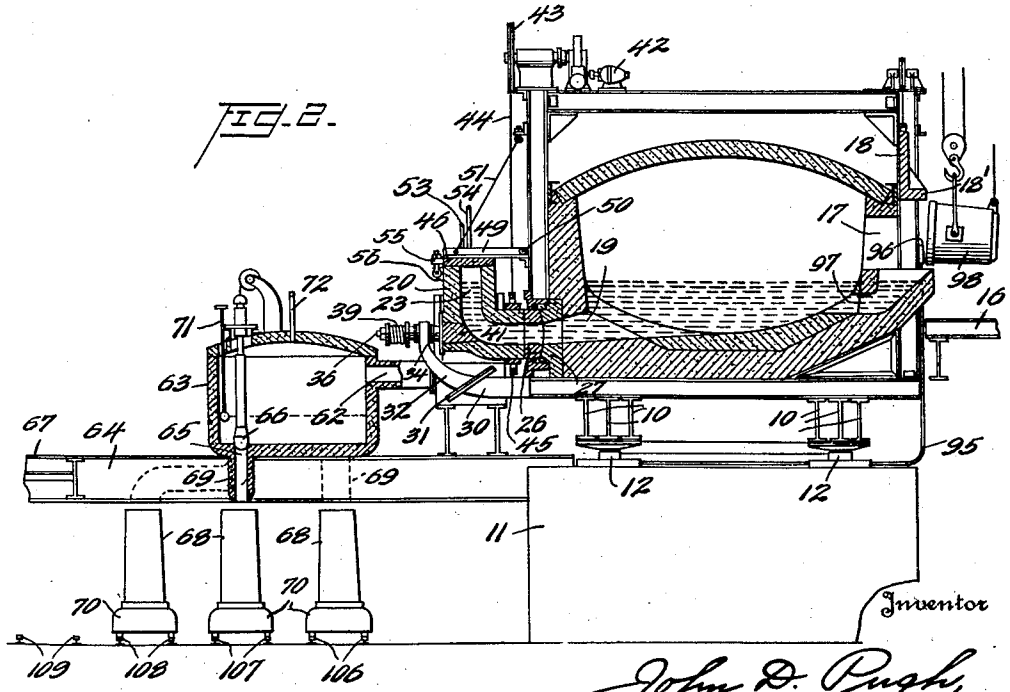


FIG. 2.



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METALLURGICAL FURNACE

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FIG. 3.

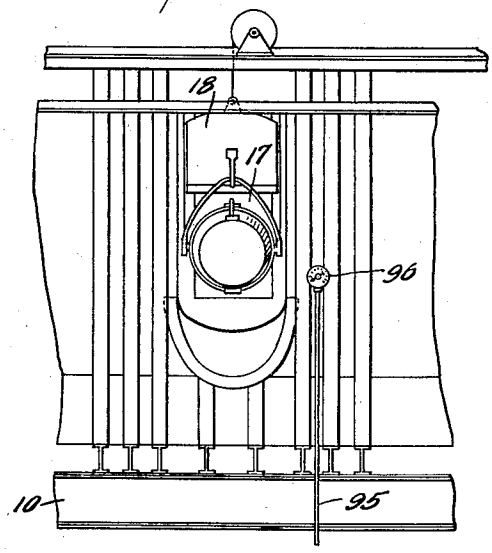


FIG. 5.

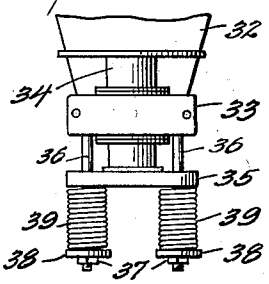


FIG. 6.

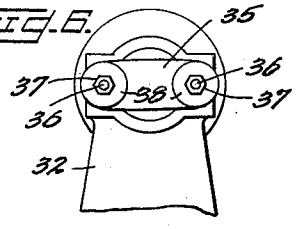


FIG. 4.

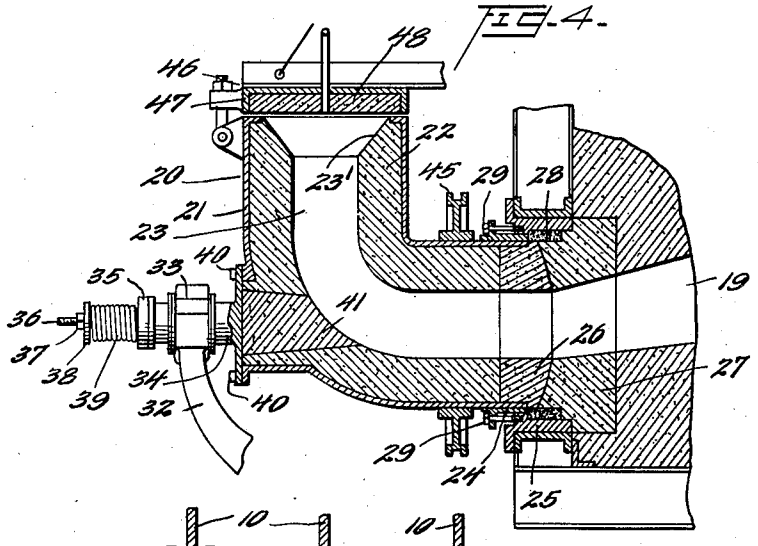
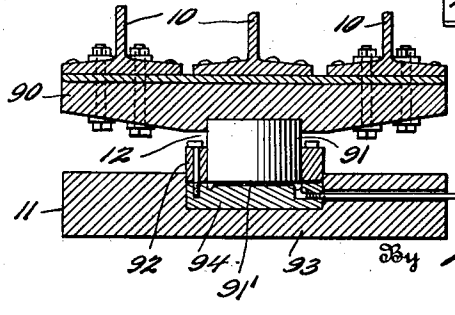


FIG. 7.



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METALLURGICAL FURNACE

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FIG. 9.

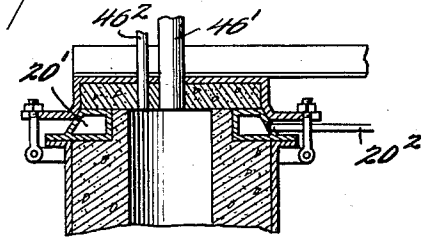
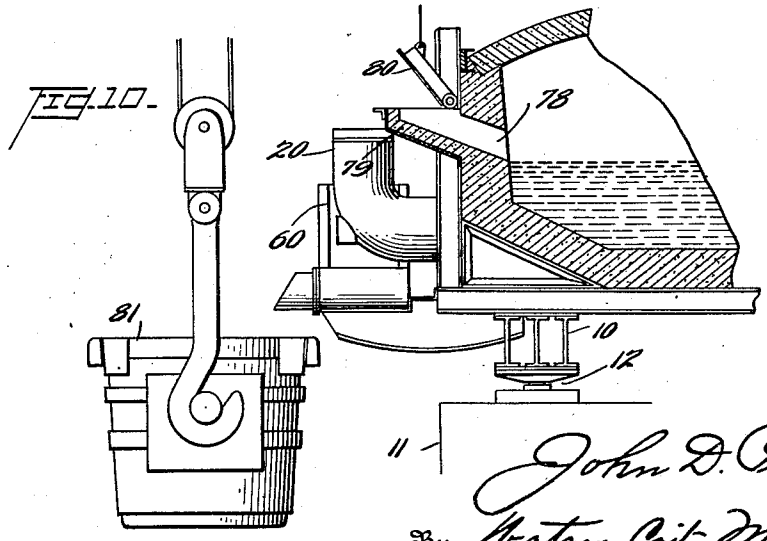


FIG. 8.

FIG. 10.



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METALLURGICAL FURNACE

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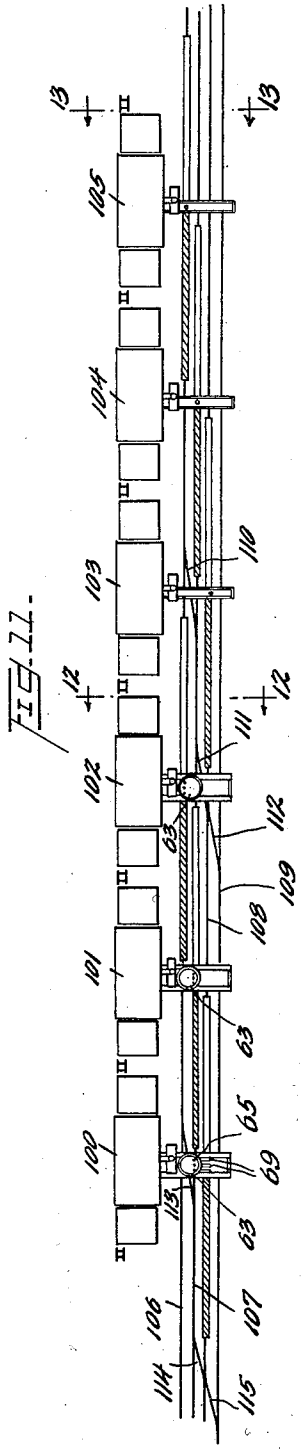


FIG. 11.

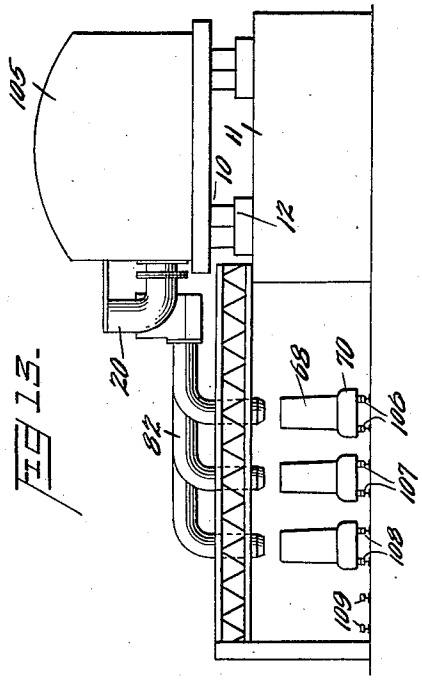


FIG. 13.

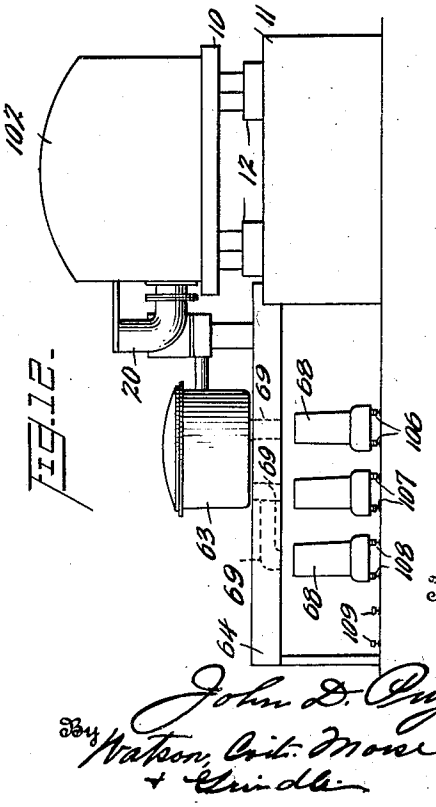


FIG. 12.

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Patented May 5, 1936 2,039,738

UNITED STATES PATENT OFFICE

2,039,738

METALLURGICAL FURNACE

John D. Pugh, Baltimore, Md.

Application May 3, 1933, Serial No. 669,251

6 Claims. (Cl. 266—13)

This invention relates to metallurgical furnaces and particularly to furnaces of the type primarily intended for the smelting and refining of metals.

One purpose of the invention is to improve upon the present methods of and means for effecting the discharge of the contents of a metallurgical furnace of the stationary type, after the solid metallic materials of the charge have been reduced to molten form and are in a refined and proper condition to be withdrawn and transferred to suitable molds, such as ingot molds.

It is now almost universal practice, and has been for many years, to provide metallurgical smelting furnaces with outlet orifices at or near their lowest points, which orifices are, during the time when the smelting operations are being carried out, closed with plugs of clay or other suitable refractory material. At the conclusion of the melting and refining operation carried out with respect to each successive charge introduced into the furnace, this discharge orifice or tap hole, as it is commonly called, is reamed out with suitable tools, the refractory plug being broken up and cleared away so that the liquid contents of the furnace may escape in a continuous stream, generally being conducted by means of an open runner to a mobile ladle having sufficient capacity to receive the entire charge of molten material held by the furnace. In such prior practice the charge flows continuously until the furnace is completely emptied of its contents.

In accordance with the present invention, the discharge conduit or tap hole of the furnace remains at all times clear and unblocked, and a novel device associated therewith, and adapted to be manipulated under the close control of the furnace operator, normally prevents the discharge of the molten contents of the furnace by causing the hydrostatic pressure tending to effect the escape of molten material through the tap hole to be exactly counterbalanced by the equal hydrostatic pressure of a column of molten material without the furnace and beyond the tap hole, the upper surface of which lies in the same horizontal plane as does the upper surface of the bath of molten material within the furnace. This means or device may be manipulated by the furnace operator so that the pressure of this counterbalancing body of molten material without the furnace may be made less than the pressure of the body of molten material within the furnace so that flow through the discharge aperture may occur, which flow may be caused to continue until the furnace is completely emptied of its contents or may be interrupted at any time after the desired amount of molten material has been withdrawn. In other words, there is substituted for the commonly used seal of refractory material a liquid seal which may be readily controlled in a manner not possible in the case of sealing devices heretofore designed or suggested.

The invention further contemplates an improvement in the means for and methods of casting into suitable units, such as ingots, the molten product of a smelting furnace, the furnace operator having means at his disposal to closely control at will the delivery of molten material into the molds, the improved mechanism also greatly expediting the process of casting or teeming.

A further purpose of the invention is to provide means for facilitating and improving upon the known methods of smelting furnace operation generally, especially to provide improved means for and methods of operating the well-known open hearth furnace, in which type of furnace the great bulk of the steel now commercially manufactured is smelted and refined.

The invention also contemplates improvements facilitating the operation of a battery of open hearth furnaces consisting of two or more such furnaces in close proximity, such batteries being commonly found in the larger steel plants of the country. Thus mechanism is provided by means of which it is possible to carry out at will, and without inconvenience or confusion, the simultaneous discharge of the contents of any number of furnaces comprising a battery and the ready removal to a finishing plant of the series of molds into which the molten contents of the furnaces have been discharged.

Other objects of the invention and important advantages resulting from its use will be apparent to one skilled in the art from an examination of the accompanying drawings, in which several embodiments of my invention are illustrated, and from the following detailed description, in which the several forms of the invention selected for illustration by way of example are specifically described.

In the drawings:

Figure 1 is a side elevation, partly broken away, of an open hearth furnace of well-known type, to which the invention has been applied;

Figure 2 is a transverse vertical section through the furnace at its mid-point;

Figure 3 is a side elevation of a portion of the furnace as viewed from the front;

Figure 4 is an enlarged vertical section taken

axially through the mechanism for effecting and controlling the discharge of the molten materials from the furnace, Figure 5 is a plan view of a portion of this mechanism, and Figure 6 is an end view of the same;

Figure 7 is a section on line 7—7 of Figure 1;

Figure 8 is a view generally similar to Figure 2, taken transversely through a furnace of the open hearth type but showing a modified form of means for controlling the discharge from the furnace and effecting the transference of the molten materials to suitable molds;

Figure 9 is an enlarged sectional view through a portion of this mechanism;

Figure 10 is a fragmentary sectional view through an open hearth furnace, again showing a somewhat modified type of discharge mechanism for the molten material;

Figure 11 is a rather diagrammatic plan view of a battery of open hearth furnaces showing the trackways along which the trains of molds are conducted to and from the furnaces in the ordinary operation of the steel plant;

Figure 12 is a section on line 12—12 of Figure 11; and

Figure 13 is a section on line 13—13 of Figure 11.

As has been before indicated, the invention relates or pertains to metallurgical smelting or refining furnaces generally, not being limited in its application in the industry to use in connection with an open hearth furnace. As one of its greatest fields of usefulness is in connection with open hearth furnaces, however, it is shown in the drawings as being applied to such a furnace. Again, the details of construction of the open hearth furnace may be widely varied, it being immaterial whether the furnace be gas-fired, oil-fired, or fired with powdered coal or the like. The details of the reverberatory lining, gas and air ports, buckstays, supporting plates, and other elements of the furnace are likewise immaterial.

The furnace shown rather diagrammatically in the drawings comprises the usual metallic supporting framework and the usual bottom, side walls, and roof of refractory material supported by this framework. The hearth or combustion or refining chamber of the furnace, however, is separated from the furnace ends, as shown, and the weight of the refining chamber is transmitted to the ground or supporting base by means which permits the operator to weigh the contents of the metallic charge which forms the bath, for purposes hereinafter to be made clear.

Thus, as will be apparent from an inspection of Figures 1 and 2 of the drawings, the entire weight of the central portion or refining chamber of the furnace is carried by six longitudinally extending I-beams, indicated at 10, these I-beams being arranged in two groups of three beams each. The weight of this portion of the furnace is in turn transmitted to transversely extending supporting pedestals 11 through hydraulic weighing devices, of which there are four, generally indicated at 12, and the details of which will be hereinafter specifically described. The furnace ends, comprising the usual uptakes, air and gas ports 13 and 14 respectively, water cooling devices, etc., are separately supported upon the ground or base, and no part of the weight of the materials used in the construction of these end portions is transmitted to the supporting bases 11. The furnace ends, of which there are two, are spaced from the ends of the combustion or refining chamber, one of the narrow separating transverse vertical slots or spaces being indicated at 15, it being understood that the furnace in its entirety is preferably symmetrical with respect to its transverse central vertical plane, the furnace end which is not illustrated being preferably the same in design as that which is shown and being also formed separately and spaced from the opposite end of the refining chamber in the same manner that the furnace end actually illustrated is so spaced.

A portion of the charging floor is indicated at 16, the central opening in the side wall provided for charging the furnace and inspecting the interior thereof is indicated at 17, and the vertically slidable door for the opening 17 is indicated at 18. The discharge orifice for the molten material is preferably positioned directly opposite the central charging aperture 17, this discharge orifice, which is indicated at 19, comprising an elongated aperture formed in the refractory bottom lining and lateral brick wall of the furnace, inclining downwardly and outwardly from the bath so that at the proper time, when this aperture is unsealed, the entire contents of the bath may, if desired, be allowed to escape from the refining chamber. This discharge aperture 19 is commonly termed the "tap hole", and it has heretofore been conventional practice to plug this hole with clay or other suitable refractory material prior to the time when the furnace is charged and fired and to remove this refractory plug by suitable instruments after the metallic ingredients of the charge have been reduced to molten condition and suitably refined, so that the contents of the bath are ready to be discharged from the furnace. In accordance with prior practice, the entire bath is allowed to escape once the refractory plug has been moved, being caught and retained by a large casting ladle having a capacity sufficiently great to receive this large amount of metal.

In accordance with the present invention, means is provided for effecting a liquid seal of the tap hole 19, this means comprising essentially a spout-like member 20 which, when turned in one direction or as shown in Figures 1 and 2, maintains in its hollow interior a body of molten material of such height as to develop a static pressure at the tap hole equal to the static pressure of the liquid of the bath. As can be seen most clearly from an inspection of Figure 4, member 20 is generally tubular, having a horizontal portion and a portion disposed at right angles thereto. It comprises a metallic shell indicated at 21 heavily lined with a suitable refractory material indicated at 22, the actual discharge conduit for the molten materials being a central channel 23 of circular cross section and extending from end to end thereof, the outer end of this channel being flared as shown at 23'.

The inner end of member 20 is rotatably supported within a short cylindrical collar 24 which is in turn mounted within a ring 25 rigidly supported by the framework of the furnace. The refractory lining 22 terminates, at the inner end of the spout 20, in a flat annular surface, and tightly abutting against this surface and extending beyond the end of the shell 21 is an annular member or block 26 formed of smooth, dense, refractory material such as graphite, the opposite end surface of this block being spherical. Refractory block 26 moves with the spout 20 when the spout revolves about the horizontal axis of the supporting ring 24. Rigidly supported by the furnace structure is a second block 27 of graphite

or like dense and smooth refractory material, block 27 being centrally apertured as shown, this central aperture comprising in fact a continuation of the tap hole 19, and the outer end of this central aperture being in register with the central aperture in the rotatable block 26. The outer surface of block 27 is annular and spherical, being concave so as to fit tightly against the adjacent surface of block 26. Blocks 26 and 27 are so formed with respect to the supporting ring 25 that these members define, in conjunction with the aforementioned ring, an annular pocket, indicated at 28, which pocket is filled with a smooth, refractory, pulverulent material such as powdered graphite. The annular collar 24 is secured to ring 25 by a plurality of bolts 29, which bolts may be adjusted from time to time when found necessary to move collar 24 toward and partially into the pocket 28 so as to place the pulverulent material contained in this pocket under suitable compression. It is the function of the compressed pulverulent material to prevent leakage of molten metal past the abutting surfaces of blocks 26 and 27.

A supporting bracket 30 rigid with the framework of the furnace chamber has detachably affixed thereto at 31 an extension 32 which projects outwardly and upwardly, supporting at its upper end a bearing 33 disposed coaxially with the horizontal axis of the spout 20 and adapted to rotatably support a trunnion member 34 rigidly attached to the shell 21 of the spout. Bearing against the outer end of trunnion member 34 is a transverse plate 35 apertured to slidably receive spaced parallel bolts 36, the inner ends of which are connected to bearing block 33 and the outer ends of which are threaded and provided with adjusting nuts 37 which define the positions respectively of circular spring abutments 38, between which and the transverse member 35 are confined the coiled compression springs 39. It is the function of these springs to exert an inward axial pressure on trunnion 34 which constantly urges the inner surface of refractory block 26 into close contact with the outer surface of block 27, thus preventing leakage of molten metal past the abutting surfaces of these blocks. Trunnion 34 is detachably secured to the shell 21 of the spout by bolts 40, and the inner end of the trunnion member likewise confines in position a tapered plug 41 of refractory material, which in reality forms a portion of the refractory lining 22 of the spout.

From the above description it will be clear that the weight of the spout is carried in part by the ring 24 supported by the furnace structure and in part by the bearing block 33 which is coaxial with ring 24, and that therefore the spout may be revolved about its horizontal axis through a wide angle in either direction of rotation from its vertical position, as shown in the drawings. In order to effect the rotation of this spout by power, a motor 42 is mounted upon the top framework of the furnace chamber, which motor, through suitable reduction gearing, operates a pulley or sheave 43. A suitable cable, wire rope, or sprocket chain 44 passing over sheave 43 also passes around the grooved pulley wheel (or sprocket) 45 rigidly mounted upon the horizontally extending portion of the spout. The motor 42 is preferably of the type which may be rotated in either direction so that, by the proper energization of this motor, the spout may be rotated to desired position.

Normally, that is, while the furnace is in operation with a charge on the hearth, either reduced to molten condition or in process of such reduction, the spout is disposed as shown in Figures 1 and 2 of the drawings, in which position it holds and sustains a column of molten material, the level of the upper surface of which is in the same horizontal plane as the level of the upper surface of the bath contained within the refining chamber of the furnace. The two bodies of liquid are then in hydrostatic balance at the tap hole, and there is no flow through this discharge orifice. During this time it is generally desirable to have above the open upper end of the spout a cover to prevent undue radiation of heat, which might result in the freezing of the upper surface of the molten material in the spout, that is, in the formation of a "scull." Such a closure is indicated at 46 and, as shown, comprises a downwardly facing flanged metallic disc 47 lined with refractory material 48, the disc being rigidly secured to a member 49 having one end fastened at 50 to the furnace frame and its other end supported therefrom by means of a cable 51. If desired, means is associated with the cover 46 for conducting fuel and air therethrough, such, for instance, as conduits 53 and 54, so that a flame may be maintained below the cover and above the upper surface of the liquid standing in the spout, for the purpose of imparting additional heat to this liquid to prevent its hardening.

The cover likewise comprises a support for the spout when it is desired to remove the plug 41 for the purpose of cleaning the spout and tap hole. Thus a socket 55 for a bolt or similar means is attached to the cover, and a second socket or bolt retaining device 56 is attached to the spout near the outer end thereof. By connecting the sockets or brackets 55 and 56 by bolts or attaching devices, the weight of the outer end of the spout may be transmitted to the cover and thence to the frame of the furnace through the supporting cable 51 so that it is then possible for the operator to remove the detachable supporting bracket 32, trunnion 34, and refractory plug 41, so that free access may be had to the interior of the horizontal portion of the spout and the tap hole of the furnace proper.

In certain instances it may be desired to utilize the pouring spout and tap hole as a channel for the introduction of air or other gas into the bath in order to agitate or refine the same. In such case, the mouth of the spout is preferably formed as shown in Figures 8 and 9, with a tapered outer end surface, and the cover is provided with a correspondingly tapered surface to fit tightly against the same so that the cover forms a substantially air-tight closure. Air or other gas may be introduced by means of a pipe 46' under such pressure as to insure its passage through the spout and tap hole into the bath, through which it will rise. The introduction of compressed air in this manner will result in the oxidation of some of the molten contents of the bath, and the heat thus generated will counteract any tendency of the metal to "freeze" in the tap hole, thus keeping it open by means under the control of the operator. Again, it may be desired to maintain a heating flame within the upper end of the spout above the surface of the molten material therein, in which event a conduit 46^2 for gaseous fuel may extend through the cover. Where the spout is thus heated, it is preferably water-cooled, as by an annular cooling water chamber 20' connected to a source of water supply by a flexible hose 20^2.

A suitable aperture for the escape of products of combustion will, of course, be provided.

The spout 20 may be revolved in either direction of rotation by the power means previously described, and, when it is desired to deliver molten material to ingot molds, for instance, the spout is rotated to the left (Figure 1), or in a counter-clockwise direction, so that its delivery end is lowered below the level of the upper surface of the bath, thus causing a flow of metal through the tap hole and spout. This metal is delivered over the lower edge of the mouth of the spout into an inclined runner indicated at 60, the molten metal delivered in this manner into the runner flowing downwardly to its lowest point and thence being transmitted by means of the substantially horizontal tubular runner 62 into the interior of a stationary pouring ladle, indicated at 63. Both the runners 60 and 62 and the ladle 63 are supported upon a suitable bridge-like framework, generally indicated at 64, beneath which are positioned the trackways along which the ingot mold supporting cars may be moved. Ladle 63 is preferably provided with three discharge apertures in its bottom, one of which is indicated at 65, the flow through each of these apertures being controlled by any well-known or suitable valve device 66, operable from the top of ladle 63, or from a distant point, as from the platform 67 upon which an operator may stand and from which position he is able to look into the top of an ingot mold, indicated at 68, positioned below aperture 65, and hence to control the discharge of molten materials in such manner that the ingot mold may be filled but not caused to overflow. The tubular member 69 guides the downwardly flowing stream of molten material to the immediate proximity of the mouth of the mold. Each of the mold cars 70 supports three ingot molds 68, and the three pouring apertures in the bottom of ladle 63 are located so as to be as nearly as possible directly above the molds. Any misalignment between the pouring orifices and the mold mouths may be compensated for by inclining the several tubular members 69, as shown in Figure 1.

Ladle 63 may have any desired capacity but preferably is not required to receive the entire contents of the bath and is therefore preferably constructed so as to have relatively small capacity, as shown. It is provided principally for the purpose of making it possible to conveniently fill a plurality of ingot molds with molten material simultaneously, and other means for accomplishing this same purpose may be provided, if desired. A pouring ladle such as indicated at 63 is preferable, however, since it provides a substantial reservoir of molten material, in a relatively quiescent state, immediately above the molds, thus insuring that the pouring operation is conducted in a steady and rapid manner. It also provides a chamber for the introduction of recarburizing material through 68 to supplement or substitute such operation in the furnace. An indicator 71 is provided for the convenience of the operator upon platform 67, this indicator having a float which rests upon the surface of the liquid within the ladle 63 and showing the operator how much liquid is contained therein at any time. For the purpose of maintaining a heating flame within ladle 63, either when the container is empty or partially full, its roof is perforated for the admission of a fuel pipe 72, by means of which, for instance, a combustible gas may be discharged into the upper part of the ladle. If necessary, passages for air and products of combustion may also be formed in the ladle roof. The flow of molten material to the ladle, of course, is accurately controlled by the manipulation of the pouring spout 20.

A second inclined runner, located to the right of the pouring spout, is indicated at 75 in Figure 1, this runner having communicating with its lowest point a horizontal tubular runner 76 for conducting molten materials in a generally horizontal direction to a downwardly directed delivery spout 77. In the event that it is desirable to discharge all or any portion of the bath into a ladle of the mobile type, such ladle may be placed beneath the discharge orifice of conduit 77, the pouring spout rotated in a clockwise direction (Figure 1), and the desired amount of molten material withdrawn from the bath in this manner. By the proper manipulation of the spout, slag may be diverted to a mobile ladle for disposal and metal only caused to flow to the pouring ladle 63. Likewise it is possible to remove that portion of the bath which lies at the general elevation of the tap hole, discharge it into a mobile ladle, and then pour it back into the bath for further refinement through an aperture in the furnace wall provided for that purpose, this aperture being indicated at 78 in Figure 10 and the furnace being provided exteriorly with an inclined lip or trough-like extension 79, normally closed by a tilting cover 80 for guiding the molten material discharged from a ladle, such as that indicated at 81, through the furnace wall and into the bath. By the means just described, it is possible to secure a more thorough intermixture of the metallic ingredients of the bath than can normally be obtained.

In certain instances it may be desirable to omit the relatively large pouring ladle 63, and in this event the inclined runner 60 may lead the discharged metal to a horizontal tubular runner 82 which has a downturned end 82' terminating in a discharge port 82^2 positioned immediately above the upper end of a mold or above the open mouth of a ladle such as shown at 81 in Figure 10. Flow through the runner 82 is controlled by means of a valve 83 of any well-known type, which valve is manipulated by means of a rod or tube 84, protected with refractory material, which projects through the wall of tube 82 and to the end of which may be connected a cable such as indicated at 85. If desired, the runner 82 may be branched so as to have a plurality of downwardly projecting metal delivering ends so that it is possible to deliver molten metal to each of two or three ingot molds simultaneously. Generally, however, I provide in connection with each furnace a single runner 82, thus necessitating filling one mold at a time. The pouring spout and furnace of Figure 8 may be identical with those shown in Figures 1 and 2.

I have previously explained that the entire weight of the furnace combustion chamber, pouring spout, and charge held in the furnace is transmitted to the base through four devices, generally indicated at 12, and by means of which the weight of the furnace and bath may be determined. One of these devices 12 is shown in section in Figure 7. The several beams 18 are bolted to a rectangular member 90 to which is centrally affixed a plunger 91. Plunger 91 is shaped as a short cylinder and slidably fits within a ring 92 supported upon a rectangular block 93 resting upon base 11. Ring 92 is tightly bolted to a circular disc-like member 94. Immediately below

the plunger 91 is a flexible diaphragm 91', the margins of which are tightly clamped between ring 92 and disc 94, a small quantity of fluid being trapped between the diaphragm and disc 94. This fluid may conveniently be glycerin, and a pipe or conduit 95 provides the sole means of ingress of glycerin into the chamber below the diaphragm and the sole means of escape therefrom.

The several fluid pressure chambers, of which there are four, are brought into communication with an indicating gauge by pipe connections, not illustrated, such gauge, however, being shown at 96 in Figure 3. The gauge is so calibrated as to indicate the weight of the furnace and its contents in any suitable units of weight. For a complete description of the details of the indicator and the scale system in general, reference may be had to my prior Patent No. 1,579,658, granted April 6, 1926. It need only be said here that, after the weight of the furnace structure itself has been determined by the operator, he can without difficulty determine with exactness the weight of the charge on the hearth and may know at all times how much metal is in the furnace. The indicator, therefore, is of assistance in the event that it is desired to operate the furnace in a continuous manner rather than by the batch method, since the operator is able to replace any quantity of metal withdrawn by the exact amount of fresh metal.

By means of the novel pouring mechanism described, therefore, it is possible to operate a stationary furnace so as to realize all of the advantages to be derived from the use of a tilting furnace, without at the same time having the complicated structure of the tilting furnace. I also preferably provide the furnace with an aperture in the side wall, in this instance placed directly opposite the tap hole, for the introduction of molten material. This aperture is indicated at 97 and may be conveniently positioned directly below the charging aperture 17 so that its upper end may be closed by a horizontal projection 18' of door 18 when this door is lowered into position to close the charging opening 17. When the door is raised, molten material may be introduced into the bath below the surface thereof for the purpose of replenishing the supply of molten material to be refined or for recarburization purposes. A conduit such as shown at 97 is particularly useful for carrying out recarburization processes since the recarburizing metal may be directly introduced into the main body of the metal on the hearth without passing through the layer of slag always present on the surface of the metal. A small mobile ladle is indicated at 98 and is shown to be in position to discharge liquid into the upper end of the channel 97.

Referring now to Figures 11, 12, and 13. Here a battery or six furnaces is illustrated, these furnaces being placed end to end and in what may be designated axial alignment, as is customary practice in steel plants of substantial size. The three left-hand furnaces indicated at 100, 101, and 102 are provided with discharge controlling spouts, such as shown in Figures 1, 2, and 4, and also with stationary pouring ladles 63, such as illustrated in Figures 1 and 2. The three right-hand furnaces 103, 104, and 105 are provided with pouring spouts and with runners of the type shown in Figure 8 of the drawings, pouring ladles such as 63 being omitted. Four separate trackways for trains of mold cars are indicated at 106, 107, 108, and 109 respectively, cross-overs for these trackways being indicated at 110, 111, 112, 113, 114, and 115, by means of which the trains of mold cars may be moved from track to track. On each of trackways 106, 107, and 108 are shown diagrammatically two trains of mold cars, six trains in all or one for each furnace, with each train located at the pouring mechanism of the adjacent furnace in two different positions. The train extended to the left (cross-hatched) indicates its position after molds are filled and before departure to the finishing mills. The position of the same train prior to filling of the molds is shown at the right (not cross-hatched). The length of the train and spacing of the furnaces are adapted to permit a complete train to extend from the pouring apparatus without blocking free movement of other trains on cross-overs between adjacent tracks.

The pouring apertures of ladles 63 of furnaces 100, 101, and 102 are indicated diagrammatically by dots 65, and it will be seen that the pouring apertures of the ladles 63 associated with furnaces 101 and 102 are positioned so as to overlie respectively trackways 106 and 107 so that the contents of these ladles may be discharged vertically downwardly into the ladles passing below. In the case of ladles 63 of furnace 100, the tubular guides 68 associated with the discharge apertures are downwardly and outwardly inclined so that the discharge ports of these tubes overlie trackway 108 or, in other words, are in position to conduct metal to the ingot molds supported on cars moving along this trackway. In Figure 2 of the drawings, one of these downwardly and outwardly curved tubes 68 is indicated in dotted lines. In the case of furnaces 103, 104, and 105, metal runners 82 differ in length so that the discharge ports 82^2 of these members overlie respectively the several tracks 106, 107, and 108, as will be apparent from an inspection of Figures 11 and 13.

By an arrangement of molten metal discharge and pouring devices such as described, and with an arrangement of trackways and switches such as set forth, it is possible to completely discharge the contents of all six furnaces of the battery simultaneously into molds and also to remove any one of the several trains from the proximity of the furnace without necessitating the removal or shifting of any other train. This follows from the use of the various cross-overs shown and from the use of the single running track, indicated at 109. From an inspection of Figure 11, it can readily be seen that any one of the trains may be removed to the running track by moving it over the proper switches without conflict with any other train. It is, of course, true that in no case will six furnaces of a battery be simultaneously tapped, but nevertheless it is highly desirable that the pouring devices of a battery be so organized and the trackways so arranged that any two or three of them, or even more, may be simultaneously tapped should by any chance the necessity for doing so ever arise. This is particularly true where it is intended that the furnaces shall be operated in a continuous manner.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A stationary metallurgical furnace comprising a hearth provided with a constantly open discharge port or tap hole formed in the wall thereof at its lowest point, and movable means effective at said port and positioned exteriorly of the fur-

nace wall for controlling the flow of molten material through said port.

2. A container for molten materials having a constantly open discharge port or tap hole formed in the wall thereof at its lowest point, the discharge end of the tap hole being encircled by a portion of the container having an outwardly facing annular surface, a pouring spout supported exteriorly of said container, one end of which has an annular surface in contact with the annular surface of the container, said spout being rotatable about the common axis of said contacting annular surfaces so that the opposite end may be moved to a position above or below the level of the surface of the metal in the container, as desired, and resilient means constantly acting on the spout and urging the annular surface thereof into close contact with the annular surface of the container.

3. A metallurgical furnace comprising a hearth, a mold positioned laterally of and below the hearth, and means stationary with respect to the furnace and mold for permitting the outflow from said furnace of a measured portion of the molten contents thereof and conducting the same to said mold.

4. A metallurgical furnace comprising a hearth, a mold positioned laterally of and below the hearth, said mold having less capacity than the hearth, a pouring spout permanently associated with the furnace and adjustable relatively thereto to initiate or interrupt flow of molten material from the bath upon the hearth at the will of the operator, and means for delivering molten material issuing from said spout to said mold, by gravity.

5. In combination, a metallurgical furnace having a chamber for retaining a body of molten metal, said chamber having a constantly open discharge port in its wall, a pouring ladle fixed with respect to the furnace, and means for conducting molten metal from the furnace discharge port to the pouring ladle including an adjustable conduit for the molten metal which may be moved to metal pouring or flow interrupting position as desired, whereby measured quantities of molten metal may be withdrawn from the furnace at desired intervals.

6. A metallurgical furnace comprising a hearth, a mold positioned laterally of and below the hearth and having a capacity less than that of the hearth, and a movable flow regulating device permanently associated with the furnace for controlling the escape of molten metal therefrom and for conducting such metal to the mold, whereby a measured volume of molten metal may be allowed to flow from the furnace to the mold by gravity and the remainder confined within the furnace.

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