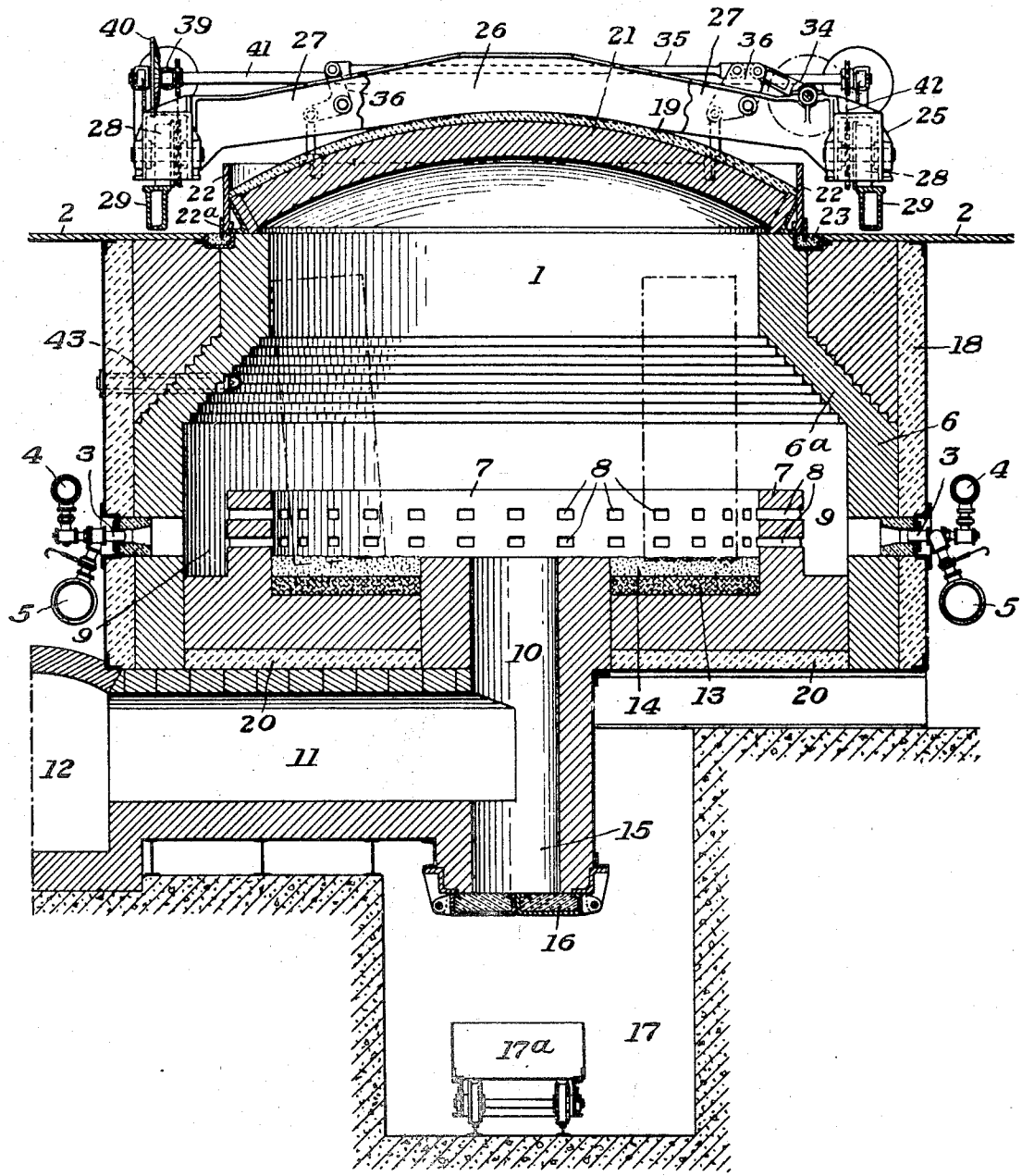
Aug. 25, 1936. M. H. MAWHINNEY ET AL 2,052,187

METHOD AND APPARATUS FOR HEAT TREATING INGOTS

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Fig. 1.



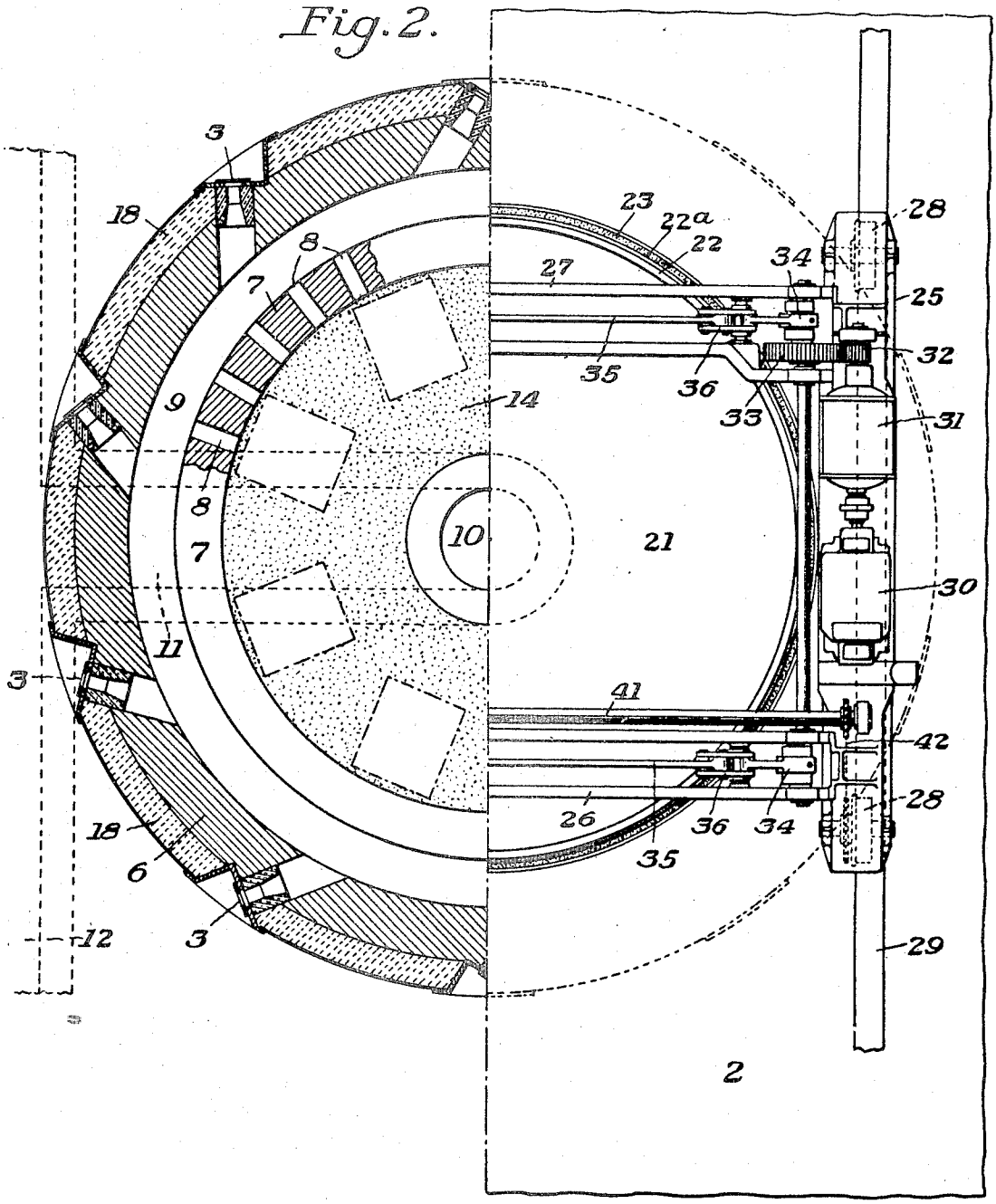
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Fig. 2.



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METHOD AND APPARATUS FOR HEAT TREATING INGOTS

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Fig. 3.

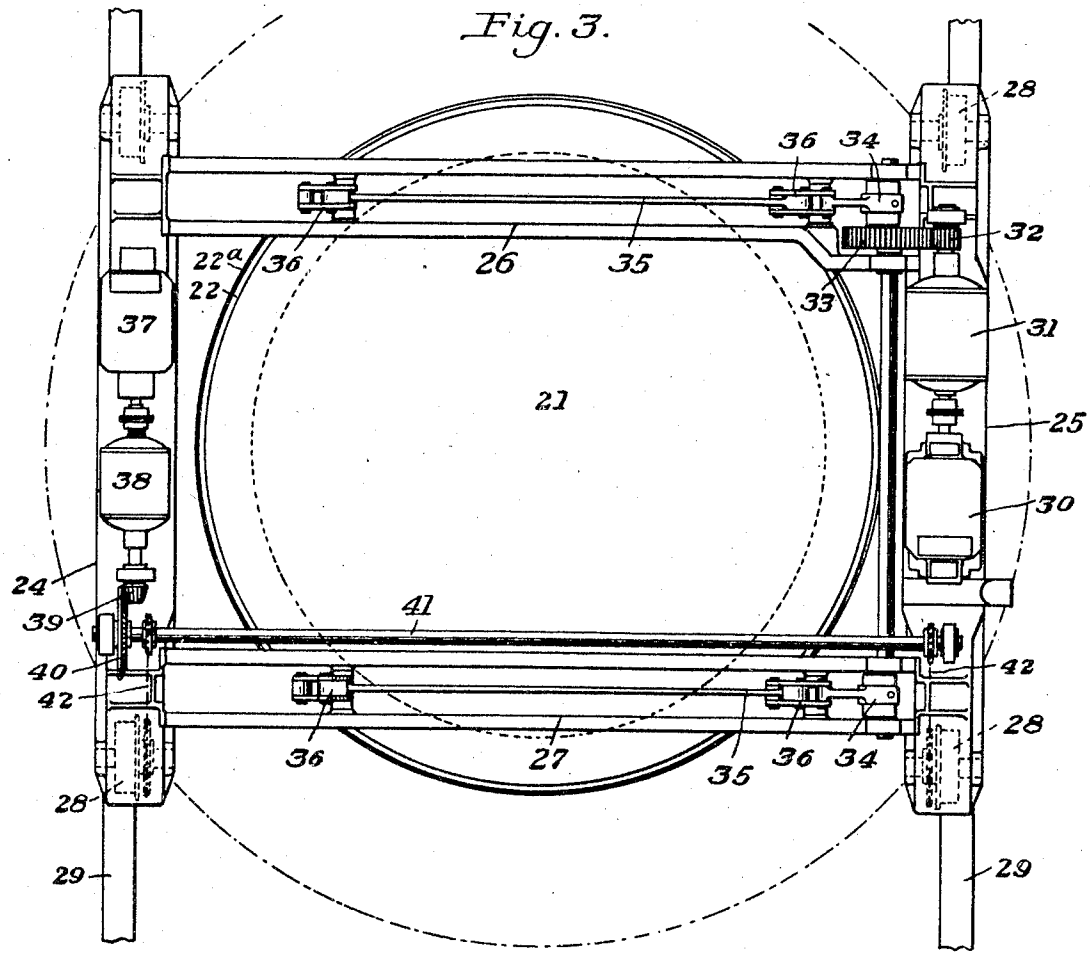
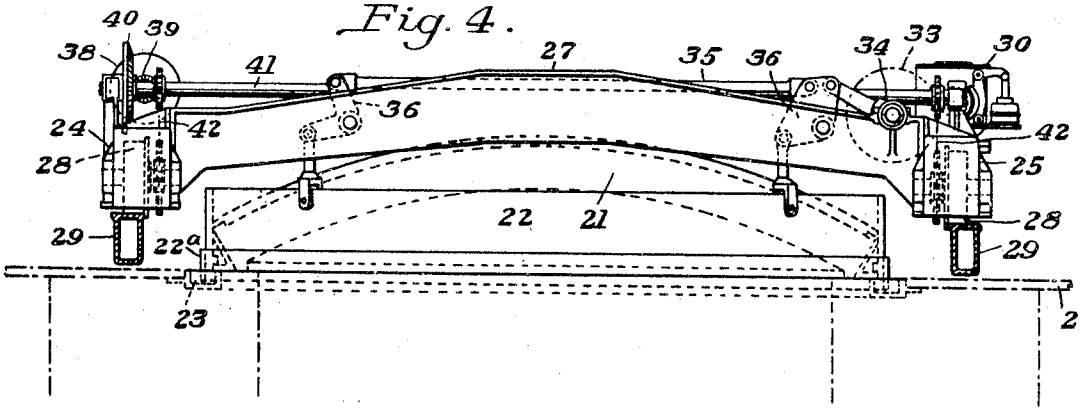


Fig. 4.



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METHOD AND APPARATUS FOR HEAT TREATING INGOTS

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Application July 16, 1935, Serial No. 31,594

17 Claims. (Cl. 263—43)

Our invention relates to ingot heating furnaces to replace the type commonly termed "soaking pits", and to a method of heating ingots. Such furnaces are used in steel mills for the purpose of bringing ingots to the proper temperature for rolling. The ingots may be placed in the furnace only a short time after being cast and so while still at a relatively high temperature; or they may be charged cold. Thus, the furnace must serve the purpose either of heating the ingots to rolling temperature or of merely causing them to come to uniformity at the desired temperature.

In the United States the soaking pits have been generally of two types, i. e., either the standard regenerative pit or the so-called one-way fired pit. In the one-way fired pit the firing is unidirectional, the fuel, air and products of combustion entering at the top. Such a pit is usually equipped with a recuperator, which is a heat exchange apparatus in which heat from the waste gases is used for preheating the cold combustion air or in some cases both the air and fuel gas. In the case of the regenerative pit, there are two sets of passages communicating with the pit so arranged that at a given time fuel and air enter through one set of passages and the waste gases are led out by the others through a regenerator or regenerators containing refractory structure, which is thereby highly heated. At the proper time the flow is reversed and the heated refractory structure gives up its heat to the incoming air or air and gas.

In all of these soaking pits the results obtained are greatly dependent upon the skill of the operator and, even with the most careful operation, cannot be termed satisfactory. The two objectives sought to be accomplished: first, the uniform heating of each single ingot throughout its mass and, second, the heating of all ingots accurately to the desired rolling temperature; are both difficult of attainment because of the methods of firing used. In a furnace of rectangular shape the different ingots are unavoidably exposed differently relative to the path of flame and to radiating walls, with the invariable result that some are either underheated or overheated. Furthermore, as a result of non-uniform temperature at different levels, it is usual to find temperature differences as high as 100° to 200° F. from top to bottom of the same ingot.

By our invention we overcome these and other difficulties, provide uniform heating throughout the mass of ingots, expose each ingot to the same heating effect as every other, provide an improved furnace structure, permit the maintenance of a reducing flame when desired, economize fuel, and allow ingots to be heated under such predetermined program as may be desired.

In the accompanying drawings which illustrate one embodiment of our invention,

Figure 1 is a vertical sectional view;

Figure 2 is a plan view partly in horizontal section;

Figure 3 is a plan view; and

Figure 4 is an end elevation of the cover and actuating mechanism therefor.

In the drawings, we show a preferred form of apparatus for carrying out our invention. The furnace is preferably of circular form, with chamber 1 located below the level of the operating floor 2. Burners 3 are disposed in a row about the periphery of the chamber near the bottom. These burners are preferably not directed radially, but rather tangentially, into the chamber. These burners may be connected to separate gas and air lines 4 and 5 or may utilize premixed gas and air from any of the usual premixing devices. They may also be arranged for the burning of oil if desired.

A feature of the invention is that the diameter of the chamber at the bottom is made larger than the diameter at the top by corbelling of the wall 6 of the circular chamber as indicated at 6a. This arrangement provides a combustion space for the combustion of the gas or oil issuing from each of the several burners around the periphery.

In the illustrated embodiment of the invention, a circular baffle wall 7 provided with two rows of openings 8 is disposed within the chamber 1 spaced from the side wall 6 so as to provide an annular chamber 9 within which the streams of burning fuel and products of combustion circulate. This baffle wall protects the ingots in the furnace from the burner flame and aids in causing circulation of the products of combustion. It may, however, be omitted since the tangential arrangement of the burners prevents direct impingement of the flame on the ingots.

An outlet flue 10 in the bottom of the furnace, preferably at center, communicates by suitable passages 11 and 12 with a stack or other suitable means for disposing of waste gases. Between the flue 10 and the baffle wall 7 the floor of the chamber is in the form of an annular shelf with the outlet flue 10 at the center. This portion of the furnace bottom may embody a layer 13 of material highly conductive to heat, such as rammed chrome ore, which may in turn be covered by a layer 14 of granular material. This granular

material may be "coke breeze", as is customary in soaking pits, or it may be crushed refractory material, which may be advantageous through the avoidance of contamination of the steel from the impurities contained in the coke. In addition, the slagging action of the ash in the coke will be avoided. The principal function of this layer is to provide the proper support of unevenly shaped ingot bottoms.

The outlet flue 10 terminates at the bottom in a slag pit 15 equipped with swinging covers or doors 16 to normally close the end of the flue 10 but to permit the removal of slag when desired. In the tunnel 17 in the foundation, provided for the removal of slag, a slag car 17a may be used or simply wheelbarrows, as desired.

The furnace is preferably insulated to prevent waste of heat by layers of insulating material 18, 19 and 20, in the sides, top and bottom, respectively.

The cover 21 is preferably circular in shape, enclosed within a cover ring 22. The cover is provided with a sand seal flange 22a which, when the cover is in place, enters a sand seal trough 23 in the top of the furnace.

For the purpose of opening the furnace for placing or removal of ingots, we provide a cover mechanism as best shown in Figures 3 and 4. This mechanism includes trucks 24, 25 and cross beams 26, 27. The trucks are provided with wheels 28 adapted to run upon rails 29. For the purpose of lifting the cover so as to withdraw the sand seal flange 22a from the sand seal trough 23, we provide mechanism embodying motor 30, speed reducer 31, spur gears 32, 33, crank shaft 34, links 35 and bell cranks 36. For the purpose of moving the cover horizontally, we provide motor 37, reducer 38, gears 39, 40, shaft 41 and chain drive 42.

Suitable means such as cable reels or the like (not shown) are provided for the purpose of leading electric power to the motors and of controlling these motors from any desired remote point.

A furnace constructed in accordance with our invention has distinct advantages over the usual rectangular ingot furnace or soaking pit as a result of its circular form. There is no neecssity of using tremendously heavy binding or reinforcing members for the casing or shell. Expansion of the refractory structure produces only a tensile stress in the steel plates of the shell. There is no opportunity for the circular walls to collapse inward as is frequently the case with rectangular pits.

In the usual soaking pit the ingots are located directly in the combustion zone and are subjected to burning gases under conditions which are often highly injurious to the ingots. As has been mentioned above, our furnace includes a combustion chamber of ample volume at the bottom, provided by enlarging the diameter of the circular chamber. Firing into this combustion chamber are a compartively large number of small burners preferably equally spaced around the periphery. With this large number of burners the concentration of heat at each burner is small, and this fact, together with the combustion space provided, effectively protects the ingots from localized heating. Furthermore, as a result of the tangential disposition of the burners, recirculation takes place, which provides improved temperature uniformity and avoids subjecting the ingots to excessively hot gases. Also, gases in the course of the recirculating movement wipe past the vertical walls 6 and the corbelled portion 6a, heating them uniformly to a temperature at which heat transfer by radiation is very effective. The products of combustion come in contact with the ingots only after they have been "tempered" and thoroughly mixed by recirculation. The combustion products finally escape through the flue 10.

We provide effective heating of the bottoms of the ingots, which portion of the ingot is the most difficult to heat in the usual type of soaking pit. This object is accomplished by having the heat enter the pit adjacent the bottom to offset the natural tendency of heat to rise to the top.

The upper limit of the corbelled walled portion 6a is at a level below the tops of the ingots, and as a result the ingots may, when necessary, be allowed to lean against the walls as shown in Figure 1 at the left. The wall is corbelled inwardly, which has the further advantage that a temperature responsive device such as thermocouple 43 may be inserted in the wall without danger of damage from ingots during their placing or removal.

In carrying out our method, the cover is first moved to one side, exposing at least a portion of the interior of the pit. Ingots are then set vertically on the annular bed of refractory material in any desired manner, either leaning against the wall or standing unsupported. The cover is moved as required in order to expose all parts of the interior so that a full charge may be inserted. The cover is then returned to position over the furnace and lowered so that the sand seal flange enters the sand seal trough.

The air and gas adjustment for the burners having been set to produce the desired atmosphere, heating is caused to proceed at such rate as is determined by the size of the ingots, etc. The thoroughly mixed products of combustion from the many individual burners give off a portion of their heat to the refractory structure, whence it is radiated to the ingots, and a portion to the ingots themselves by direct radiation and contact. Very uniform heating throughout the entire furnace, as well as uniformity in each ingot, results for the reasons previously explained.

The outgoing products of combustion leave the furnace through flue 10 and may be taken away by any suitable means, such as an exhaust fan or a stack, but in case a stack is used we preferably prevent it from producing any draft or subatmospheric pressure in the furnace by such means as bleeding cold air into the base of the stack. It is desired to operate the furnace with a pressure in the chamber equal to, or very slightly higher than that of the surrounding atmosphere, so as to prevent infiltration of external air, which would have the effect of oxidizing the ingots.

In removing the ingots, the cover is first lifted and then moved to one side or the other a sufficient amount to expose an ingot which it is desired to remove. After removal of the ingot, the cover is preferably returned to position, though it is not necessarily lowered. The operation is continued until the pit is emptied, the cover being moved in each case only far enough to expose the ingot or ingots to be immediately removed. It is advantageous, as will be seen, to have the ability which we provide to remove the cover in either direction so as to expose a minimum area of the pit at any time.

Much of the heat is thus conserved and fuel consumption reduced. Of great importance also is the fact that drastic chilling of the refractory lining is thus reduced to a minimum and the

deterioration of the refractories considerably retarded.

In the case of a battery of our improved furnaces, the furnaces themselves are entirely separate from one another, and although they may be connected to the same stack, they may be operated at different temperatures or under different atmospheric conditions as required.

The construction of our furnaces as separate units permits maintenance work to be carried on in any pit without interfering with the operation of the remaining pits in a battery, in contrast to the usual construction of blocks of pits where the failure of one pit necessitates the shutting down of the remaining pits in the block.

Our furnace requires only a low fuel consumption which is made possible by the elimination of excessive stack draft, positive air-fuel ratio, less cover opening per ingot and an insulated tight structure. This low fuel consumption can be accomplished without the use of recuperators, although such apparatus may be used for further economies if desired.

When heating certain kinds of ingots it is highly desirable to bring them to temperature at a predetermined rate, which is usually considerably slower throughout at least a portion of the heating than could be obtained by "forcing" the furnace. For such requirements we preferably use control apparatus embodying a so-called program controller. Such instruments and the other apparatus required are well known in the art. Our furnace, however, is exceptionally well adapted to the use of such apparatus because the atmospheric conditions within the chamber do not suffer from low rates of firing, nor is the temperature distribution adversely affected. The interior form of our furnace, which permits the use of a thermocouple without danger of damage, is therefore of further advantage.

We have illustrated and described a preferred embodiment and manner of practicing our invention. It is to be understood, however, that the invention may be otherwise embodied or practiced within the scope of the following claims.

We claim:

1. A pit type ingot heating furnace having a substantially circular heating chamber, a surrounding row of burners projecting thereinto above the chamber floor, and an annular floor arranged to receive a group of ingots in vertical position, said furnace having an outlet for products of combustion disposed centrally and in the bottom thereof.

2. A pit type ingot heating furnace having a surrounding row of burners projecting thereinto adjacent the bottom thereof, and an annular floor arranged to receive a group of ingots in vertical position, said furnace having an outlet for products of combustion disposed centrally and in the bottom thereof.

3. A pit type ingot heating furnace having a surrounding row of burners disposed tangent to a common circle projecting thereinto, and an annular floor arranged to receive a group of ingots in vertical position.

4. A pit type ingot heating furnace having a surrounding row of tangentially arranged burners projecting thereinto adjacent the bottom thereof, and an annular floor arranged to receive a group of ingots in vertical position, said furnace having an outlet for products of combustion disposed centrally and in the bottom thereof.

5. A pit type ingot heating furnace having a surrounding row of fluid-fuel burners projecting thereinto, an annular floor arranged to receive a group of ingots in vertical position, and a baffle wall between said row and said floor.

6. A pit type ingot heating furnace having a heating chamber a surrounding row of fluid-fuel burners projecting thereinto adjacent the bottom thereof but above the chamber floor, an annular floor arranged to receive a group of ingots in vertical position, and a baffle wall between said row and said floor, said furnace having an outlet for products of combustion disposed centrally and in the bottom thereof.

7. A pit type ingot heating furnace having a substantially circular heating chamber arranged to receive a group of ingots in vertical position, the diameter of said chamber being greater adjacent the bottom than adjacent the top, and a row of burners surrounding and projecting into the enlarged portion of said chamber.

8. A pit type ingot heating furnace having a substantially circular heating chamber arranged to receive a group of ingots in vertical position, the diameter of said chamber being greater adjacent the bottom than adjacent the top, and a row of burners surrounding and projecting into the enlarged portion of said chamber, said chamber having an outlet for products of combustion disposed centrally and in the bottom thereof.

9. A pit type ingot heating furnace having a substantially circular heating chamber of larger diameter adjacent its bottom than adjacent its top, an annular floor arranged to receive a group of ingots in vertical position, a surrounding row of fluid-fuel burners projecting into the enlarged portion of said chamber, and a baffle wall between said row and said floor, the annular floor having only a single outlet for the products of combustion, the outlet being in the center of the floor.

10. A pit type ingot heating furnace having a substantially circular heating chamber arranged to receive a group of ingots in vertical position, the diameter of said chamber being greater adjacent the bottom than adjacent the top, and a surrounding row of burners disposed tangent to a common circle and projecting into the enlarged portion of said chamber.

11. A pit type ingot heating furnace having a combination waste gas flue and slag removal opening in the bottom adjacent the center of the furnace.

12. In the method of heating ingots, the steps consisting in arranging the ingots in vertical position substantially in a circle in a heating chamber, and supplying heat to them from points outside the circle by introducing a plurality of streams of fluid fuel into the chamber at a level between the tops and bottoms of the ingots.

13. In the method of heating ingots, the steps consisting in arranging the ingots in vertical position substantially in a circle in a heating chamber, and supplying heat to the ingots from points located substantially in a circle outside the ingots by introducing a plurality of streams of fluid fuel into the chamber at a level between the tops and bottoms of the ingots.

14. In the method of heating ingots, the steps consisting in arranging the ingots substantially in a circle in a heating chamber, supplying heat to the ingots from points located substantially in a circle surrounding the ingots by introducing a plurality of streams of fluid fuel into the chamber at a level between the tops and bottoms of the ingots, and taking off substantially all of the products of combustion substantially concentrically of and adjacent the bottoms of the ingots.

15. In the method of heating ingots, the steps consisting in supplying heat to the ingots in vertical position from points substantially surrounding them, baffling the heat before reaching the ingots, and taking off substantially all of the products of combustion substantially concentrically of and adjacent the bottoms of the ingots.

16. In the method of heating ingots, the steps consisting in directing a plurality of streams of fluid fuel substantially in a circle surrounding a group of ingots, and taking off substantially all of the products of combustion substantially concentrically of the group of ingots adjacent the bottoms thereof.

17. In the method of heating ingots, the steps consisting in arranging the ingots in vertical position substantially in a circle in a heating chamber, introducing a plurality of streams of fluid fuel into the chamber at a level between the tops and bottoms of the ingots, flowing the products of combustion in a circle surrounding the ingots and at the same time causing them to flow upwardly and then downwardly in the chamber, and withdrawing them from the bottom of the chamber concentrically of the circle of ingots.

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