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SOAKING PIT CONSTRUCTION FOR METAL INGOTS

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2 Sheets-Sheet 1

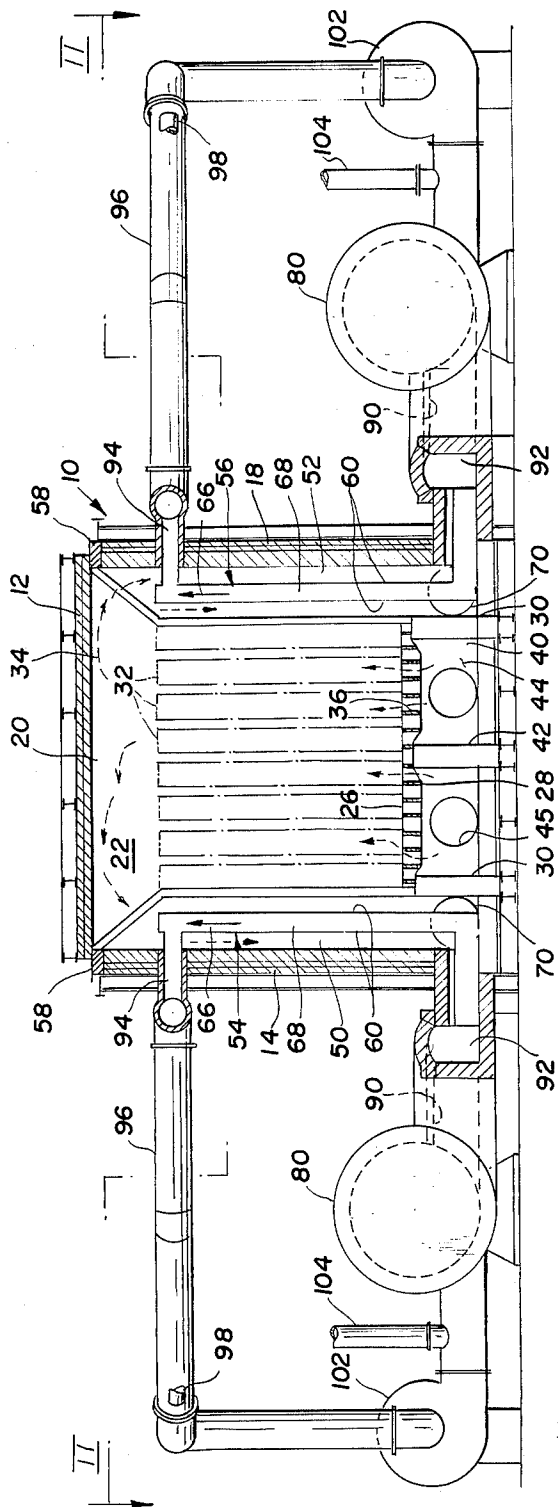


Fig. 1.

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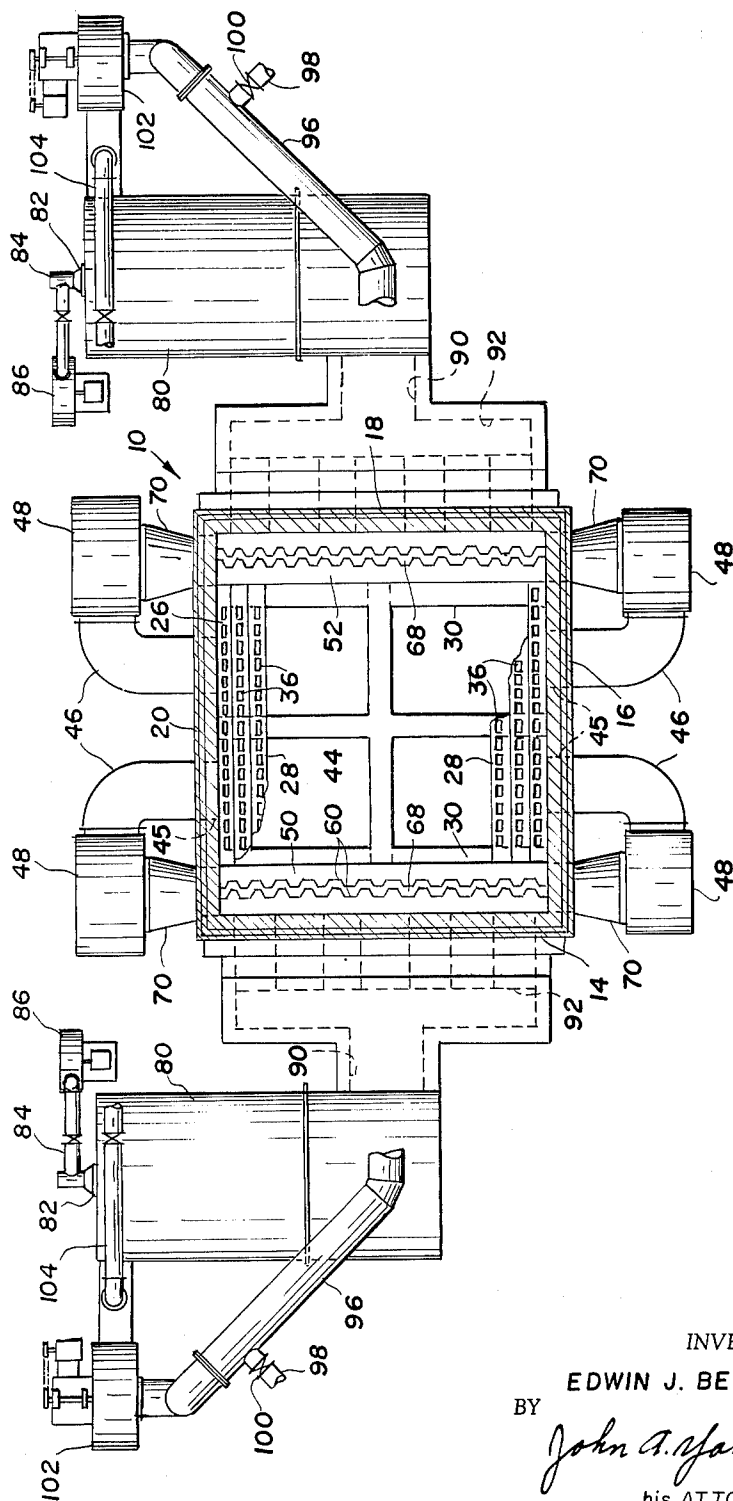


Fig. 2.

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SOAKING PIT CONSTRUCTION FOR METAL
INGOTS

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This invention relates to a soaking pit for ingots of metal such as aluminum which are not susceptible to heating by direct exposure to combustion product materials because metals of this class are contaminated by direct exposure. To prevent such contamination there is used instead, a flow of heated gases which sweep over and heat the surfaces of the aluminum ingots and are then reheated and recirculated in a continuous cycle. Reheating of the circulation gases is effected by natural gas or other high calorific content gases which are burned and are elevated to a substantial temperature capable of heating up the recirculating flow of air or other gaseous medium which in turn heats up the aluminum ingots. The fuels used for aluminum ingot soaking pits are characterized as "clean burning" fuels and they generate high temperatures and the heat exchange means is generally in the form of conduits or the like.

It is characteristic of aluminum soaking pits that the heat exchange effected with the aluminum ingot is accomplished primarily by convection heat transfer since the bright surface of the aluminum substantially precludes the receiving of heat by radiation, i.e., the aluminum acts as a white body and not as a black body, therefore, it can be heated only by an efficient mechanism of convection heat transfer.

It is one of the objects of the present invention to provide a soaking pit for aluminum ingots which is constructed to generate a continuous flow of heated gases to cause a heating of aluminum ingots by an efficient mechanism of convection heat transfer.

It is a further object of the present invention to provide a soaking pit which is subdivided into a number of portions each receiving a substantially equivalent continuous flow of gases so that all of the ingots within the pit are subject to a uniform heating action.

A further object of the invention is to provide a heating chamber for aluminum ingots wherein fuel of a low calorific content is used but without contamination of the aluminum ingot and without impeding a continuous current of combustible material flow which imparts heat to a current of air circulated continuously through the soaking pit to heat the ingots.

A further object of the invention is to provide a novel arrangement of two continuously circulating gaseous flows which are passed in heat exchanging relation, the one flow being circulated through an aluminum ingot soaking pit and the other flow being constituted as the combustion product of low calorific content fuel and sufficient oxygen to effect efficient combustion of such fuel.

A still further object of the invention is to provide in combination with a heat exchanger for an aluminum ingot soaking pit, a means for accurately controlling the heating effect during the heat up and soak phases of pit operation wherein a part of the combustion product flow is continuously vented and is balanced by an inflow of combustible product which develops the heat for transmission through the heat exchanger.

A further object of the invention is to provide an aluminum ingot soaking pit having two circulating flows of air and a heat exchanger for each flow which is of novel construction and is usable with a low calorific content fuel which generates the high temperature gases used for heat-

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ing up the flow of air as it passes through the heat exchanger.

Fuels usable with the invention include those which are of high and low calorific content and vary from solid to liquid to gaseous forms so that the soaking pit can utilize whatever fuel is available. This wide selection of fuels is unattainable by previous soaking pits.

Other objects and features of the invention will become apparent from a consideration of the following description which proceeds with reference to the accompanying drawings, wherein:

FIGURE 1 is an elevation view showing in section, a soaking pit having combustion product flow indicated in full lines and soaking pit air flow in dashed line arrows; and,

FIGURE 2 is a section view taken on line II-II of FIGURE 1 and including the apparatus for effecting circulation of the two gaseous media which are circulated in heat exchanging relation to impart a distribution of heat to the ingots within the soaking pit.

Referring now to the drawings, the soaking pit, designated generally by reference numeral 10, includes a cover 12 which rests on the upright walls 14, 16, 18 and 20 which comprise the sides of a soaking pit chamber 22 having a floor 26 made up of cast beams 28 having their ends resting on piers 30. The beams 28 are of cast material which is heat resistant and is capable of supporting the weight of aluminum ingots 32 which are spaced relatively to permit vertical currents of heated air which follow the path of dashed line arrows 34. The beams contain openings 36 which permit currents of air to rise upwardly through floor 26 from chamber 40 at the bottom of the pit.

The chamber 40 is subdivided by cross piers (FIG. 2) 42 and 44 into four subdivisions each having a recirculating air inlet 45 and a conduit 46 connecting with a fan or pump 48. In this way there is a substantially equal flow rate of heated air for each section of the subdivided lower chamber 40 and, therefore, the ingots 32 which surmount the subdivided chamber portions are subjected to substantially equivalent heating effects regardless of their location within heating chamber 22.

The heated gases which elevate the ingots 32 are circulated continuously through compartments 50, 52 in the direction of the dashed line arrows, one at each side of the soaking pit. The circulating air passes during each cycle through a closed path which includes compartment 40, and one or the other heat exchangers designated generally by reference numerals 54 and 56. The currents of circulating air are deflected by the cover 12 at the top of the soaking pit and are directed along opposite paths into compartments 50, 52. A seal 58 between the cover 12 and side walls 14, 16, 18 and 20 maintains a slight super-atmospheric pressure within the chamber 22. Within compartments 50, 52 the downwardly traveling air moves past the walls 60 of the heat exchangers 54, 56; these walls being bent into the shape of corrugations to increase the surface area through which heat exchange is effected between the down flowing air and countercurrently flowing combustion gases which move in the direction of solid line arrows 66 within compartments 68 which are sealed from compartments 50, 52. The counterflow of gases produces a heat exchange causing the recirculating air to be heated up and the air is then passed through ducts 70 to one of four different fans or pumps 48. The pumps then discharge the air under pressure through conduits 46 into chamber 22 where it passes upwardly sweeping past the ingots 32 which are heated by the convection heat transfer from the heated air currents.

Since the chamber 68 is of thin cross-section and having walls which are corrugated, there is a substantial sur-

face area to volume ratio for chamber 68 and, therefore, heat exchange is promoted to provide for transfer of appreciable quantities of heat from the combustion product gas chambers and recirculating air in chambers 50, 52. There is no obstacle presented to the flow of gases within chambers 68 (or within chambers 50, 52) and, therefore, no appreciable pressure drops are produced within the system. Moreover, there is no appreciable opportunity for clogging the flow of combustion product within the chamber 68 because no reversal of flow path takes place; the side walls are smooth and present an unobstructed flow path for the gas flow; and the cross-section of the chamber while thin to produce laminar flow, is still sufficient to allow free travel of the combustion product gases. A low calorific content fuel having a high ratio of entrained materials is usable without developing clogging or impedance to the flow path of combustion gases.

The combustion gases are generated initially within a heating chamber 80 having a burner 82 which receives a combustible flow of low calorific content fuel and air from line 84. Generally, the combustible flow in an appropriate ratio and amount is provided by an inlet pump 86 which is controllable to generate heat appropriate to the cycle of the soaking pit. For example, during heat up and before the pit 22 and ingots 32 are raised to the desired temperature, the burner rate is high and appreciable quantity of fuel and air are burned within burner chamber 80 so as to quickly heat up the recirculating flow of air within the chamber 22. After the chamber and ingots have attained a suitable soaking temperature the burner rate is diminished to provide only enough heat to provide make up heat whereby the ingots will be held at a proper temperature.

Thus the combustion product flow is circulated through the heat exchangers 54, 56 at a rate which is in accordance with pit operation. Each of the heat exchangers in operation is non-susceptible to clogging because of entrained carbonaceous or other contaminants produced from burning low calorific content fuel which is economical to obtain but is almost always as a practical matter, rejected in the operation of previously employed aluminum ingot soaking pits.

A flow of combustion product is provided for each heat exchanger and the structure for each is identical so that only one will be described in detail. After burning in heater 80 the combustion products are passed through outlet 90 and into a rectangular chamber 92 from which they are passed into the chamber 68 where they rise upwardly, exchanging heat with the countercurrently flowing air in chambers 50, 52 through the walls 60. The combustion product gases after reaching the top of chamber 68 are passed through a rectangular chamber 94 and then pass into a duct 96 having an air inlet line 98 with a servo valve 100. The purpose of air inlet is to provide an inflow of air which cools the recirculating combustion product gas before entry into fan or pump 102 which produces the circulation of the combustion product gas. If the combustion product gas were not cooled it would necessitate special heat resistant materials of construction for the fan or pump, thus making this a far more costly item of manufacture. Before the flow of combustion product gases are returned to the chamber, a quantity of the flow is vented to atmosphere through line 104, the outflow being enough to balance the quantity of gas obtained by the burning operation as well as the inflow of cooling air from line 100. Thus, during each cycle of movement of the hot combustion product gas there is a heating phase of the cycle, a controlled outflow which balances the inflow of combustion product, a heat exchange with the recirculating air communicating heat to the ingots, and abrupt flow direction changes. Surges of pressure and excessive gas velocities are avoided in order to preclude "dumping" of entrained material within the heat exchanger.

In operation, it is possible to use a grade of fuel having a thick viscous quality not previously thought suitable for aluminum ingot soaking pit operations. A flow of such fuel, together with a quantity of air which provides substantially complete combustion of the fuel is provided the burner 82 and burning is effected in chamber 80, the combustion product flow then being directed through outlet 90 and chamber 92 to the interior compartment 68 of the heat exchanger where it flows upwardly and produces a heating effect on the countercurrently flowing air in compartment 50. The combustion product flow is then passed through 94 and duct 96 where it is diluted with enough air from line 98 to moderate the temperature bringing it within the limitations of the materials of construction in fan or pump 102. The pump 102 pressurizes the flow causing a forced draft which recirculates it into chamber 80 where it is reheated by an additional increment of fuel and air and the circulation of combustion product gas is repeated as described.

During the cycle, however, a portion of the combustion product flow is vented through line 104 to balance the inflow of air from line 100 and combustion product material derived from burner operation 82.

The intensity of heating is a function of the soaking pit operation. That is, until the soaking pit reaches approximately 1150° F. the heat is intense and is reduced, however, when soaking temperature is attained so that only make up heat is provided in the pit. Within the pit air is continuously circulated along vertically upward currents within the chamber 22 and is subdivided approximately evenly between opposite sides of the soaking pit being equally distributed between heat exchangers 54 and 56. The air is further subdivided within chamber 40 after being heated, into four distinct flows by a respective fan or blower 48 so that each cross-sectional portion or quadrant of the pit receives an equivalent flow of heated air, therefore, each ingot is uniformly heated regardless of its location within the pit.

After soaking has taken place for a designated period of time the cover 12 is removed and the ingots are withdrawn for rolling operation.

The operation as described proceeds continuously and since the two flows of gases are passed in heat exchanging relation but are at all times isolated from each other, there is no opportunity for contaminating the ingot by direct exposure to the combustion product materials which are laden with carbonaceous materials. Therefore, in spite of the lower grade fuel which is used, there is assured a precise control of heating conditions and heating method whereby the ingots are brought to a soaking temperature and are held at that temperature for a suitable length of time before rolling operation.

Although the present invention has been illustrated and described in connection with a single example embodiment, it will be understood that this is illustrative of the invention and is by no means restrictive thereof. It is reasonably to be expected that those skilled in this art can make numerous revisions and adaptations of the invention which are suited to different design requirements and it is intended that such changes and revisions which incorporate the principles disclosed therein, will be included within the scope of the following claims as equivalents of the invention.

I claim:

1. In a soaking pit for aluminum ingots and the like, a heating chamber having a floor with openings therein which provide for vertical circulation of heated air to effect a heating action on aluminum ingots received therein, a heat exchange chamber for receiving a flow of such gases after they pass through the heating chamber and are thereafter returned under pressure for repeated recirculatory movement through said heating chamber, means for subdividing the flow of heated air within said heating chamber into substantially uniform flows so that

subdivided flows will sweep uniformly the aluminum ingots therein, means for collecting such subdivided flows and thereafter directing them to said heat exchange chamber, a pump adapted to circulate under pressure a heated flow of combustion product gases through said heat exchange means, a burner for receiving a combustible flow of fuel and air for generating a high temperature flow of gases for circulation through said heat exchange means, an exhaust for removing a portion of the circulating combustion product flow to maintain the pressure conditions at a substantially constant value, and means providing an inflow of air at controllable rates together with said combustion product gases to establish the temperature of the circulating product gases.

2. A soaking pit for aluminum ingots comprising an ingot-supporting floor having openings which provide for circulation of heated gases past the aluminum ingot surfaces, means for subdividing the flow of heated gases within said soaking pit into a plurality of portions each adapted to receive a substantially equivalent heating effect, means for channeling said subdivided flow within the soaking pit into substantially uniform flows throughout the entire cross section of said soaking pit to uniformly sweep the surfaces of the aluminum ingots mounted therein, means for subsequently collecting the subdivided flows after they have vertically traversed said soaking pit to provide return flows which are recirculated for reheating, two heat exchange members having vertically disposed heat exchanging surfaces which receive a constant flow of recirculating gases and are returned in substantially constant amount to each of said portions for uniformly heating the ingots, a heat-input flow of combustion product gases which are circulated under pressure and under continuous flow in separated relation from said constant flow of recirculating gases, said heat-input flow being continuously circulated through said heat exchange members and comprising for each of said members a conduit, burner and pump for producing a flow of heated gas at a controlled temperature and quantity under all conditions of pit operation.

3. The soaking pit construction in accordance with claim 2 including means for inducing a controlled quantity of air together with said combustion product gases to provide a heating effect within the heat exchange

members which is adapted for accurate heating of the ingots.

4. The soaking pit construction in accordance with claim 2 wherein the combustion product flow is continuously vented in controllable amounts to atmosphere and is balanced by an input flow of combustion product gases generated by heating and provided in amount substantially to balance the outflow of said gases.

5. The soaking pit construction in accordance with claim 2 including a pumping means for each of the subdivided portions of said soaking pit to provide a recirculating flow of heated gases in substantially the same amount to each subdivided portion.

6. In a heating apparatus for aluminum ingots and the like, a heating chamber having an ingot supporting floor with openings therein for continuous vertical circulation of heated gas which flows past the ingot surfaces and provides a heating effect, means for channeling a flow of gases from said heating chamber past a heating medium which raises the temperature of said gases which are then returned for recirculation through said heating chamber, a combustion chamber adapted to receive a combustible flow of fuel and oxygen, a pump for circulating said combustion product flow through said exchange medium, and means for venting a portion of the combustion product flow prior to recirculation, and partition means for subdividing the flow of gases from said heating chamber and which are thereafter passed through said heating chamber into a plurality of compartments, each of said compartments including a fan for recirculating the heated gases vertically through the heating chamber at a substantially uniform rate and distribution throughout the cross section of said chamber.

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