April 18, 1950 D. W. LLOYD 2,504,707

METHOD AND APPARATUS FOR HEATING INGOTS

Filed Sept. 5, 1946 3 Sheets-Sheet 1

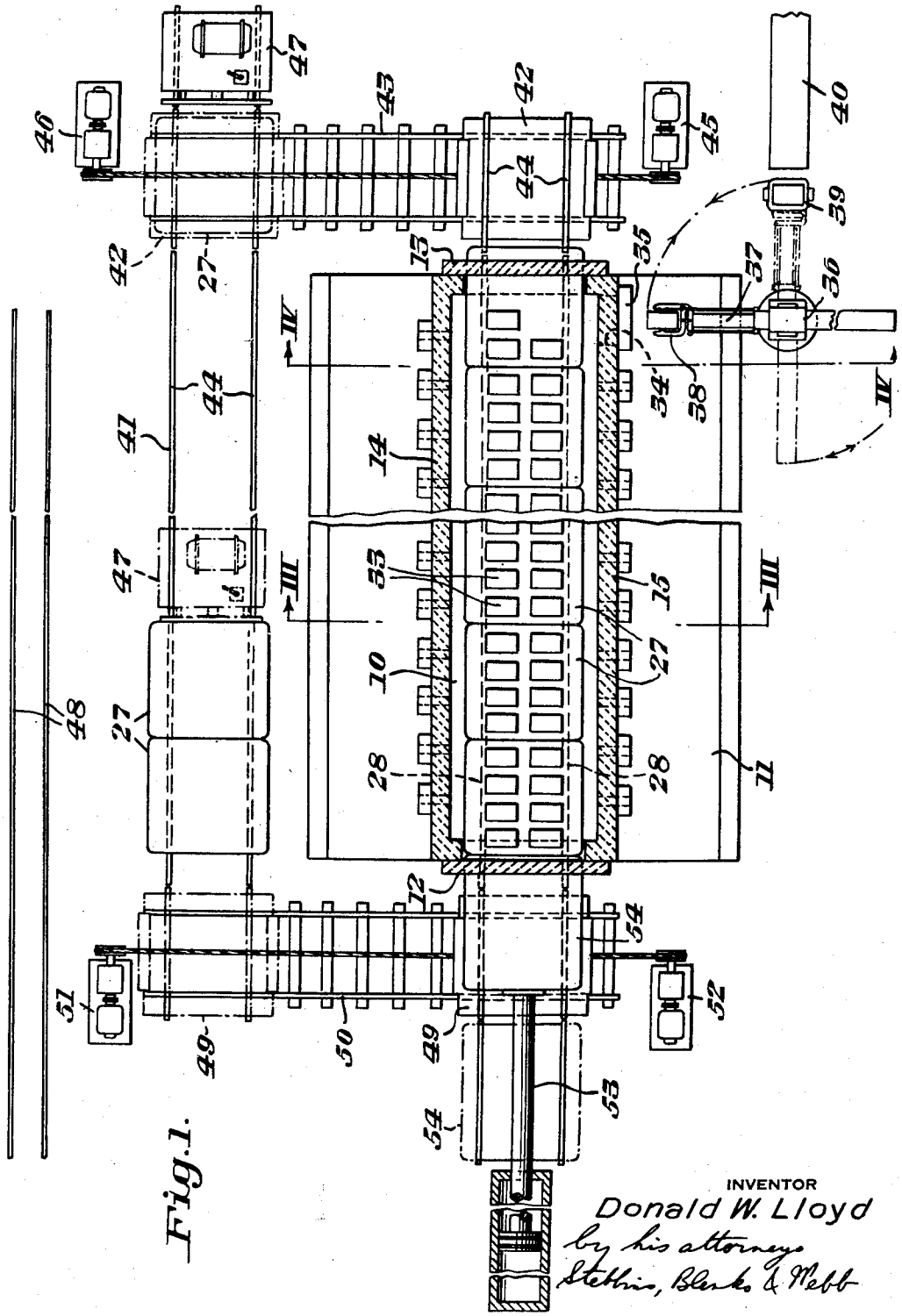


Fig. 1.

INVENTOR
Donald W. Lloyd
by his attorneys
Stetbins, Blenko & Webb

April 18, 1950 D. W. LLOYD 2,504,707

METHOD AND APPARATUS FOR HEATING INGOTS

Filed Sept. 5, 1946 3 Sheets-Sheet 2

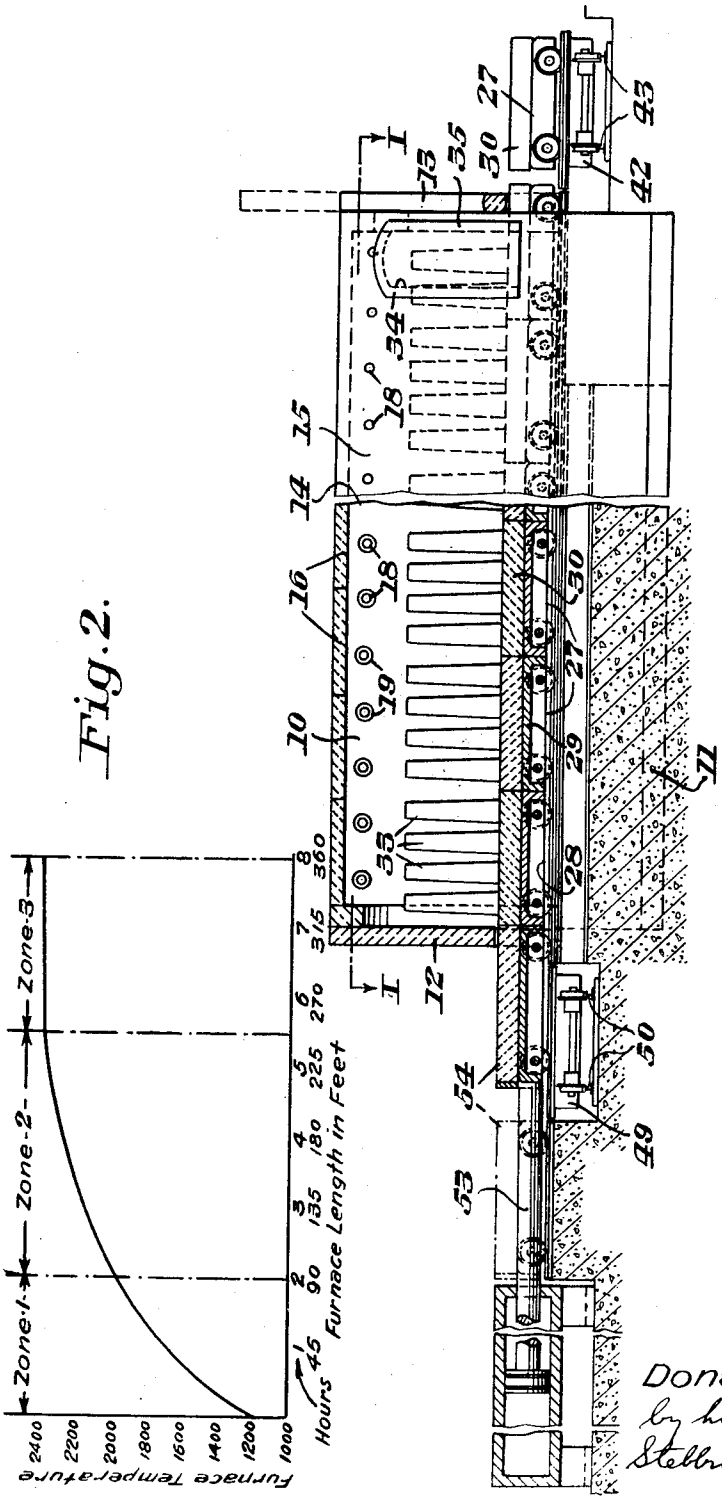


Fig. 2.

Fig. 5.

INVENTOR
Donald W. Lloyd
by his attorneys
Stellins, Blenko & Webb

April 18, 1950 D. W. LLOYD 2,504,707

METHOD AND APPARATUS FOR HEATING INGOTS

Filed Sept. 5, 1946 3 Sheets-Sheet 3

Fig. 3.

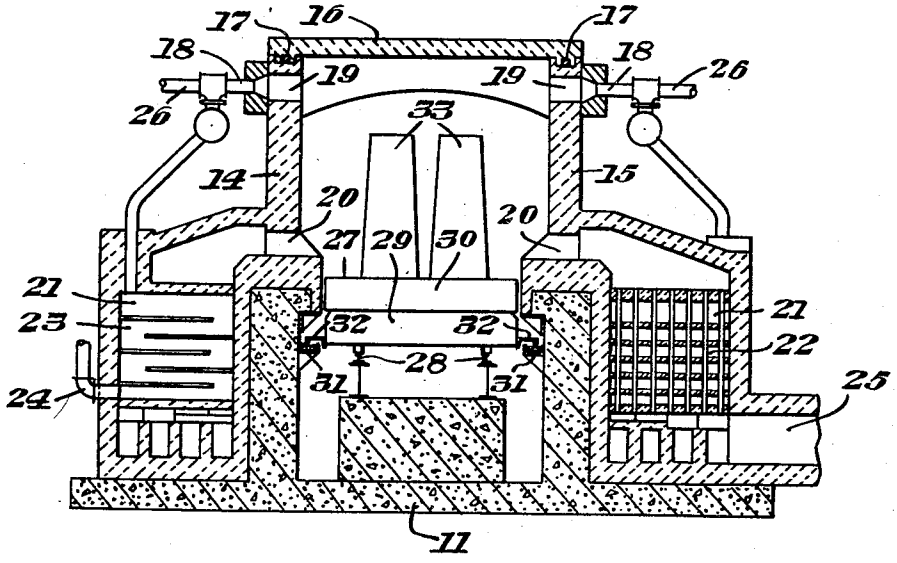
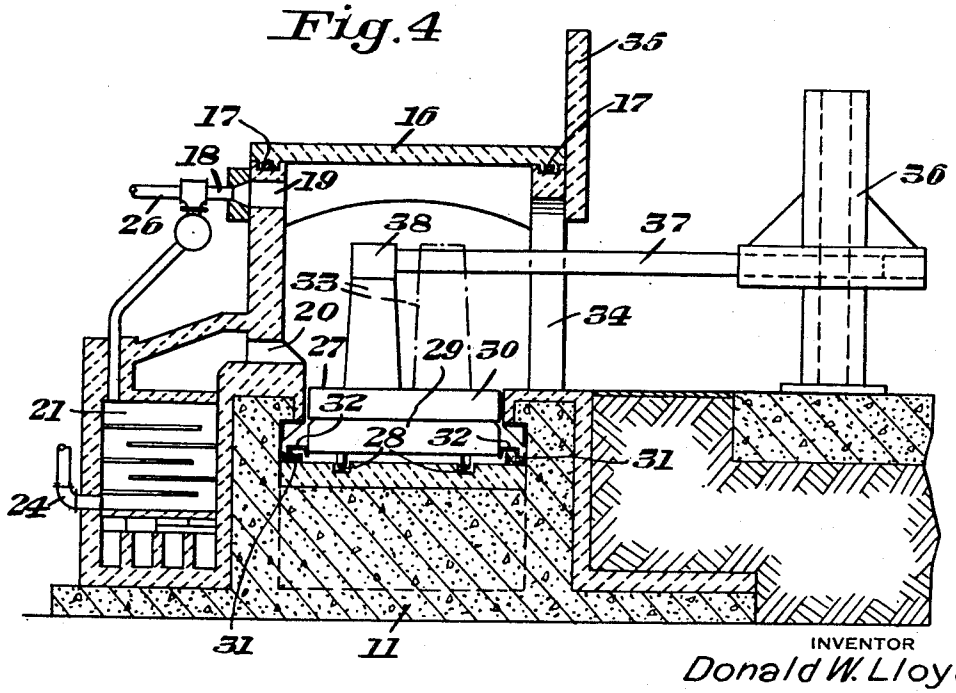


Fig. 4



INVENTOR
Donald W. Lloyd
by his attorneys
Stebbins, Blenko & Willi

Patented Apr. 18, 1950

2,504,707

UNITED STATES PATENT OFFICE

2,504,707

METHOD AND APPARATUS FOR HEATING INGOTS

Donald W. Lloyd, Youngstown, Ohio

Application September 5, 1946, Serial No. 694,993

2 Claims. (Cl. 263—40)

1

This invention relates to a furnace for heating ingots and an improved method of handling and heating ingots preparatory to rolling.

The conventional practice of heating ingots for rolling in the manufacture of steel is to employ pit furnaces having removable covers and charge the ingots into the pits and remove them therefrom by an overhead crane. There are numerous objections to this practice. In the first place, a number of workmen are required to maintain the pit furnaces in operation and to operate the covers and crane. The crane or an ingot in transit is likely to strike the furnace walls and cause damage thereto. A further objection is that ingots for successive rolling are taken from different points in the pit and may not have been heated to the same temperature. This increases the difficulty of rolling by necessitating changes in the adjustment of the blooming mill. The pit covers are normally opened once every minute and a half to permit the charging or removal of an ingot, each ingot being handled individually. This permits the loss of a substantial amount of heat and the hot gases arising from from the pit when the cover is removed are obnoxious to the workmen in the vicinity.

I have invented a novel furnace and a method for heating ingots whereby the aforementioned objections are overcome. In a preferred embodiment and practice, I charge the ingots in groups into the entrance end of a continuous furnace, advance them progressively through the furnace while gradually heating them, and remove them individually as they approach the other end. In their travel through the furnace, the ingots are heated in successive stages and are subjected to a final soaking so that, on removal, they are all uniformly heated to precisely the same temperature for rolling. The ingots to be heated are placed on pusher cars which travel through the furnace after entering one end thereof. At the other end, an opening is provided in the side wall of the furnace and an ingot crane mounted adjacent the furnace is adapted to enter the opening and seize the ingots for delivery to a tilter which places them on the approach table of the blooming mill. The furnace has burners spaced therealong adjacent the top thereof. Recuperators spaced along the furnace adjacent the bottom have passages for exhaust gases and for heating incoming air for combustion. A loading track is positioned adjacent the furnace and transfer cars at each end of the furnace travel between it and the loading track to move the pusher cars in a continuous path.

2

A complete understanding of the invention may be obtained from the following detailed description and explanation which refer to the accompanying drawings illustrating a preferred embodiment and practice. In the drawings:

Figure 1 is a plan view showing the furnace in horizontal section and the apparatus associated therewith in plan;

Figure 2 is a central longitudinal section through the furnace; line I—I of Figure 2 indicates the plane on which the section through the furnace as shown in Figure 1 is taken;

Figures 3 and 4 are transverse sections taken respectively along the planes of lines III—III and IV—IV of Figure 1; and

Figure 5 is a curve illustrating the heating cycle for ingots, according to my invention; showing the temperatures at various zones in the length of the furnace.

Referring in detail to the drawings, a continuous furnace 10 of the tunnel type is constructed on a foundation 11. The furnace chamber has a length several times its width or height, is open at the ends and has doors 12 and 13 for closing the open ends. The side walls of the furnace are indicated at 14 and 15. The roof is composed of a plurality of independently removable sections or slabs 16. Seals 17 close the joints between the room sections and side walls.

Burners 18 are spaced along the length of the furnace and fire through ports 19 in one or both side walls. While the burners as illustrated are located near the top of the furnace, they may be placed in any suitable location. When burners are mounted on both sides of the furnace, as shown, they are preferably staggered. Outlet ports 20 for exhaust gases are located near the bottom of the furnace on each side thereof and communicate with recuperators 21 extending along both sides of the furnace. The recuperators include waste gas ducts 22 and air passages 23 arranged in the known manner so that the entering air is heated by the outgoing waste gases but are maintained separate therefrom. The section of Figure 3 shows the passage for the entering air on the one side and the ducts for the waste gases on the other. It will be understood, however, that the recuperators are continuous along the length of the furnace. Entering air is supplied to the passages 23 by a conduit 24 while exhaust gases from the ducts 22 are delivered to the stack by a flue 25. Fuel is supplied to the burners 18 by pipes 26 extending to any convenient source thereof.

Pusher cars 27 are adapted to travel through

the furnace in close abutment on a track 28. Each car comprises a wheeled frame 29 and a refractory floor 30. A layer of coke breeze (not shown) is spread on the floor 30 to protect the latter from damage by the placing of the ingots thereon. Sealing channels 31 are mounted on the side walls of the furnace interiorly thereof and sealing channels 32 are mounted on the frames of the cars so that their outer flanges project downwardly into the channels 31. The latter are filled with sand or other suitable granular sealing material although it is feasible to use a liquid such as oil or water, since the sealing channels are sufficiently removed from the furnace interior to maintain a temperature not greatly above that of the atmosphere. Each of the cars 27 is adapted to carry a plurality of ingots 33 disposed on end and in spaced relation thereon.

The side wall 15 is provided with an opening 34 adjacent the door 13 to permit removal of the ingots individually from the cars as they approach the discharge end of the furnace. The opening 34 is normally closed by a door 35. An ingot crane 36 mounted adjacent the opening 34 has an arm or ram 37 adapted to extend through the opening into the furnace and is provided with tongues 38 for seizing an ingot. The crane 36 is rotatable and delivers the ingots removed from the furnace to an ingot tilter 39. The tilter 39 serves to lay the ingots down on an approach table 40 leading to a blooming mill (not shown).

A loading track 41 extends alongside the furnace 10. A transfer car 42 traveling on a cross track 43 carries the pusher cars from the track 28 to the track 41, being provided with rails 44 at such a level as to constitute a continuation of these tracks. The car 42 is actuated back and forth along the track 43 by stationary traction mechanisms 45 and 46, each of which comprises a motor, a reduction gear and a drum for winding up a cable connected to the car. A motor-driven pusher car 47 advances the pusher cars along the loading track 41. While the pusher cars are on the track 41, they are loaded by an overhead crane with ingots taken from buggies placed on an unloading track 48 after the molds have been stripped following pouring and freezing of the ingots. The pusher cars, when loaded, are moved onto a transfer car 49 similar to that shown at 42 traveling on a cross track 50 under the control of traction mechanisms 51 and 52. When a loaded pusher car has been brought into line with the furnace, the door 12 is opened and the car is pushed into the furnace by an hydraulic ram 53.

Each entering car advances the entire line of cars and causes the discharge of the car at the other end of the furnace from which the ingots have been removed. The door 13 is left open sufficiently to clear the car floor. An empty pusher car 54 is secured to the ram for engaging the loaded car when in position to be charged into the furnace. This car permits the door 12 to be lowered to the position shown in Figure 2 after the entry of a loaded car and also permits the line of cars in the furnace to be advanced by the ram 53 in steps equal to the spacing between successive pairs of ingots disposed side by side. This brings the ingots on the car at the discharge end of the furnace successively in alinement with the opening 34 for easy removal.

According to the method of my invention, I control the firing of the burners 18 at various points along the length of the furnace in order to effect heating of the ingots in a predetermined

cycle. In a zone of predetermined length adjacent the entrance end of the furnace, I maintain a temperature sufficient to bring all portions of the ingots to a temperature approximately equal to the residual temperature at the center of the ingot, i. e., about 1200°, and heat it progressively thereabove to about 2000°. That is to say, the ingots will ordinarily have cooled to that temperature by the time they reach the loading track 48, from two to three hours after pouring. This stage of the heating cycle is illustrated by the first portion of the curve of Figure 5 designated zone 1. It will be noted that the curve shows temperatures plotted against the travel through the furnace measured by time as well as distance. The speed of travel of the pusher cars is correlated with the length of the furnace to afford successive ingots the time in the furnace necessary to heat them to the proper temperature.

In the second or intermediate portion of the length of the furnace, the burners are fired to cause a gradual increase in the temperature of the ingots throughout to approximately 2400°. This stage of the heating is indicated by the portion of the curve of Figure 5 designated zone 2. It will be evident that the length of each of the zones is proportional to the time required for passing therethrough as indicated by the curve.

The portion of the furnace adjacent the discharge end constitutes a soaking zone in which the burners are fired at a rate sufficient only to maintain the ingots at the maximum temperature reached in zone 2, thus permitting any slight variations in temperature between various points of the ingots to become equalized. At the end of this final stage indicated in Figure 5 by the portion of the curve designated zone 3 the ingots are in line with the opening 34 and are removed individually by the crane 36, the door 35 being opened each time an ingot is to be removed. As previously stated, the pusher 53 is operated so as to bring the center lines of the ingots of each pair on the cars into alinement with the center line of the opening 34 and the crane 36. In other words, for the installation illustrated in which four pairs of ingots are carried by each car, the entire line of pusher cars is advanced in four steps in order to permit the removal of all eight ingots. During the removal of the ingots from the lead car, the car 54 advances into the furnace and when the lead car has been emptied, the pusher 53 and car 54 are retracted leaving space for the next car at the entrance end of the furnace. The door 12 is thus fully opened only once for each succeeding car.

While the heating cycle described is preferred, the number of zones and the temperatures to which the ingots are heated therein may be varied to suit the requirements of a particular installation.

When the lead car has been emptied, it is pushed on to the transfer car 42 and shifted to the loading track 41 after the car 47 has been retracted to the position shown in solid lines in Figure 1. Thereafter, it is pushed down the track toward the entrance end of the furnace for reloading and a loaded car is brought across the track 50 on car 54 into position for entry into the furnace.

It will be apparent from the foregoing that the invention is characterized by many outstanding advantages over the present practice of heating ingots in pit furnaces and removing the cover thereof on the charging and removal of each individual ingot. In the first place, all the ingots heated according to my invention are subjected

to substantially identical treatment so that their final temperature is uniform. This permits the blooming mill to be made fully automatic with a consequent increase in its capacity. Since the ingots are charged onto the cars while the latter are outside the furnace, the danger of injury to the furnace walls is reduced to a minimum. While removal of the ingots involves the introduction of the ram of the crane **36**, it is possible to position the ingots accurately for removal as above explained so that there is little or no danger that the crane will strike the furnace walls or fail to engage the ingot properly for safe removal.

Since the ingots are charged in successive groups, the door **12** need be opened only a fraction of the number of times the ordinary pit cover has to be removed for charging the same number of ingots. In a specific case, the door **12** need be opened only once every fifteen minutes as compared to once every one and a half minutes for the conventional pit cover. This permits a saving in the amount of fuel consumed since the cooling of the furnace resulting from such frequent opening of the door is avoided. Since the pusher cars emerge from the furnace after they are unloaded, ample opportunity is afforded for "making bottom" if necessary before reloading.

A further advantage of the invention is the fact that the amount of manual labor required is much less than in the case of pit furnaces. The smaller number of operators required, furthermore, have much more comfortable working conditions than the operators of the conventional pit furnace. The furnace may be provided with automatic means for controlling the fuel-air ratio, the stack damper position and the temperatures in the various zones whereby the utmost fuel economy may be obtained.

Although I have illustrated and described but a preferred embodiment of the invention, it will be recognized that changes in the construction disclosed may be made without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. A tunnel-type ingot-heating furnace comprising an elongated heating chamber, a track

extending therethrough, a plurality of cars adapted to travel on said track each having a floor for receiving a plurality of ingots, a door at the entrance end of the heating chamber through which the cars and ingots are admitted to the heating chamber, an exit opening at the other end of the heating chamber through which the cars pass out of the heating chamber, a second opening in one side of the heating chamber near the exit end of the heating chamber, the portion of the heating chamber at said second opening constituting a soaking zone in which the temperature is maintained substantially constant, and means operating through said second opening for removing ingots individually from each car while in the soaking zone and before the car passes out of the heating chamber, whereby the ingots in the soaking zone are maintained at substantially constant temperature during removal of each ingot therefrom.

2. In the operation of a continuous tunnel-type ingot-heating furnace, the steps of placing a plurality of ingots on a car, thereafter moving the car into and through the furnace and removing the ingots individually generally horizontally and transversely of the direction of movement of the car from the car and from the furnace while the car and ingots are within and near the exit of the furnace, whereby the ingots in the furnace adjacent the furnace exit are maintained at substantially constant temperature during removal of each ingot from the furnace.

DONALD W. LLOYD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
Re. 8,240	Johnson	May 21, 1878
66,594	Johnson	July 9, 1867
549,962	Hemphill	Nov. 19, 1895
627,835	Wellman	June 27, 1899
930,811	Smythe	Aug. 10, 1909
1,296,122	Roth	Mar. 4, 1919