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[54] **SLAB TRANSFER APPARATUS**  
**11 Claims, 6 Drawing Figs.**

[52] U.S. Cl. .... **219/10.71,**  
 219/10.69, 219/10.79; 263/6; 266/5

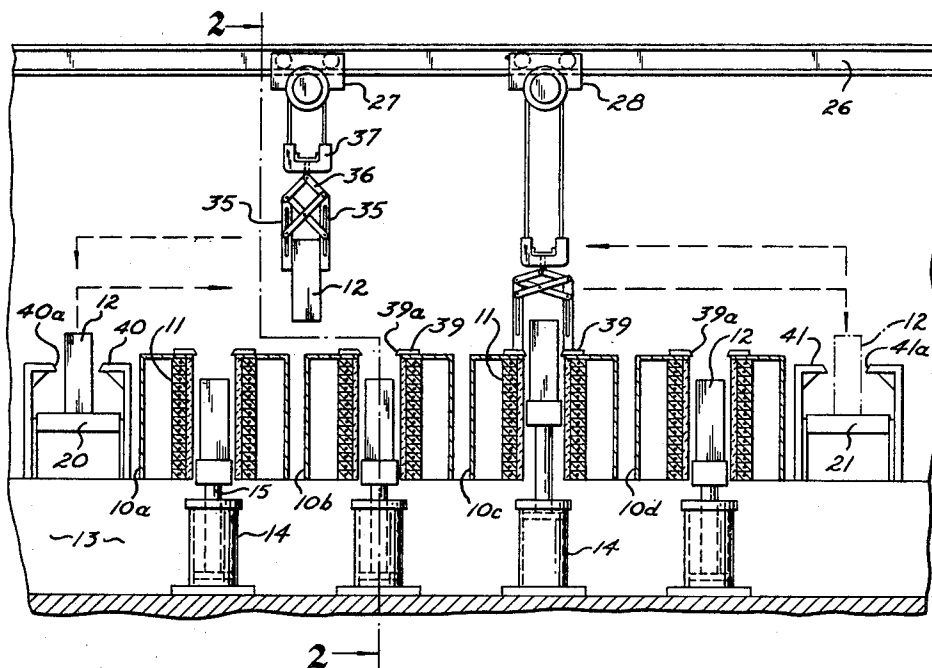
[51] Int. Cl. .... **H05b 5/00,**  
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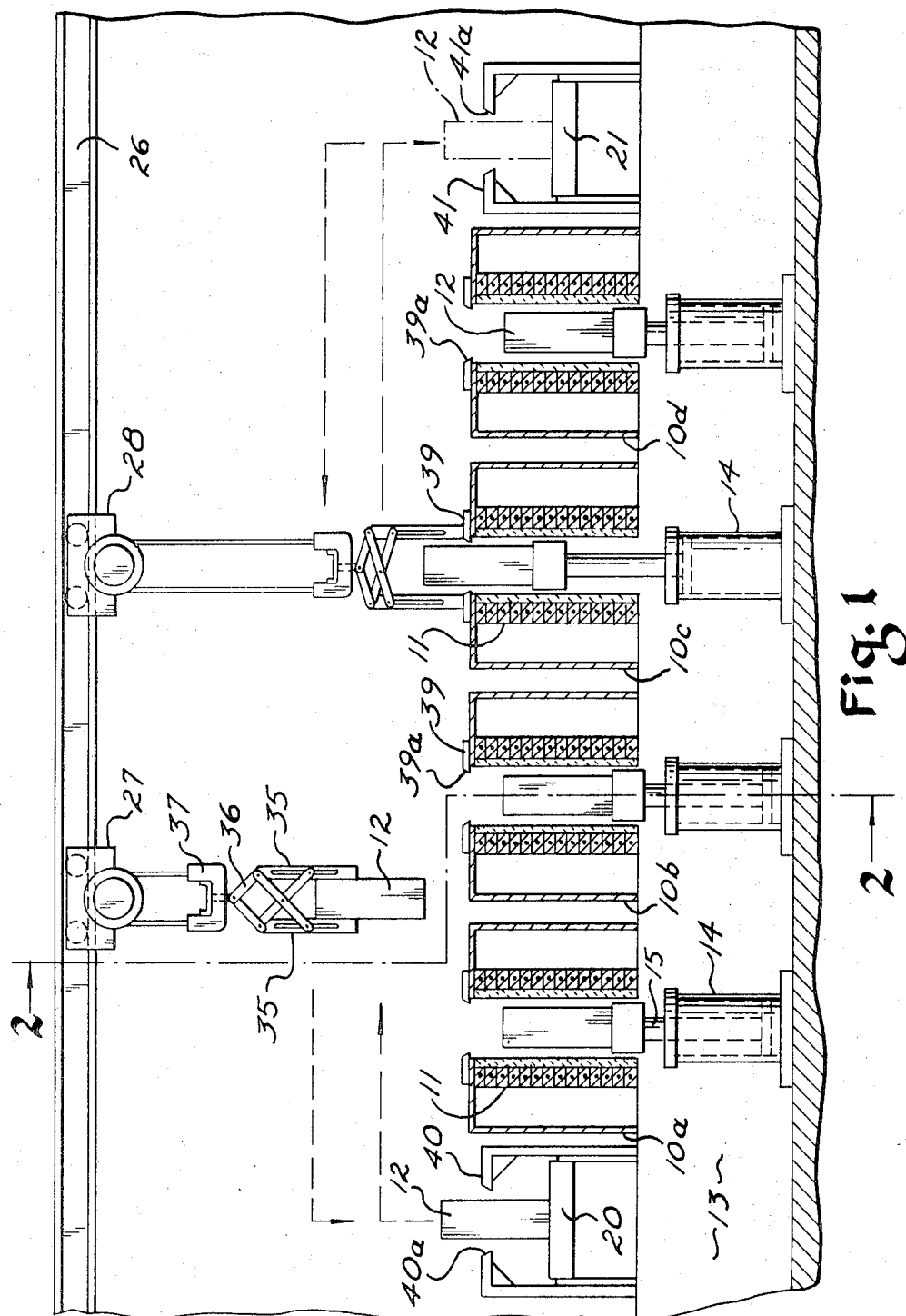
[50] Field of Search ..... 214/27;  
 263/6; 266/55; 219/10.71, 10.69, 10.79

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**ABSTRACT:** There is disclosed herein a plurality of aligned induction heaters which are open at both the top and bottom, lift means for partially ejecting a heated slab from each heater and receiving a cold slab, crane and hoist means for picking up a slab at any heater and transferring it to an outgoing conveyor, and crane and hoist means for picking up a cold slab from an incoming conveyor and delivering the same to a heater.





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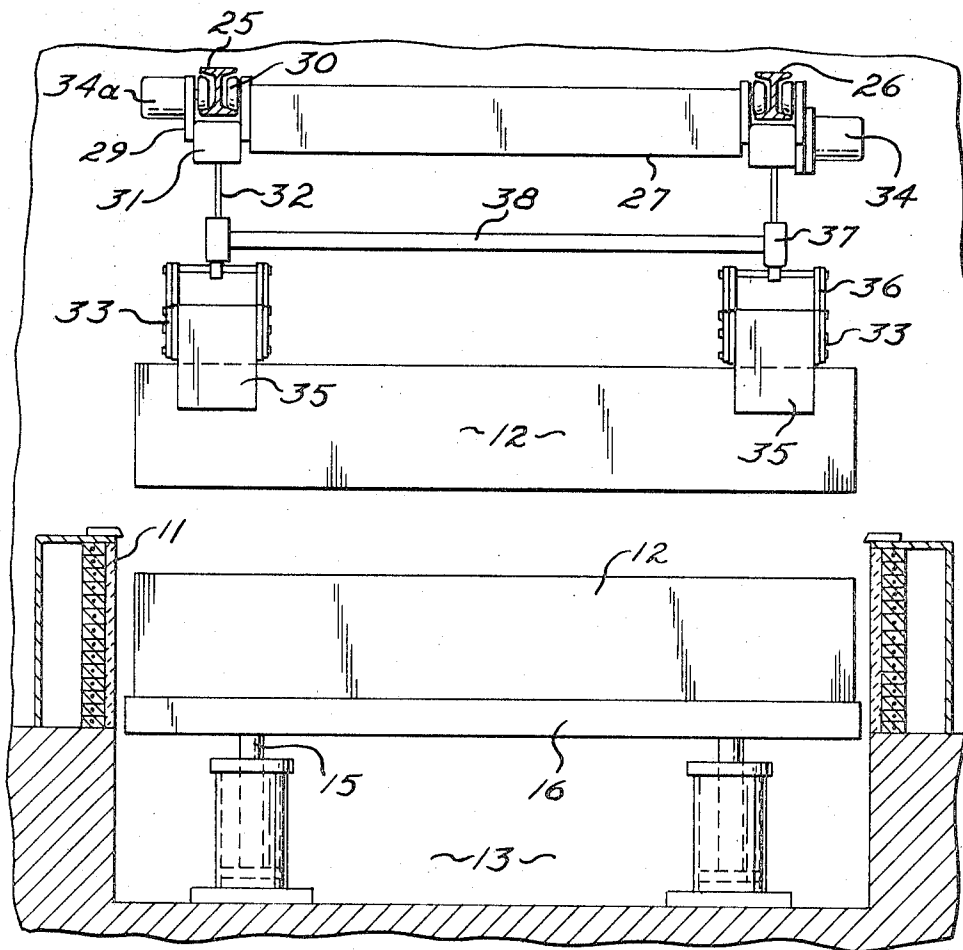


Fig. 2

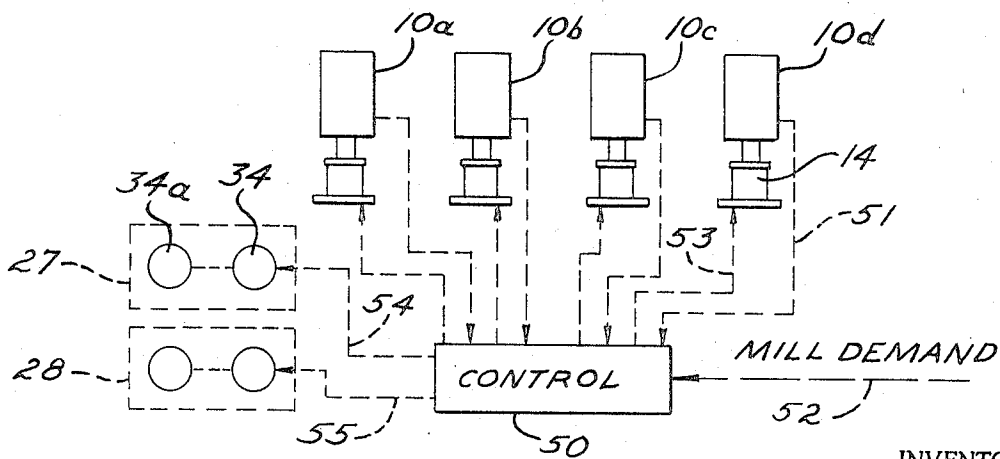
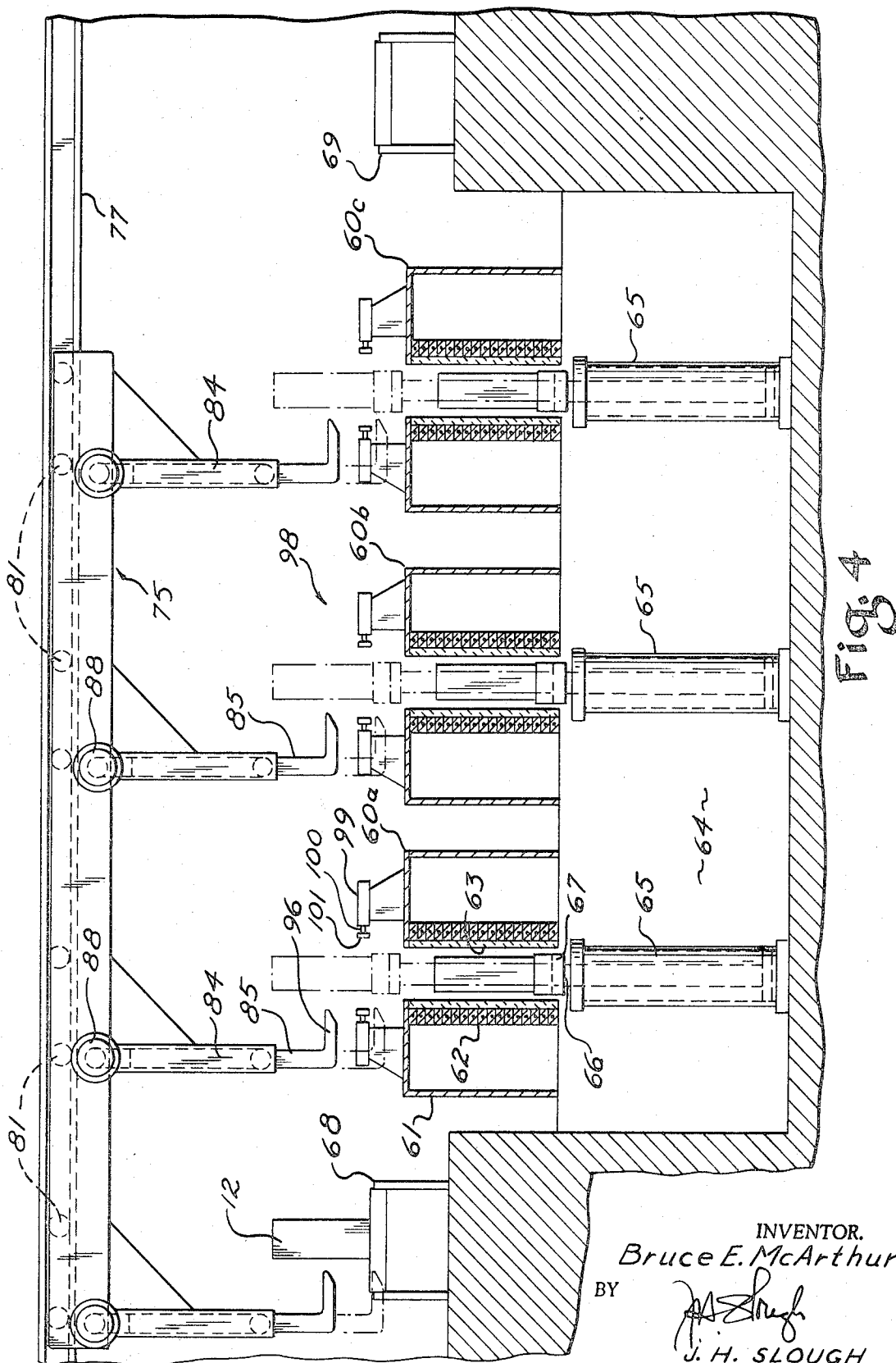
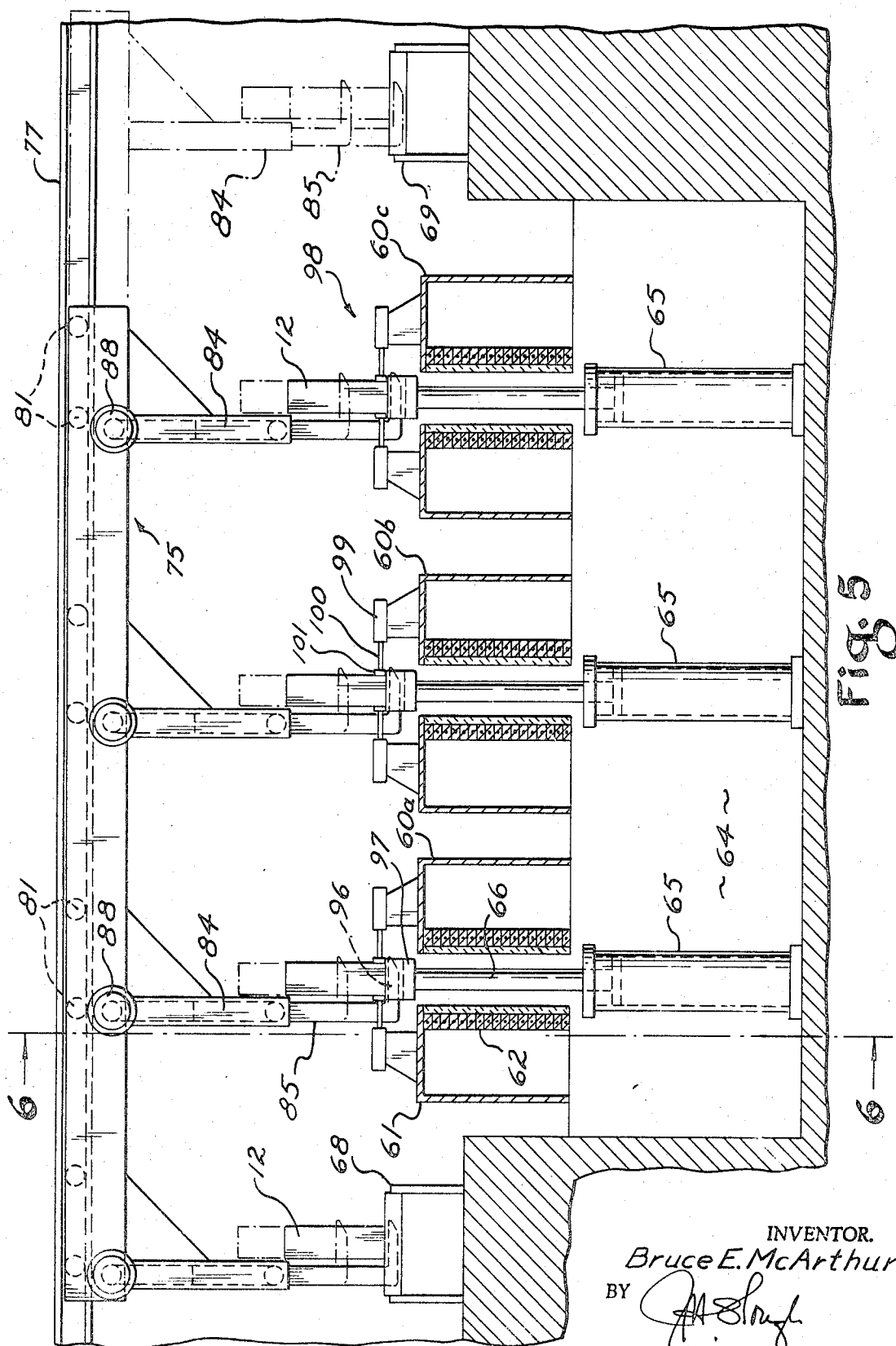


Fig. 3

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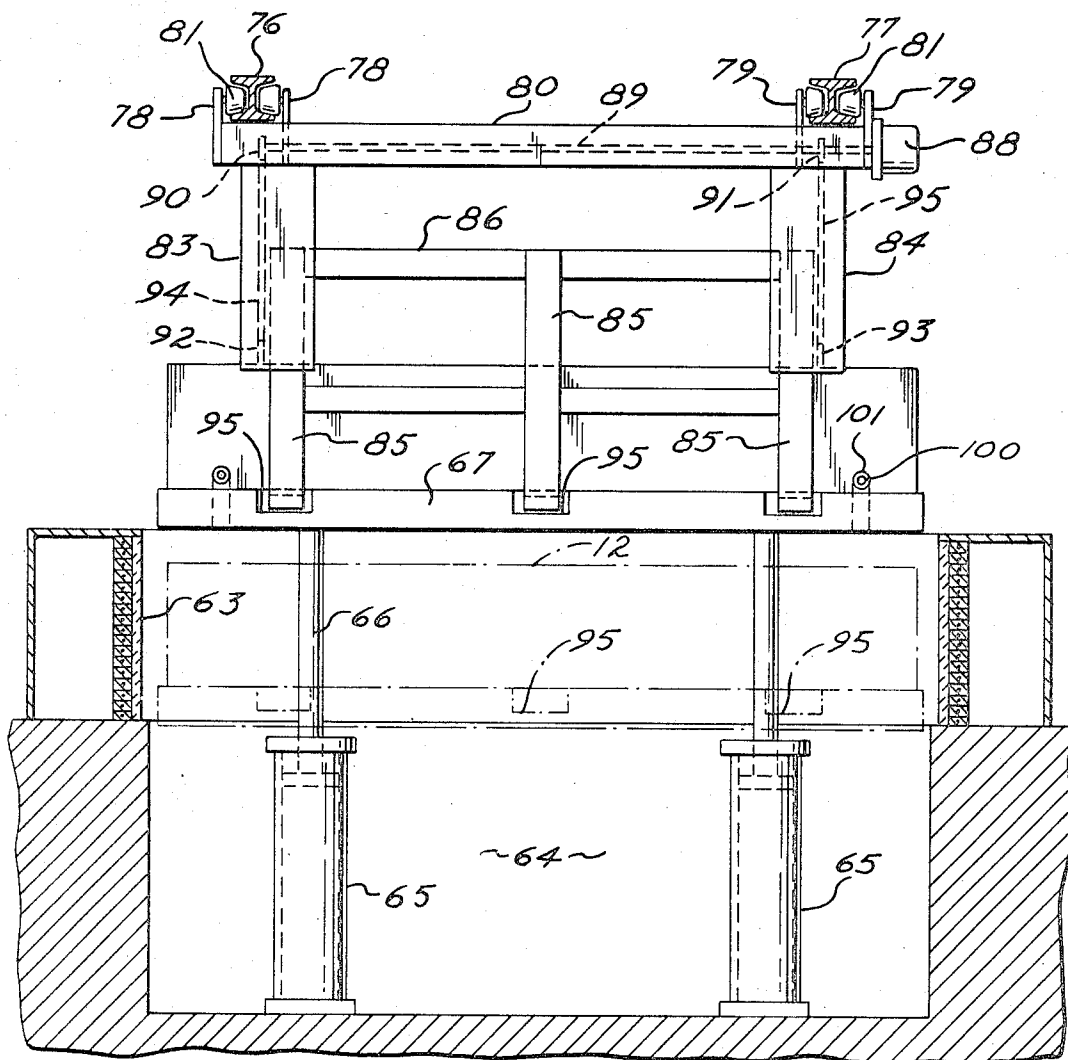


Fig. 6

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## SLAB TRANSFER APPARATUS

This invention relates to the induction heating of metal and particularly to apparatus for loading and unloading a plurality of induction heaters to provide a continuous supply of heated metal slabs to a rolling mill.

In general, the invention as herein disclosed comprises a plurality of induction heaters arranged in a line and provided with an incoming conveyor at one end of the line and an outgoing conveyor at the other end of the line. The heaters are disposed over open pits or recesses containing lift means for raising a workpiece at least partially above the upper end of the heater whereby it can be engaged by hoist means. Cold slabs are brought into the system by the incoming conveyor and are transferred to the individual heaters by a loading crane and hoist or fork means whereby the workpieces are heated to the desired temperature. An unloading crane and hoist or the above-mentioned fork means pick up the heated workpieces and transfer them to the outgoing conveyor to be delivered to a mill.

The present invention is particularly directed to and adapted for the handling of workpieces in the form of elongated slabs of metal having a greater length than width and a greater width than thickness, said slabs being disposed on one side edge during heating and transfer to and from the conveyor.

An important object of the invention is to provide means for heating an elongated slab of metal positioned on one side edge by introducing the slab into the top of an induction heater disposed on a vertical axis and removing the slab from the top of the heater.

Another object of the present invention is to provide apparatus for systematically heating workpieces in a plurality of induction heaters whereby a fully heated slab is always available upon mill demand and each heater is promptly reloaded upon removal of the heated workpiece.

Another object of the invention is to provide improved means for efficiently loading and unloading elongated slabs of metal in a plurality of induction heaters.

Still another object of the invention is to provide apparatus as set forth above including control means for maintaining a continual movement of the slabs into and out of the system.

Other objects of the invention and the invention itself will be readily understood from the following description thereof and the accompanying drawings, in which said drawings:

FIG. 1 is a semischematic elevation of the heaters, conveyors and crane and hoist means of a first form of the invention, the heaters being shown in cross section for purposes of clarity;

FIG. 2 is a transverse section taken along the line 2-2 of FIG. 1;

FIG. 3 is a simplified diagram of control means for the slab transfer apparatus;

FIG. 4 is a semischematic elevation of a second form of the invention;

FIG. 5 is a view similar to FIG. 4 showing the parts thereof in different operative positions; and

FIG. 6 is a vertical section taken along the line 6-6 of FIG. 5.

Referring now to the drawings in all of which like parts are designated by like reference numerals, FIG. 1 shows a plurality of like induction heaters 10a, 10b, 10c, and 10d. Each heater is provided with an induction coil 11 defining an opening adapted to receive an elongated slab 12 which has a greater length than width and a greater width than thickness and which said slab is disposed on one side edge whereby the width thereof becomes its vertical dimension. The heaters are open at both the top and bottom and are disposed above an open pit or recess 13 wherein there are mounted a plurality of hydraulic lifts 14 having upwardly projecting piston rods 15. As shown in FIG. 2, two lifts 14 are provided beneath each of the heaters, the upper ends of the piston rods 15 thereof carrying an elongated slab support 16 adapted to receive one of the slabs 12 disposed edgewise thereon. FIG. 2 shows the normal heating position of the lifts 14 wherein the slab 12 is substan-

tially axially centered with respect to the induction coil 11 where it remains static during heating.

Adjacent to the first heater 10a there is provided an incoming conveyor 20 by means of which cold slabs 12 are initially introduced into the system. Adjacent to the heater 10d, there is provided an outgoing conveyor 21 by means of which a heated slab 12, as shown in broken lines in FIG. 1, is conveyed to the mill upon demand.

The means for loading and unloading the heaters 10a-10d also include a pair of laterally spaced I-beams 25 and 26 across which overhead cranes 27 and 28 are mounted. The cranes 27 and 28 are identical in construction although different in function, the crane 27 serving as a heater loading crane and the crane 28 serving as a heater unloading crane. These cranes may be of any conventional form and as herein disclosed comprise end housings 29 adapted for rolling engagement with the lower flanges of the I-beams 25 and 26 by means of beveled wheels 30. Each housing 29 also carries pulley means 31 supporting downwardly directed cables 32 having conventional lifting grabs 33 at their lower ends. The pulley means 31 may be synchronously driven by a reversible hoist motor 34 whereby the grabs 33 can be raised and lowered in a conventional manner, and the cranes are driven along the I-beams by suitable motors 34a.

The grabs 33 are of a known type having parallel gripping jaws 35 connected by parallel acting linkage 36 the upper ends of which are pivotally carried by U-shaped cable retainers 37. As shown in FIG. 2, the retainers 37 are preferably connected by a stabilizing means 38 to prevent the grabs from twisting relative to each other.

As illustrated in FIG. 1, the grabs 33 are of the type which open automatically when the weight of the jaws 35 is taken off of the linkage 36 and which, conversely, tighten or move inwardly with a force proportional to the load disposed between said jaws. The weight of the slab 12 carried by the grabs 33 of the loading crane 27 in FIG. 1 causes the jaws 35 thereof to grip the said slab sufficiently so that the same may be lifted by operation of the hoist means. On the other hand, the grabs 33 of the unloading crane 28 have the jaws 35 thereof in the open position while resting on top of the heater 10b, the angle of the linkage 36 flattening in a horizontal plane to allow this opening movement. It will be noted that the upper ends of the heaters 10a-10d are provided with protective guide stops 39 extending slightly inwardly of the heater opening. The inner ends of said guide stops are provided with downwardly and inwardly angled, sloping guide surfaces 39a for directing the lowering slab toward the center of the heater. By providing a reduced opening at the top of each heater, the guide stops 39 ensure that a slab inserted into the heater will not touch or damage the inner walls of the heater. Said guide stops also provide striking or abutment means for receiving the lower ends of the jaws 35 to cause them to open. It will be further noted that similar guide stops 40 and 41 having sloping guide surfaces 40a and 41a, respectively, are provided on either side of the conveyors 20 and 21, respectively, to cause opening of the grabs 33 when they are lowered over said conveyors.

In operation, all of the heaters 10a-10d are initially loaded by the loading crane 27. This is effected by lowering the grabs 33 thereof downwardly onto the guide stops 40 whereby the jaws 35 open up. The conveyor 20 can then convey a cold slab in between the jaws 35. When the grabs 33 of said loading crane 27 are raised, the jaws 35 move inwardly to pick up the slab whereby it can be conveyed to any one of the heaters. At any given heater, the lift 14 is actuated to move the piston rods 15 and the slab support 16 upwardly to the position shown with respect to heater 10c in FIG. 1. In this position, the cold slab can be lowered onto the slab support 16, further lowering the hoist means causing the jaws 35 to open whereby the slab can be lowered to the normal heating position of 10a, 10b, and 10d.

When the slabs are heated and upon mill demand, the unloading crane 28 picks up the heated slabs and transfers them to the outgoing conveyor 21. To effect the unloading opera-

tion, the grabs 33 of the unloading crane 28 are lowered over the selected furnace to the position illustrated in FIG. 1 wherein the jaws 35 open. The associated lifts 14 then move the slab 12 upwardly to the position illustrated whereby the same can be engaged by the grabs 33 for movement to the outgoing conveyor 21.

In the system and apparatus disclosed, it is desired that the heaters be continuously loaded with cold slabs as the heated slabs are removed and transferred to the mill. As shown in FIG. 3, a central or main control 50 is adapted to receive control data or signals from the heaters 10a—10d and from the mill indicating that a heated slab is to be transferred to the outgoing conveyors 21. Broken lines 51 from the heaters indicate, for example, the transmission of temperature sensing information back to the controls indicating which of the heaters contains a completely heated slab. Broken line 52 indicates means for mill demand signals to be transferred to the main control which will not effect delivery of a slab to the outgoing conveyor 21 unless such demand is made. The broken line 53 indicates control signals which can be directed to the lifts 14 to selectively actuate the same if a heated slab in a given heater is to be raised to the position illustrated in FIG. 1 at heater 10c. The broken lines 54 and 55 represent control lines directed to the loading crane 27 and unloading crane 28, respectively, to actuate the same to remove a selected heated slab from a given heater and to load said given heater with a cold slab.

The main or central control 50 may comprise computer storage and read out means for effecting a programed sequence of operations or may comprise any other suitable, known control means. It will be readily understood that the control 50 will actuate the unloading crane 28 only when it is determined that there is a demand from the mill and that one of the slabs in one of the heaters has reached sufficient temperature to be delivered to the mill. When the proper conditions are met, said control will actuate the unloading crane 28 to unload the heater and transfer the slab to the outgoing conveyor 21. At the same time, the loading crane 27 will pick up a cold slab and move the same toward and into the now empty heater.

The second embodiment of the invention as shown in FIGS. 4—6 also comprises a plurality of induction heaters arranged in a line between an incoming conveyor and an outgoing conveyor and includes a transfer mechanism for synchronously picking up and depositing slabs at the heaters and conveyors

The induction heaters are shown at 60a, 60b, 60c, each heater comprising a frame 61, an induction coil 62, and a relatively thin inner refractory lining 63. Said heaters are bridged across a pit or recess 64 in which said recess are mounted a plurality of hydraulic lifts 65 having upwardly acting piston rods 66 carrying slab supports 67 for raising and lowering slabs 12. As in the first embodiment of the invention, the heaters 60a—60c are open at both the top and bottom, and a lift 65 is provided beneath each heater for transferring a slab between the full line, static heating position and the broken line position shown in FIG. 4. The incoming conveyor is indicated at 68 and the outgoing conveyor is shown at 69, and it will be noted that both said conveyors are disposed at substantially the same level as the slab support when said slab supports are in their upper, broken line position.

The slabs 12 are transferred horizontally by means of an overhead transfer mechanism 75 carried by a pair of laterally spaced, overhead I-beams 76 and 77. The mechanism 75 comprises pairs of horizontal side frame members 78 and 79 transversely connected by cross beams 80 and adapted for rolling engagement with the lower flanges of said overhead I-beams by means of beveled wheels 81.

The framework comprising the side frame members and cross beams is provided with four pairs of transversely aligned, downwardly projecting fork mounting members 83 and 84 adapted to guide vertically acting forks 85. As best seen in FIG. 6, each pair of mounting members 83 and 84 carries three forks 85, one fork being disposed midway between said

mounting members, and two endmost forks being slidably received in said mounting members. Transverse braces 86 and 87 unitarily connect all three forks 85 for movement vertically as a unit. Means for the forks may comprise any suitable known mechanism, and as herein disclosed includes a motor and gear transmission 88 mounted on the outer side frame member 79 and driving a shaft 89 having sprockets 90 and 91 carried thereby generally above the outermost forks 85. The lower ends of the fork mounting members 83 and 84 are provided with sprockets 92 and 93 connected by chains 94 and 95 to the upper sprockets 90 and 91. It will be readily understood, that the fork assembly is connected in any suitable manner to the chains 94 and 95 whereby rotation of the shaft 89 by the motor and gear transmission means 88 causes the forks to move vertically. It will be further noted in FIG. 6 that the slab supports 67 are each provided with three recesses or cutouts 95 extending transverse to the longitudinal dimension of the slab support adapted to receive horizontally projecting tines 96 of the forks 85.

Slab aligning hydraulic pushers 98 are mounted in opposed pairs on top of the heater frames 61, each pusher comprising a hydraulic cylinder and piston motor 99 having a piston rod 100 preferably provided at its outer end with an enlarged end portion 101.

The pushers 98, acting in opposed pairs adjacent to the ends of the slab 12, are adapted to correct any misalignment of the slab when it is deposited upon a slab support 67 just prior to said slab being lowered into the heater. After the slab is deposited, said pushers are actuated whereby the piston rods 100 are moved from their retracted position as shown in FIG. 4 to the extended position shown in FIG. 5 whereby the enlarged end portions are brought against the sides of the slab 12. Thus any skewing of the slab is corrected before the same is lowered into the heater thereby preventing contact with and damage of the relatively thin refractory lining. It will be readily appreciated that in induction slab heaters, any space between the wall and the load is extremely costly in terms of capacitors and efficiency. Therefore, only a minimum space can be provided in practice. To keep this space at a minimum, the refractory lining must also be thin and cannot possibly stand being scraped by a slab. Therefore, it is necessary to guide the slab in and out of the heater very precisely.

In operation, the overhead transfer mechanism 75 is movable horizontally along the I-beams 76 and 77 between the full and dotted line positions of FIG. 5 by any suitable means such as a motor and gear transmission means 102 shown in FIG. 6. The motor and gear transmission means 88 which drive the forks 85 are synchronized to simultaneously move said forks between the dotted and full line positions shown in FIGS. 4 and 5. The heaters 60a—60c are adapted to sequentially heat each slab 12 to successively higher temperatures whereby when the slab is finally removed from the heater 60c and transferred to the outgoing conveyor 69, the same has reached the proper temperature to be received at the rolling mill. As the slabs 12 of the heaters are indexed toward the right, a new slab is transferred from the incoming conveyor 68 to the number one heater 60a.

Assuming an initial condition as shown in full line in FIG. 4 wherein each of the heaters contains a slab 12 and wherein the lifts 65 are in the lowered position, upon demand from the mill, the forks 85 are lowered to the broken line position shown therein and the said lifts are actuated to raise the slabs to their uppermost position, also shown in broken line. The motor and gear transmission means 102 is then actuated to move the transfer mechanism to the right whereby the tines 96 move beneath the slab 12 on the incoming conveyor 68 as well as the slabs at each of the heaters. The tines of the forks disposed over the heaters can, of course, enter the recesses or cutouts 95 in the slab support 67 whereby they can pass under the slabs.

The slabs 12 are then lifted off of the slab support 67 to the elevated, broken line position of FIG. 5 whereby they can be indexed to the right to place the new slab from the incoming

conveyor over the first heater 60a, the slab from said first heater over the heater 60b, the slab from the heater 60b over the heater 60c, and the fully heated slab from the last heater over the outgoing conveyor 69. The forks 85 are then lowered to deposit the slabs at the respective heaters and outgoing conveyor and at this time the pushers 98 are actuated to correct any skewing of the slabs disposed over the heaters. The transfer mechanism 75 is then moved rearwardly to clear the times from the slabs, and the pushers 98 are retracted whereby the lifts 65 can lower said slabs into the heater. In continuous operation, the forks 85 do not need to be returned to the neutral or raised position at the left of the heaters and conveyors between transfers of the slabs since adequate clearance is provided for the forks to pass between the pushers 98 and similar clearance is preferably provided at the conveyors by providing suitable breaks or openings in said conveyors.

The present invention; that is, wherein an elongated load is positioned on one side edge and statically heated within an axially vertical heater, a lift mechanism is provided for at least partially projecting the slab above the heater, and means are provided above the heater for transferring the slab to an outgoing conveyor can readily be applied to a single heater if desired. However, the invention is particularly well adapted for use with multiple heaters used individually to completely heat slabs, as shown in the first embodiment, or in a line of multiple heaters used for progressive or stage heating, as shown in the second embodiment. It will also be understood that the transfer mechanisms as shown herein are disclosed only in their most simplified forms, the exact structural details thereof forming no part of the present invention.

It will be understood that many changes in the details of the invention as herein described and illustrated may be made without, however, departing from the spirit thereof or the scope of the appended claims.

#### I claim:

1. In a system for heating elongated metal slabs of greater length than width and greater width than thickness disposed on one side edge, a plurality of induction heaters arranged in a line and disposed on vertical axes and open at the tops and bottoms thereof; lift means projecting upwardly through the bottom of each said heater for supporting a slab in a first position within the heater for static heating thereof; each said lift means being movable to a raised position for at least partially projecting a heated slab above the top of the heater and for receiving another slab; means for loading and unloading the slabs comprising overhead transfer means disposed for movement along said line; an incoming conveyor at one end of said line for delivering unheated slabs to a position to be picked up by said transfer means; an outgoing conveyor at the opposite end of said line for receiving heated slabs; control means for receiving a demand signal from a mill and for determining that at least one of the slabs in one of said heaters in said line is completely heated; said control means including means actuating at least the lift means at said one heater to raise the heated slab, and means actuating said transfer means to deliver the heated slab away from said line and onto said outgoing conveyor and to deliver an unheated slab from said incoming conveyor into said line.

2. In a system for heating elongated metal slabs of greater length than width and greater width than thickness disposed on one side edge, a plurality of induction heaters arranged in a line; each heater disposed on vertical axes and open at the tops and bottoms thereof; lift means projecting upwardly through the bottom of each said heater for supporting a slab in a first position within the heater for static heating thereof; each said lift means being movable to a raised position for at least partially projecting a heated slab above the top of said heater and for receiving another slab; and means for loading and unloading the slabs from the top of each said heater comprising overhead transfer means disposed for movement along said line; an incoming conveyor at one end of said line for delivering unheated slabs to a position to be picked up by said transfer means; and an outgoing conveyor at the opposite end

of said line for receiving heated slabs, means for aligning each slab with each said heater when the slab is deposited upon said lift means in raised position prior to each slab being lowered into each said heater.

3. In a system for heating elongated metal slabs of greater length than width and greater width than thickness disposed on one side edge, a plurality of induction heaters arranged in a line; each heater disposed on vertical axes and open at the tops and bottoms thereof; lift means projecting upwardly through the bottom of each said heater for supporting a slab in a first position within the heater for static heating thereof; each said lift means being movable to a raised position for at least partially projecting a heated slab above the top of said heater and for receiving another slab; and means for loading and unloading the slabs from the top of each said heater comprising overhead transfer means disposed for movement along said line; an incoming conveyor at one end of said line for delivering unheated slabs to a position to be picked up by said transfer means; and an outgoing conveyor at the opposite end of said line for receiving heated slabs; control means for receiving a demand signal from a mill and for determining the location of completely heated slabs in said heaters; said control means including means actuating a lift means at a selected heater to raise a heated slab, means actuating said overhead transfer means to deliver the heated slab of the selected heater to the outgoing conveyor and means actuating said overhead transfer means to pick up an unheated slab from the incoming conveyor and deposit said unheated slab in the empty heater.

4. In a system for heating elongated metal slabs of greater length than width and greater width than thickness disposed on one side edge, a plurality of induction heaters arranged in a line; each heater disposed on vertical axes and open at the tops and bottoms thereof; lift means projecting upwardly through the bottom of each said heater for supporting a slab in a first position within the heater for static heating thereof; each said lift means being movable to a raised position for at least partially projecting a heated slab above the top of said heater and for receiving another slab; and means for loading and unloading the slabs from the top of each said heater, said means for loading and unloading slabs comprising first hoist means for transferring an unheated slab to an empty heater having the lift means thereof in said raised position whereby said slab can be lowered to said first position for heating; and second hoist means for engaging a heated slab in raised positions and transferring said heated slab away from said line.

5. In a system for heating elongated metal slabs of greater length than width and greater width than thickness disposed on one side edge, a plurality of induction heaters arranged in a line having incoming and an outgoing end; each heater disposed on vertical axes and open at the tops and bottoms thereof; lift means projecting upwardly through the bottom of each said heater for supporting a slab in a first position within the heater for a static heating thereof; each said lift means being movable to a raised position for at least partially projecting a heated slab above the top of said heater and for receiving another slab; and means for loading and unloading the slabs from the top of each said heater comprising overhead transfer means disposed for movement along said line; an incoming conveyor at one end of said line for delivering unheated slabs to a position to be picked up by said transfer means; and an outgoing conveyor at the opposite end of said line for receiving heated slabs, said heaters adapted to successively heat slabs in said heaters to progressively higher temperatures from the incoming to the outgoing ends of said line; said lift means adapted to raise and lower said slabs simultaneously within said heaters; said means for loading and unloading the slabs comprising overhead transfer means adapted to simultaneously pick up all of the slabs in raised position, index each slab to the heater of next higher temperature, move a new slab into the heater of lowest temperature, and move the slab from the heater of highest temperature away from said line.

6. In a system as set forth in claim 4: control means for receiving a demand signal from a mill and for determining the

location of completely heated slabs in said heaters; said control means including means actuating a lift means at a selected heater to raise a heated slab, means actuating said second hoist means to deliver the heated slab away from said heaters and toward the mill, and means actuating said first hoist means to deliver an unheated slab to the empty heater and deposit said slab in said empty heater.

7. In a system as set forth in claim 4: said hoist means being movable along said line above said heaters; an incoming conveyor at one end of said line for delivering unheated slabs to a position to be picked up by said first hoist means; and an outgoing conveyor at the opposite end of said line for receiving heated slabs from said second hoist means.

8. In a system as set forth in claim 4: control means for receiving a demand signal from a mill and for determining the location of completely heated slabs in said heaters; said control means including means actuating a lift means at a selected heater to raise a heated slab, means actuating said second hoist means to deliver the heated slab of the selected heater to the outgoing conveyor, and means actuating said first hoist means to pick up an unheated slab from the incoming conveyor and deposit said unheated slab in the empty heater.

9. In a system as set forth in claim 5: an incoming conveyor

disposed adjacent to the incoming end of said line; an outgoing conveyor disposed adjacent to the outgoing end of said line; said transfer means adapted to pick up a slab at said incoming conveyor and deposit a fully heated slab at said outgoing conveyor with each indexing movement.

10. In a system as set forth in claim 9: said overhead transfer means comprising a plurality of vertically movable fork means connected together in spaced intervals equal to the spacing between said heaters and conveyors; means for simultaneously lowering and raising said fork means; means for moving said fork means horizontally along said line; said lift means adapted to project said slabs above said heaters whereby said fork means can be projected under slabs at said incoming conveyor and said heaters, said slabs can be raised and moved to the next heater with one slab being moved away from said line toward said outgoing conveyor and a new slab being introduced into said line, said slabs can be lowered to the lift means of the next adjacent heater and said outgoing conveyor.

11. In a system as set forth in claim 10: means for aligning each slab with each heater when said slab is deposited upon said lift means in raised position prior to said slab being lowered into the heater.

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**UNITED STATES PATENT OFFICE**  
**CERTIFICATE OF CORRECTION**

Patent No. 3,553,414 / Dated January 5, 1971

Inventor(s) Bruce E. McArthur

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet insert -- [73] assignee Ajax Magnethermic Corporation, Warren, Ohio, a corporation of Ohio --. Column 4, line 4, "Means for the forks" should read -- Means for propelling the forks 85 --.

Signed and sealed this 30th day of November 1971.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.  
Attesting Officer

ROBERT GOTTSCHALK  
Acting Commissioner of Patent: