

Jan. 20, 1959

Q. M. BLOOM

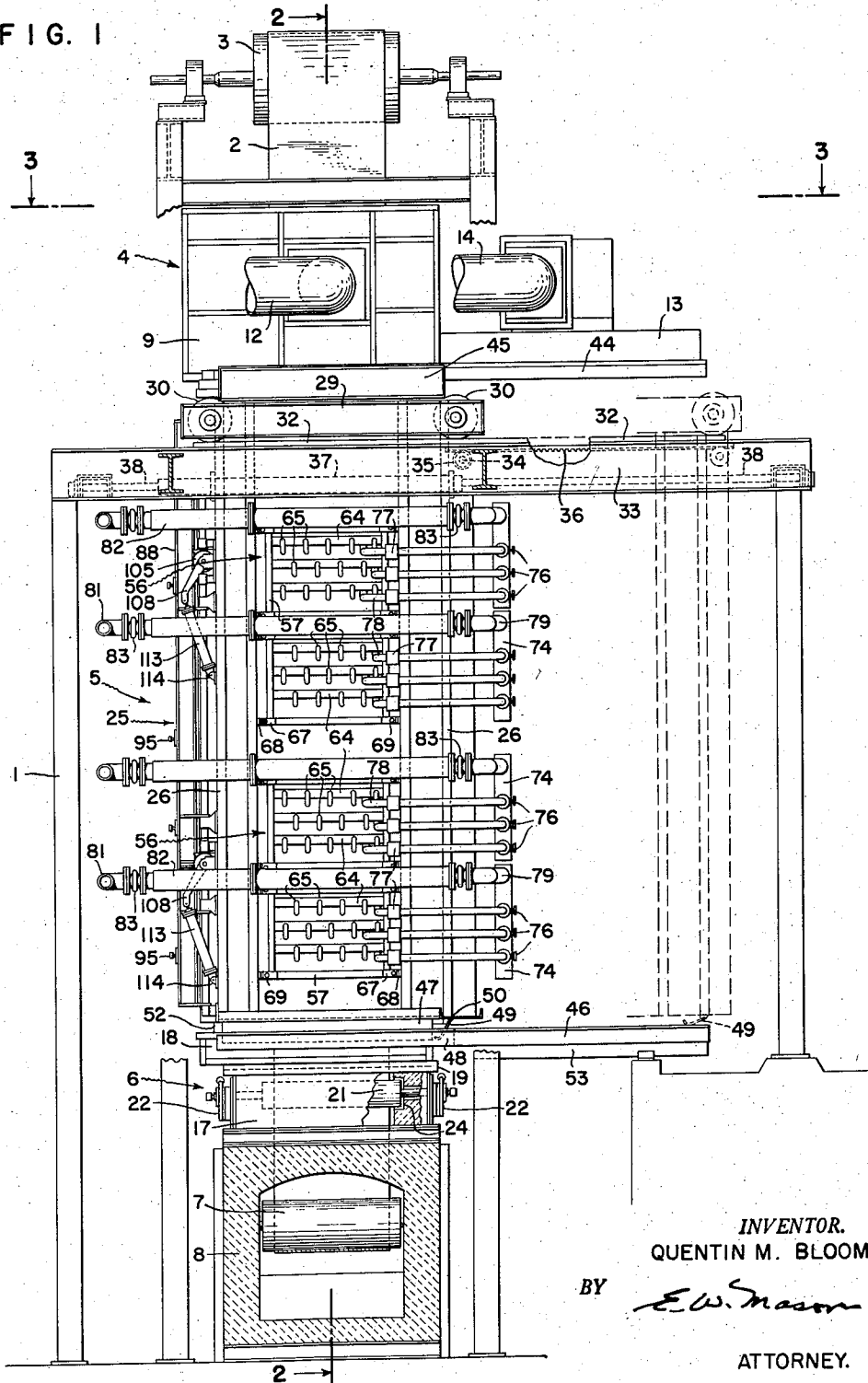
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STRIP HEATING FURNACE

Filed May 19, 1955

6 Sheets-Sheet 1

FIG. 1



INVENTOR.
QUENTIN M. BLOOM

BY *E. W. Mason*

ATTORNEY.

Jan. 20, 1959

Q. M. BLOOM

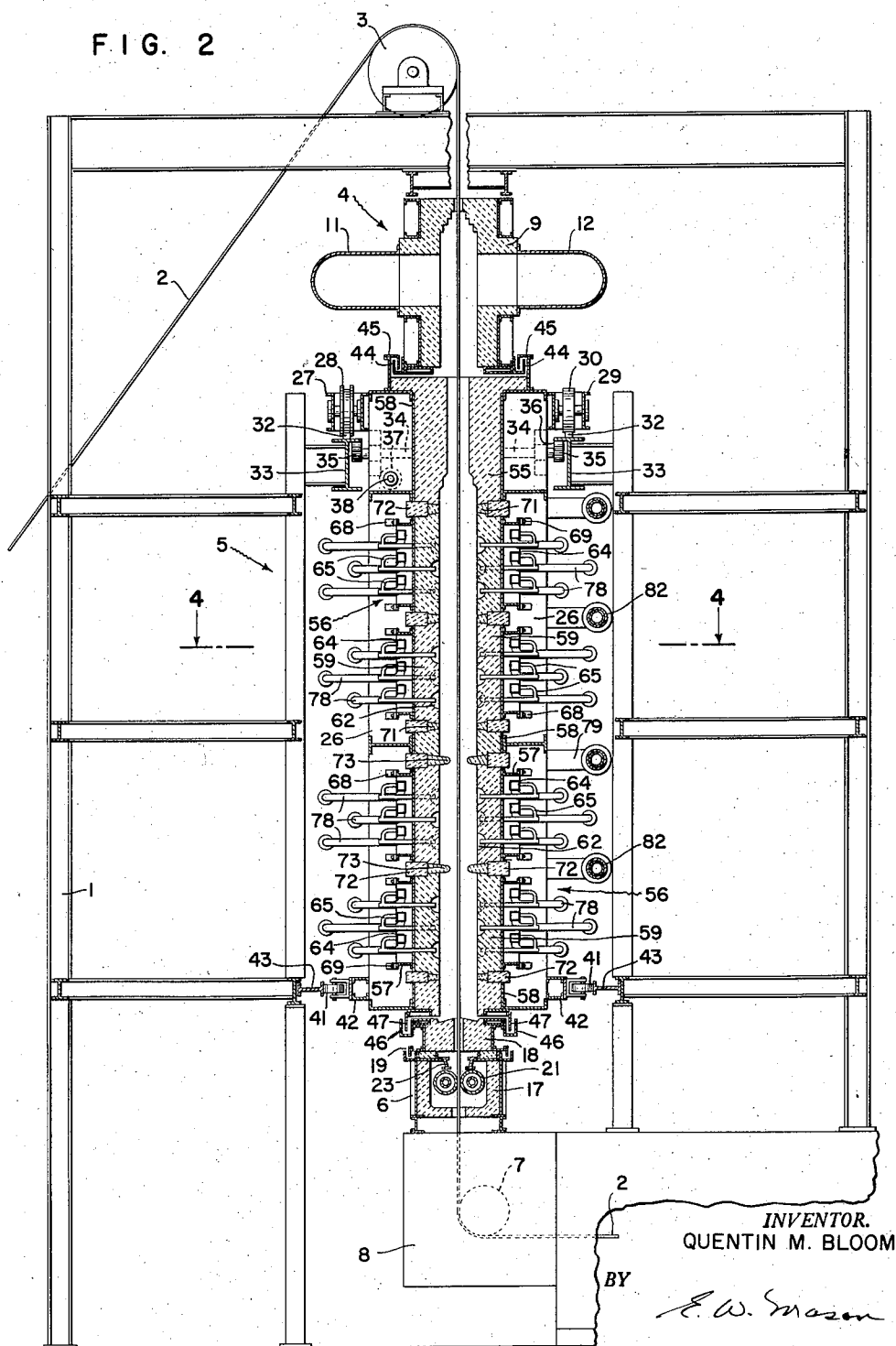
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STRIP HEATING FURNACE

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FIG. 2



Jan. 20, 1959

Q. M. BLOOM

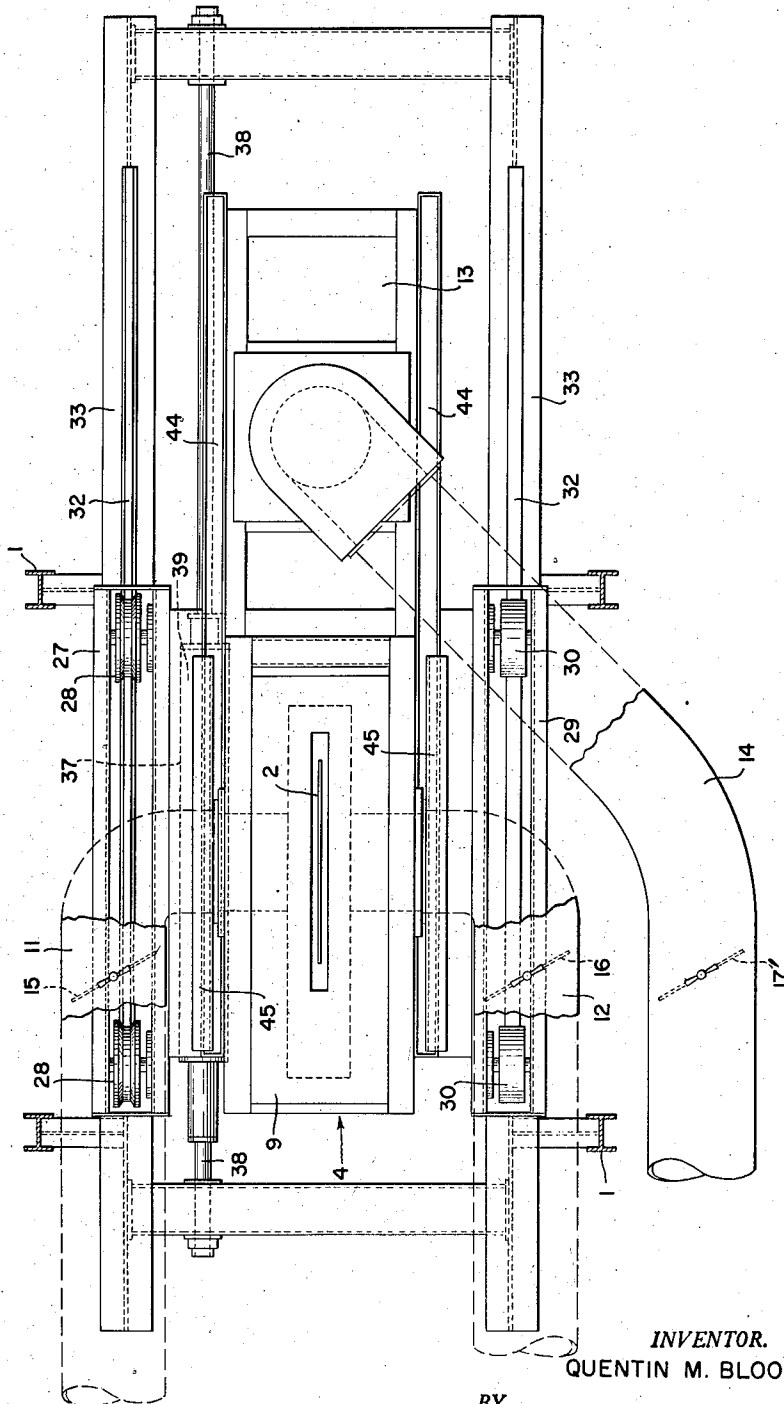
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STRIP HEATING FURNACE

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FIG. 3



BY

INVENTOR.
QUENTIN M. BLOOM

E. W. Mason

ATTORNEY.

Jan. 20, 1959

Q. M. BLOOM

2,869,846

STRIP HEATING FURNACE

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FIG. 5

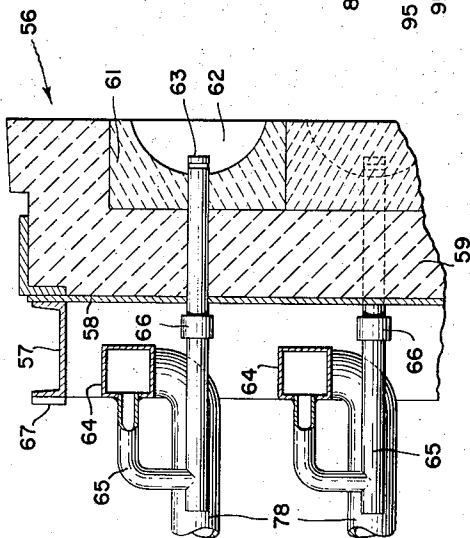
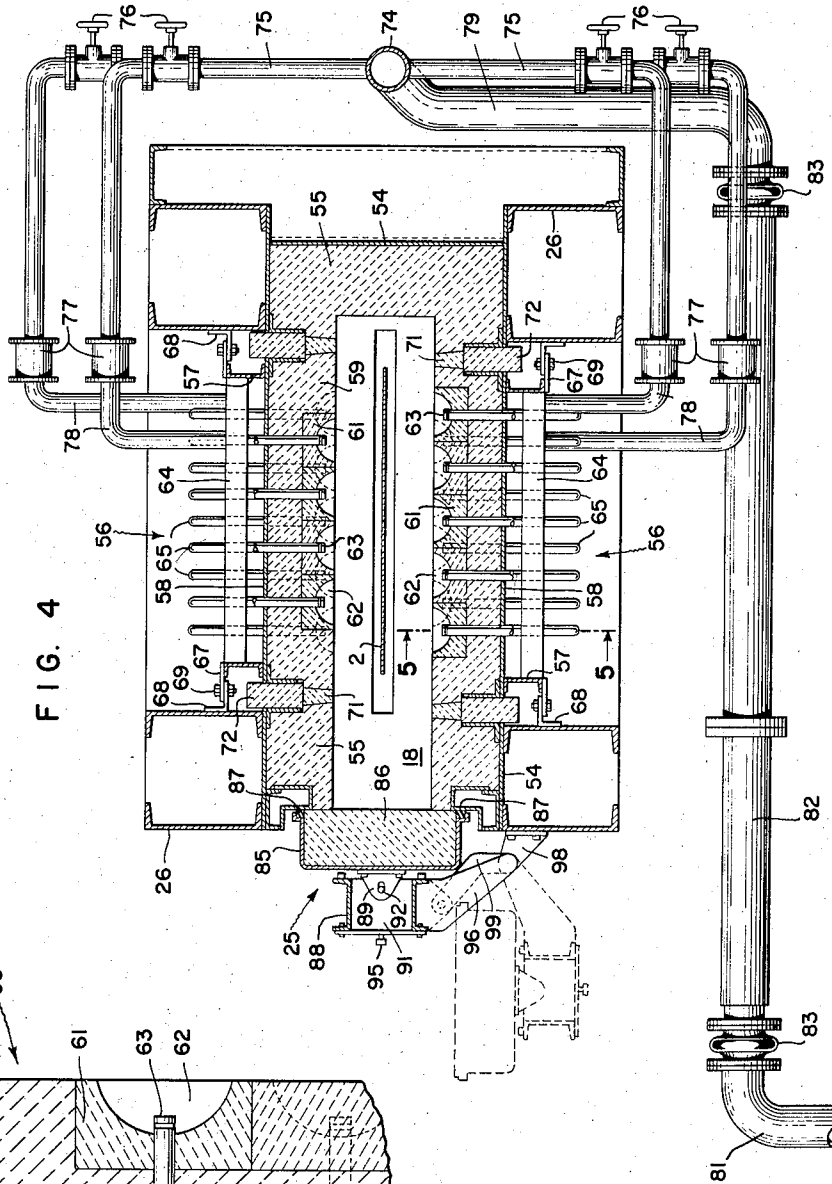


FIG. 4



INVENTOR.
QUENTIN M. BLOOM

BY *E. W. Mason*

ATTORNEY.

Jan. 20, 1959

Q. M. BLOOM

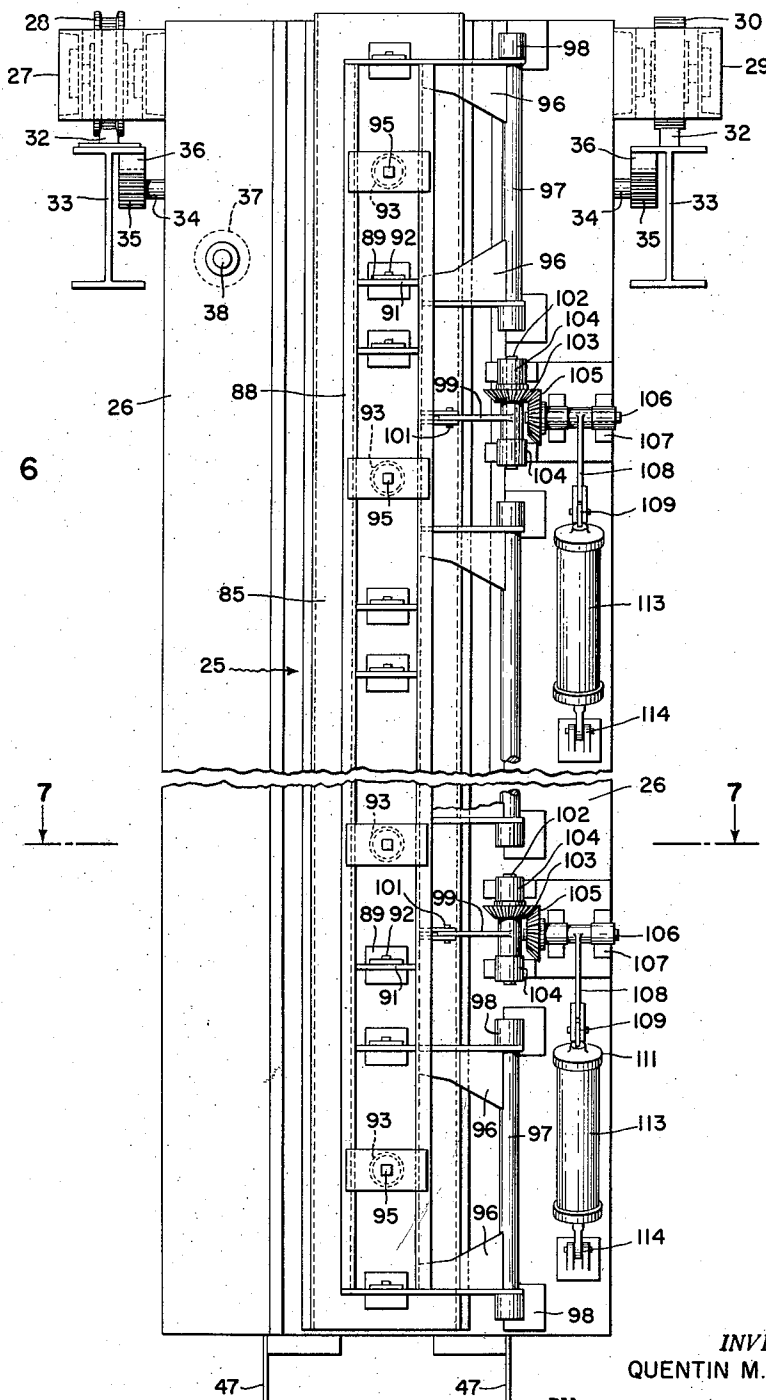
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STRIP HEATING FURNACE

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FIG. 6



INVENTOR.
QUENTIN M. BLOOM

BY

E. W. Mason

ATTORNEY.

Jan. 20, 1959

Q. M. BLOOM

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STRIP HEATING FURNACE

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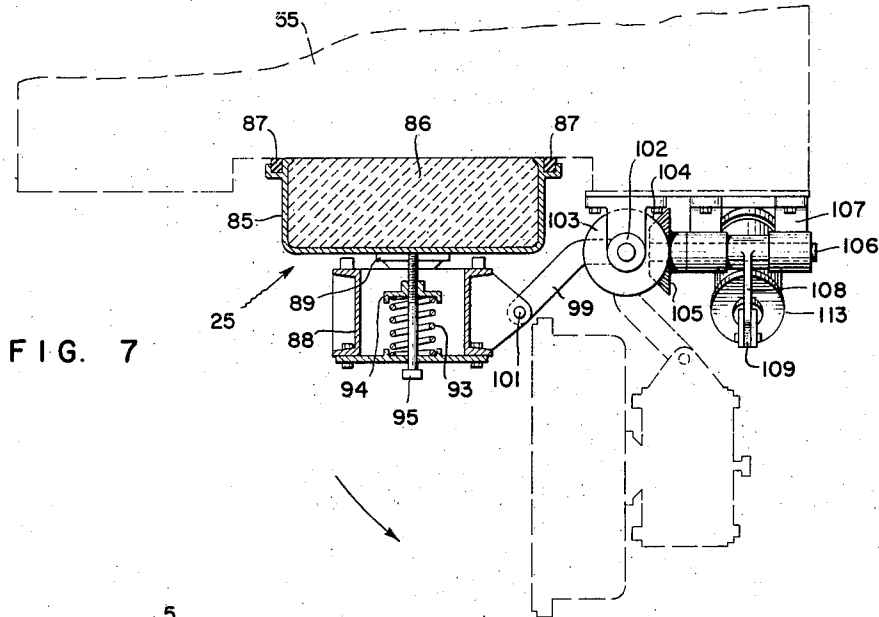


FIG. 7

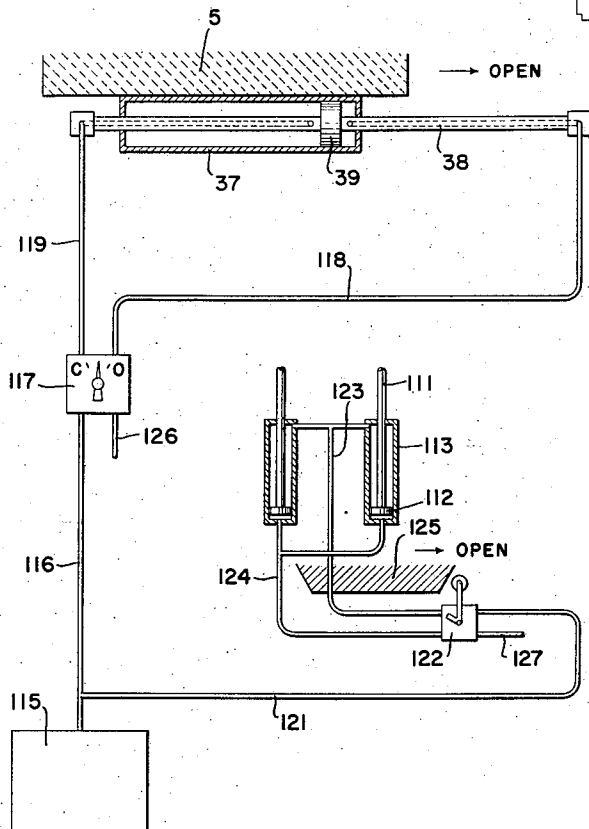


FIG. 8

INVENTOR.
QUENTIN M. BLOOM

BY

E. W. Snason

ATTORNEY

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2,869,846

STRIP HEATING FURNACE

Quentin M. Bloom, Huntingdon Valley, Pa., assignor to Selsas Corporation of America, Philadelphia, Pa., a corporation of Pennsylvania

Application May 19, 1955, Serial No. 509,633

12 Claims. (Cl. 263—3)

The present invention relates to furnaces, and more particularly to a furnace to be used for the continuous heating of strip metal such as strip steel or brass for the purpose of annealing or tempering the metal.

It has previously been proposed to heat strip metal continuously in a furnace consisting of a pair of oppositely disposed panels provided with radiant gas burners. When it was necessary to thread the strip through the furnace after a strip break, or to stop the heating process for some reason, the panels were moved away from each other in a direction perpendicular to the surface of the strip. This cooled the panels and the burners forming part thereof so rapidly, that they were subjected to severe thermal shock. As a result of the severe cooling and heating of the furnace panels, the life of the refractory parts thereof was rather short. In addition, the time required for bringing the temperature of the furnace back to normal after the panels were closed was lengthened, even though the temperature can be changed more quickly than is possible in other types of furnaces.

Prior panel type furnaces were built in one piece with the burners forming an integral portion of the side walls. This is a satisfactory arrangement, but it has the drawback that the entire furnace must be shutdown when the burners are replaced or their location and arrangement changed.

The above mentioned disadvantages of the present panel furnaces are overcome with the arrangement of the present invention. As disclosed herein, there is provided a panel type furnace that has a section in the shape of a U with a door closing the open side. When it is necessary to stop heating strip passing through the furnace, the door is opened, and the furnace is moved sideways away from the strip. After the strip has been cleared, the door is closed. Thus, the furnace is only opened momentarily, so that severe cooling cannot take place.

In the construction of the furnace, the various burners are assembled in panels. These are fastened in place on the main frame of the structure. With a construction of this type, various burners, or groups of burners, can be replaced when necessary without tearing down the entire structure.

It is an object of the invention to provide a panel type furnace for the heating of strip material which is moved sideways with respect to the strip as the furnace is moved into and out of operating position. It is a further object of the invention to provide novel apparatus for moving a furnace structure relative to the material that is being heated.

Another object of the invention is to construct a furnace having the burners in a plurality of panels or sections that can be replaced without dismantling the entire

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furnace. It is a still further object of the invention to provide a means for readily changing burners and arrangements of burners in a metallurgical furnace.

A further object of the invention is to provide a furnace which can be easily moved into and out of heating position relative to a strip of material that is moving in a fixed path.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

In the drawings:

Figure 1 is a side view of the furnace and its cooperating structure;

Figure 2 is a vertical section through the furnace taken on line 2—2 of Figure 1;

Figure 3 is a section taken on line 3—3 of Figure 1 showing the top of the stack portion of the structure;

Figure 4 is a horizontal section through the furnace taken on line 4—4 of Figure 2;

Figure 5 is an enlarged section of a portion of one of the burner panels;

Figure 6 is a front view showing the door of the furnace;

Figure 7 is a section taken on line 7—7 of Figure 6 and,

Figure 8 is a diagrammatic view of the control mechanism for moving the furnace and operating the door.

Referring first to Figures 1, 2 and 3, there is shown a frame 1 constructed of structural steel upon which all of the apparatus is mounted. The strip 2, which is to be heat treated, passes from a point to the left of Figure 2 over a guide roller 3 that is suitably journaled on the upper part of the steel framework. From here, the strip passes vertically downward through a stack section 4, the furnace 5, a seal roll section 6 and to the right around a roller 7 in a cooling or holding duct 8. The stack section 4 and the seal section 6, as well as the duct 8, are stationary and, along with rollers 3 and 7, define the path through which the strip moves. The furnace 5 can be moved from the position shown in Figure 1, wherein it surrounds the strip to heat the same, to a retracted position to the left of the full line position in Figure 1 into the dotted line position where it is removed completely to one side of the strip.

The stack section 4 includes a rectangular chamber which is in effect a chimney through which the strip travels. This section is suspended from the upper part of the frame and is provided with ducts 11 and 12 extending from opposite sides thereof through which the products of combustion produced in the furnace are exhausted. To the right of the rectangular section 9, as shown best in Figure 1, is a flat roof section 13 that is over the furnace when it is in its retracted position. This section is provided with a duct 14 through which the products of combustion can be removed when the furnace is in its retracted position. Each of the ducts 11 and 12 is provided with a damper 15 and 16, respectively, that can control the exhaust of the products of combustion and, therefore, the pressure within the furnace. It is preferable that these dampers be actuated simultaneously in some conventional manner. A damper 17' is also

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provided in the duct 14 to control the pressure of the furnace when the latter is in its retracted position.

The seal box 6 includes a lower section 17 and an upper section 18. The lower section rests upon, and may be integral with, the duct 8 and forms the side wall's of a rectangular chamber. The upper section 18 rests upon the lower section and has a narrow rectangular slot through which the strip passes. Section 18 can be removed from the section 17 when the furnace is retracted in order to give access to seal rolls 21 that are located in the latter. A sand seal 19 is provided between the sections 17 and 18 in order to make the joint between these sections gas tight. Seal rolls 21 are located in the lower section 17 and are journaled in suitable bearings 22 that are placed at each end of this section. Cooperating with the upper portion of each of the rolls is a seal plate 23 that serves to prevent a flow of atmosphere around that portion of the rolls. The rolls may be driven by some suitable motor, not shown, at a peripheral speed equal to the speed of the strip in order to prevent any scratches from being placed on the strip as it is being moved between them. The roll supports are so designed that the rolls are normally held together in order to grasp the strip but can separate to permit thick sections of strip or joints between successive lengths to pass between them.

The furnace itself is U-shaped in section as is best shown in Figure 4 and moves from the full line position of Figure 1, which is also the full line position of Figure 4, in which it surrounds the strip to the dotted line position of Figure 1 in which it is to one side of the strip. The open side of the U-shaped furnace is closed by a door 25 which is opened during the time that the furnace is moving between its full line and its dotted line positions. The operation of the door will be described below.

The furnace frame consists of a plurality of relatively heavy structural steel members 26 which extend vertically throughout the length of the furnace and which are joined by suitable cross-members to form a rigid structure. The furnace is suspended at its upper end with the lower end hanging free. The furnace is mounted for movement horizontally by means including brackets 27 and 29 that extend outwardly from the legs of the U at the top of the frame. Brackets 27 are provided with flanged wheels 82, whereas the brackets 29 are provided with flat wheels 30. The wheels rest upon parallel tracks 32 that are in turn fastened to the upper flanges of horizontally extending I beams 33. Wheels 28 guide the furnace for accurate movement, while wheels 30 can move laterally on their track when the furnace expands and contracts.

To insure accurate movement of the furnace as it travels along the rails, there is provided a shaft 34 that is journaled in the frame, which shaft has a gear wheel 35 on each end thereof. These gears each mesh with the teeth of racks 36 that are fastened to the beams 33. Therefore, as the furnace is moved horizontally to the right and left in Figure 1, for example, it will be kept in a true path by means of the action of the gears and racks.

The furnace is moved by a pneumatic system which includes a cylinder 37 that is fastened to the furnace on one side thereof adjacent to the brackets 27 as best shown in Figures 2 and 3. An elongated piston rod 38 that has a piston 39 on it passes through the cylinder and is rigidly fastened at its ends to the frame 1. Fluid is directed into and discharged from the opposite ends of the cylinder to move the furnace in a manner that will be described in detail below. The furnace is held accurately in a vertical position at all times by means of rollers 41 which are mounted for rotation in brackets 42 extending from opposite sides of the lower end of the frame. These rollers bear against tracks 43 that extend horizontally from a portion of the framework, as best shown in Figure 2 of the drawing.

A seal shown in Figures 1 and 2 is provided between the upper end of the furnace and the stack structure on

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the sides thereof in order to prevent the infiltration of air into the space between the two. This seal consists of troughs 44 that are fastened to the lower portion of the stack structure on both sides and extends for the full length of both parts 9 and 13. Flanges 45 that move with the furnace and are fastened to a part that projects upwardly therefrom are received in these troughs. The trough are filled with sand, so that a seal is maintained by the flange 45 regardless of the position of the furnace in its path of travel.

The lower end of the furnace is also provided with seals between it and the roll housing section 18. To this end, the section 18 is provided on each side with a trough 46 that receives a flange 47 extending downwardly from the furnace. Referring to Figure 1 of the drawing, it will be seen that the trough 46 extends along the sides of the roll housing 18 and over to the right to an extent equal to the travel of the furnace. It is noted that to the right of section 18 and even with its upper surface there is provided what is in effect a floor 53 for the furnace when it is in its retracted position shown in dotted lines in Figure 1. It is important that infiltration of air into the furnace through the lower portion thereof be prevented at all times when the furnace is in operation heating the strip. The troughs 46 and their cooperating flanges 47 will prevent infiltration of air along the sides of the furnace. Infiltration along the right edge of the furnace in its operating position is prevented by another sand seal including a sand filled trough 48 that extends between the troughs 46 and a sealing member 49 received in this trough when the furnace is in the full line position of Figure 1. Seal 49 is pivoted to the lower portion of the furnace at 50, so that when the furnace is moved to the right, the seal will swing around pivot 50 and ride along the top edge of the troughs. When the furnace is returned from its dotted to its full line position, this member will drop into the trough 48 and dig into the sand therein to form the seal. The left side of the furnace which has the opening in it is normally sealed by the door 25. There is provided, however, an abutment 52 which extends between the upper surface of the roll chamber section 18 and the lower surface of the door and against which the furnace abuts when it is in its full line position. This member 52 serves to close the lower end of the opening in the front of the furnace when it is in its working position.

As noted above, the furnace is constructed of a heavy steel framework including the beams 26. Extending between these beams is sheet metal backing 54 that is used to support refractory brickwork 55 forming the furnace walls. These walls are provided in their oppositely disposed faces with a plurality of openings at vertically spaced points which openings are adapted to receive removable panels 56 in which the burners of the furnace are located. Each panel has a steel frame 57 and a plate 58 which is used to back up the refractory material 59 that forms a portion of the wall of the furnace when the panels are in place as shown in the drawings. Embedded in the refractory of the panels are a plurality of burner blocks 61 which may be of such a size that they form individual burners, or they may be of such a size that a group of burners is formed from each block. In any event, the burner portion consists of a cup-shaped depression 62 formed on the face of the block into which fuel is discharged by a distributor member 63. The burners are similar to those shown in the application of James Kniveton, Serial No. 424,973, filed April 22, 1954. It will be seen by referring to the drawings that each panel has a plurality of rows of burners. As shown herein, each panel has three rows of burners, and each row is supplied by an individual manifold 64 which is fastened between portions of the frame 57. Extending between the manifold and each burner, as best shown in Figure 5, is a pipe 65 that is connected to the outer end of the distributor member by a connection 66.

The panels are assembled and are then placed in posi-

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tion in the openings provided in the opposed furnace walls. To this end, the corners of each panel are provided with horizontally extending lugs 67 that engage with brackets 68 welded to the vertically extending beams 26. Bolts 69 extend through the lugs and the brackets to hold the panels in position in the furnace wall. In order to close the space between the furnace wall and each panel, there are provided a plurality of bricks 71 which are moved into position after the panel has been bolted in place. It will be noticed from an inspection of Figure 4 that the bricks 71 are wedge-shaped, so that when they are rammed into position, they will tightly close the space between the panels and the furnace walls. After the bricks 71 have been placed in position, a suitable backing brick 72 is moved into position to give the added thickness that is necessary to this portion of the furnace wall. Reference to Figure 2 of the drawing will show that the wedge-shaped bricks between the two lower panels and the section of the furnace above the second from the bottom panel extends outwardly into the furnace chamber as is shown at 73. This construction reduces the width of the furnace chamber and will permit suitable zone control of the temperature of the furnace.

Fuel is supplied to the manifolds 64 on the panels by suitable piping which, as best shown in Figures 1 and 4, includes a vertically extending manifold 74 for each of the oppositely disposed panels on a given level. This manifold is connected by a pipe 75, having valve 76 therein, to a pipe 78 extending outwardly from each manifold 64. A connection 77 is placed between each pipe 78 and pipe 75, so that when this connection is broken, the panels can be easily removed without disturbing any of the other piping of the furnace system.

Since the furnace moves in a horizontal direction, some means must be provided to permit the supply of fuel to the furnace in any position thereof and while it is moving. To this end, each of the manifolds 74 is supplied by a pipe 79 that moves with the furnace structure. This pipe in turn is supplied by a stationary pipe 81 that is attached to the framework supporting the furnace. A telescoping fitting 82 extends between the pipes 79 and 81, so that as the furnace is moved to the right and left in Figure 4, for example, the fitting 82 will change in length to compensate for the position of the furnace. Flexible connections 83 are provided between pipe 79 and the fitting 82 as well as between this fitting and pipe 81 to provide for any slight misalignment that may take place as the furnace is being moved.

As noted above, the slot at the ends of the legs of the U of the furnace is closed by a door 25. This door, shown best in Figures 4, 6 and 7, includes a metal shell 85 extending the length of the slot which is lined with a refractory 86 to form, in effect, the fourth wall of the furnace. Each vertically extending edge of the door has a seal 87 such as asbestos rope to prevent infiltration of air past the edge of the door into the chamber. The door is supported by a frame 88 made of structural steel members, which frame is, in turn, pivoted to the frame of the furnace. The door is supported on frame 88 by a plurality of angles 89 welded to the outer surface of shell 85 which rest on crosspieces 91 that extend between the side members of the frame. Each of the angles and crosspieces is provided with a hole through which bolts 92 are placed in order to keep the door on the frame. It will be noticed, from Figure 4, that the holes in angles 89 through which the bolts extend are slightly elongated, so that some movement is permitted between the door and the frame. Normally, the door is biased away from the frame toward the furnace by means of springs 93, as shown in Figure 7, which are located between a crosspiece on the frame and a cup 94. This cup is attached to a bolt 95, the upper end of which, in Figure 7, bears against the door to force the door in a closing direction. The action of the springs is to insure that the seals will engage tightly against the outer edges of the furnace.

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Frame 88 is pivoted to one of the beams 26 as best shown in Figure 6. To this end, hinges are provided which include plates 96 that are welded to the frame and to a vertically extending hinge pin 97. This pin is received in bearings 98 that are attached to the frame of the furnace. The door is moved between its closed and its open position by a pair of arms 99 that are pivoted to the frame 88 at 101. These arms are rigidly fastened to a shaft 102 of a gear 103 with the shaft being journaled in bearings 104 on frame 26. The gear 103 is turned by a pinion 105 which is fastened to a horizontally extending shaft 106 that is journaled in bearings 107. Also fastened to shaft 106 is a sleeve that forms part of an arm 108, the other end of which is pivoted at 109 to a piston rod 111. This rod has a piston 112 on the end thereof that is received in a cylinder 113. The upper end of the cylinder is free to move in an arc as the piston rod moves therein, and to this end, the lower end of the cylinder is pivoted to the frame at 114.

To open the door, a fluid under pressure, either gas or liquid, is admitted to the lower ends of the cylinders 113 thereby forcing the piston rods out of the top. This movement, acting through arms 108, rotates pinions 105 and gears 103 to swing the door from its full to its dotted line position in Figures 4 and 7. Applying the fluid to the top of the cylinder will reverse the process to close the door.

In Figure 8, there is shown, more or less diagrammatically, a control system by means of which the furnace is moved, and the door opened and closed during this movement. In that figure, there is shown at 115 a source of fluid under pressure which may be either a gas or a liquid depending upon a particular installation. In any event, a pipe 116 connected with the source leads to a manually operated valve 117 that can be used to direct the fluid under pressure through a pipe 118 to the left end of piston 37 or through a pipe 119 to the right end thereof. It will be noticed that the fluid flows from the pipes through a bore in the piston rod 38 to a point adjacent to the piston 39 which is fixed in the center of the piston rod. Fluid from the source 115 is also used to operate the door, and for this purpose, the fluid under pressure passes through a pipe 121 to an automatically operated valve 122. This valve is normally operative to supply fluid through a pipe 123 that is connected with the upper end of cylinders 113 normally to drive the pistons downwardly in these cylinders to close the door. The actuating arm of valve 122 can be moved, however, to connect pipe 121 with pipe 124 that is connected with the lower end of each of the cylinders 113 in order to supply fluid to this end of the cylinders to open the door. Valve 122 is actuated to connect pipe 121 with pipe 124 by means of a cam 125 that is attached to the furnace and moves with the same. It is noted that valve 117 has an exhaust pipe 126 and valve 122 has an exhaust 127. If the system is hydraulic, these pipes will be connected with a reservoir to supply the source 115. If however, the system is pneumatic, pipes 126 and 127 can exhaust to the atmosphere.

In the operation of the system, if, for example, the furnace is surrounding the strip and heating the same, the furnace can be removed from the strip by adjusting the valve 117 to connect pipes 116 and 118. When this is done, fluid will flow into the right end of cylinder 37 to move the furnace 5 to the right in Figure 8 to remove it from the strip. When the furnace has moved to a point where the strip is adjacent to the door, cam 125 will engage the actuating arm of valve 122 to move this valve to a position in which pipes 121 and 124 are connected. The fluid under pressure will then flow to the bottom part of cylinders 113 to open the door. As soon as the furnace has moved to a position where the strip is cleared, cam 125 will pass beyond the actuating arm of valve 122, and permit this

valve to reconnect pipes 121 and 123 to close the furnace door. Thus, the door will be open only during the time that is required for the furnace to move past the strip.

From the above, it will be seen that I have provided a vertically extending furnace that is used to heat a strip of material as it is being moved vertically through the furnace. The temperature to which the strip is heated for a given furnace temperature will depend upon a number of variables, the most important being the speed of the strip and its thickness. Ordinarily, in the annealing of strip steel for example, the strip is brought to a temperature of approximately 1300° F. With a furnace of this type that is 21' long and operating at a temperature of 2400° F., a strip of material 0.078 thick can be heated to an annealing temperature of 1300° F., at the rate of approximately 90' per minute. This is heating strip 36" wide at a rate of 25 tons per hour.

The furnace is so designed that the burners can be removed in sections for replacement and repair when this is necessary. This design permits the furnace to be repaired in section without dismantling the entire furnace and without stopping the operation thereof for more than a short length of time. The use of panels of this type also permits the arrangement and number of burners in a furnace to be changed with a minimum of trouble. In addition, the interior of the furnace is protected to a large extent from thermal stresses when it is removed from the strip during such times that the process is temporarily stopped, since it is open to the atmosphere only momentarily.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit and scope of the invention as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

What is claimed is:

1. Apparatus for heating strip moving through a vertical path including a stationary structure adjacent to the top of said path and surrounding the strip and having exhaust means leading therefrom, said structure having an extension projecting horizontally to one side of said path at a level substantially equal to the bottom of said structure, exhaust means leading from said extension, a housing adjacent to the bottom of said path and surrounding said strip, a floor extending to one side of said housing at a level substantially equal to the top of said housing and lying beneath the extension of said structure, a pair of seal rolls in said housing and engaging opposite sides of the strip, a U-shaped furnace open at the top and bottom extending vertically between said structure and said housing and filling the space between the two, the legs of the U having vertically spaced burners therein facing the strip to heat the same, means to mount said furnace for horizontal movement, means to move said furnace from a position surrounding the strip and between said structure and housing to a position beyond the edge of the strip and between the extension of said structure and said floor, and a door pivoted to said furnace operative to close the space between the legs of the U when the furnace is in either of said positions.

2. The combination of claim 1 in which said burners are located in panels, means to mount said panels removably in said furnace, and means mounted on said furnace to supply fuel to said burners.

3. The combination of claim 2 including a fixed fuel supply, and a connection between said fixed fuel supply and said supply means on said furnace operative to connect the two at all positions of said furnace.

4. The combination of claim 1 including a sealing means between the upper end of said furnace and said structure and the extension thereof, and a sealing means between the lower end of said furnace and said housing and said floor.

5. In a furnace system for heating strip material, means for guiding a strip of material through a vertical path, stationary structure including exhaust means located on opposite sides of the strip near the top of said path, a horizontal extension of said structure including a second exhaust means at one side of said path beyond the edge of the strip and at the same height as said first mentioned exhaust means, a stationary housing containing a pair of seal rolls with one roll on each side of said strip located near the bottom of said path, a floor on a level with the top of said housing and below said second exhaust means, means forming an elongated U-shaped furnace chamber, having an open top and bottom, means to mount said chamber in a vertical position between said structure and housing and for horizontal movement from a location with the legs of the U on opposite sides of the strip and the chamber beneath said structure and between said first exhaust means and said housing to a location between said second exhaust means and said floor, and means to move said furnace between said locations.

6. The combination of claim 5 including a door pivoted to one of the legs of said structure and adapted to close the space between the legs of the U, means to close said door when said structure is in either of said locations, and means automatically to open said door when said structure is moving between said locations.

7. The combination of claim 5 including sealing means between the lower end of said structure and said housing and said floor.

8. Apparatus for heating strip material comprising structure forming an elongated furnace chamber having a side thereof substantially parallel to each side of the strip being heated, each side of said chamber being provided with an opening therein, a panel to fit in each opening, each of said panels being provided with a plurality of burners therein, means to attach a panel in each of said openings, piping having a common inlet on said panel through which fuel is supplied to a plurality of burners thereon, main piping on said structure having a portion thereof to supply fuel to each panel, and connecting means between each of said portions and an inlet whereby the panels can be disconnected individually from said main piping for removal of a panel without disturbing the remainder of the structure.

9. The combination of claim 8 in which said furnace chamber is lined with refractory material and in which each panel is lined with refractory material around the burners contained therein, and in which each panel is slightly smaller than the opening in which it is received, and means including a plurality of wedge-shaped blocks of refractory material inserted in the space between the edges of an opening and a panel with the wide part of the wedge away from the interior of the chamber whereby said blocks can be inserted and removed from the exterior of said structure.

10. The combination of claim 8 in which said chamber is lined with refractory material and in which said panels are faced with refractory material around the burners therein, and removable blocks of refractory material between the edges of each opening and the panel received therein.

11. In a furnace for heating strip material including structure having a vertically elongated furnace chamber through which the strip passes and having a side with openings therein facing and parallel to each side of the strip, a plurality of removable panels, means to fasten a panel in each side of the furnace chamber in each of the openings therein, each of said panels being provided with a plurality of burners to heat the strip,

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 piping connecting each of the burners in each panel through which fuel is supplied to the burners, main piping to supply a plurality of panels, and a connection between the piping on each panel and the main piping adapted to be broken whereby the panels may be removed 5 individually without disturbing any other panel.

12. A furnace for heating strip material comprising structure forming an elongated, vertically positioned furnace chamber, means to mount said structure for bodily movement parallel to the surface of the strip 10 from a first position in which the chamber surrounds the strip to a second position at one side thereof, a stationary exhaust means for products of combustion from said chamber located above said structure and extending in the direction of movement of said structure sufficient 15 to cover the structure in both positions of the same, a stationary strip guiding means below said structure in its first position, a floor below said structure in its second position, seal means between the upper end of said

structure and said exhaust means, and seal means between the lower end of said structure and said strip guiding means and said floor.

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