Dec. 9, 1941. K. MARSH 2,265,849

HEAT TREATING APPARATUS

Filed Aug. 2, 1940 6 Sheets-Sheet 1

Fig. 1.

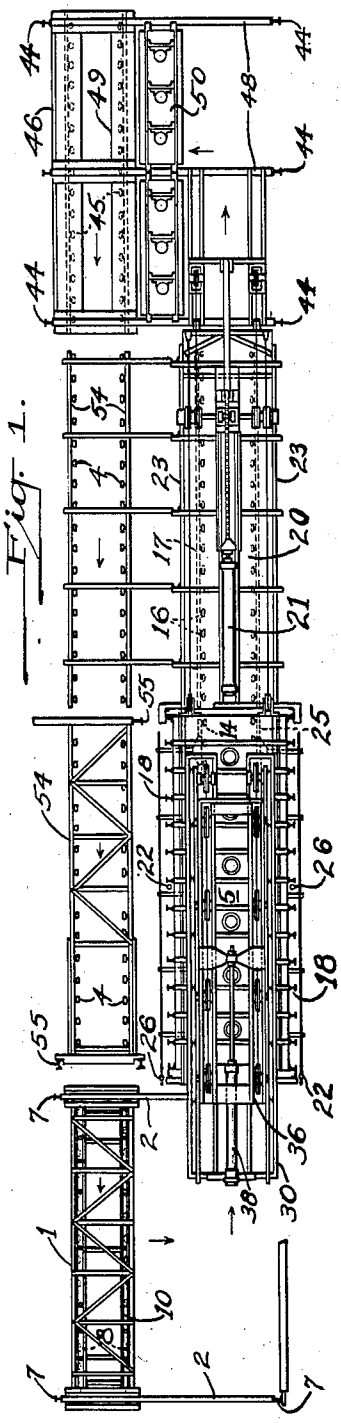
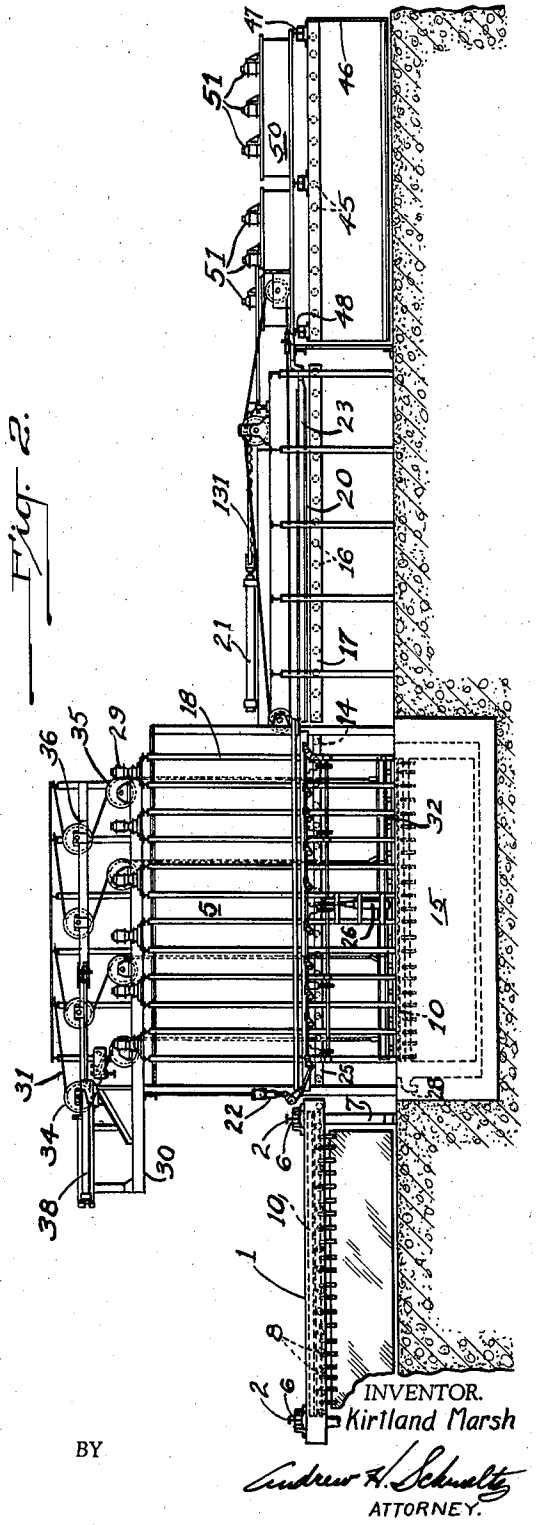


Fig. 2.



INVENTOR.
Kirtland Marsh

BY

Andrew H. Schmaltz
ATTORNEY.

Dec. 9, 1941. K. MARSH 2,265,849

HEAT TREATING APPARATUS

Filed Aug. 2, 1940 6 Sheets-Sheet 2

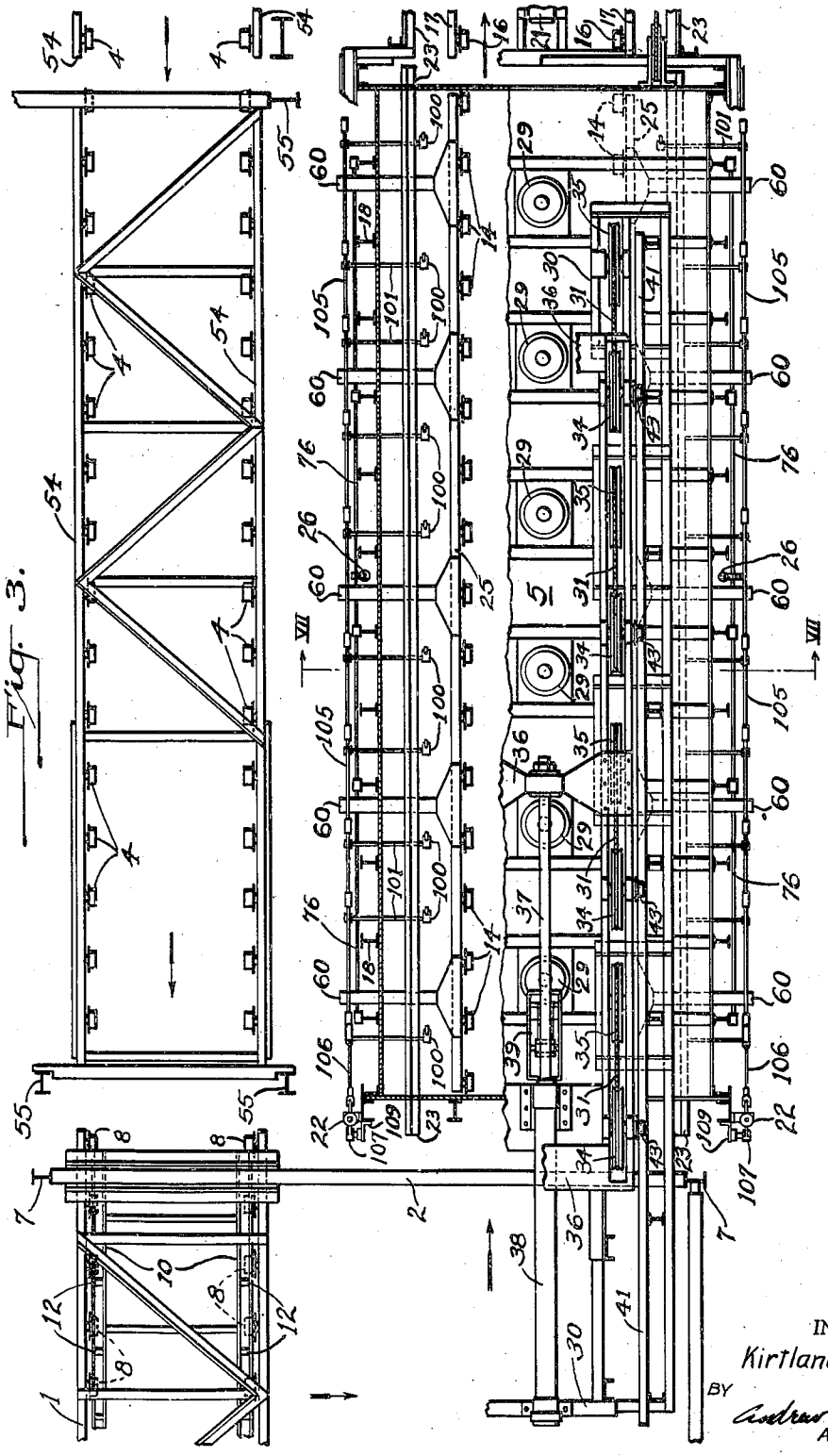


Fig. 3.

INVENTOR.
Kirtland Marsh
BY Andrew H. Schmeltz
ATTORNEY

Dec. 9, 1941. K. MARSH 2,265,849

HEAT TREATING APPARATUS

Filed Aug. 2, 1940 6 Sheets-Sheet 3

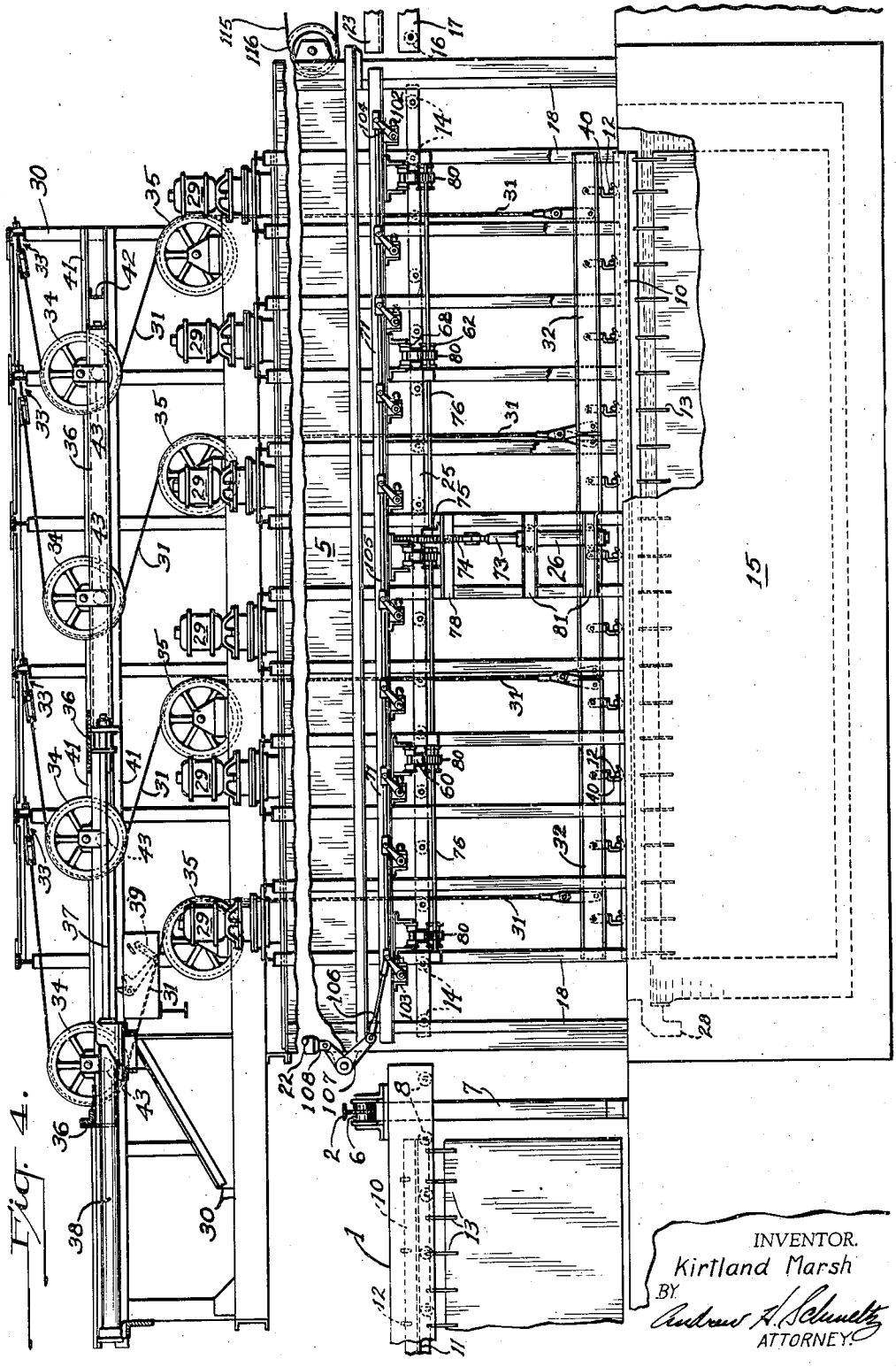


Fig. 4.

INVENTOR.
Kirtland Marsh
BY
Andrew A. Schmeltz
ATTORNEY.

Dec. 9, 1941. K. MARSH 2,265,849

HEAT TREATING APPARATUS

Filed Aug. 2, 1940 6 Sheets-Sheet 4

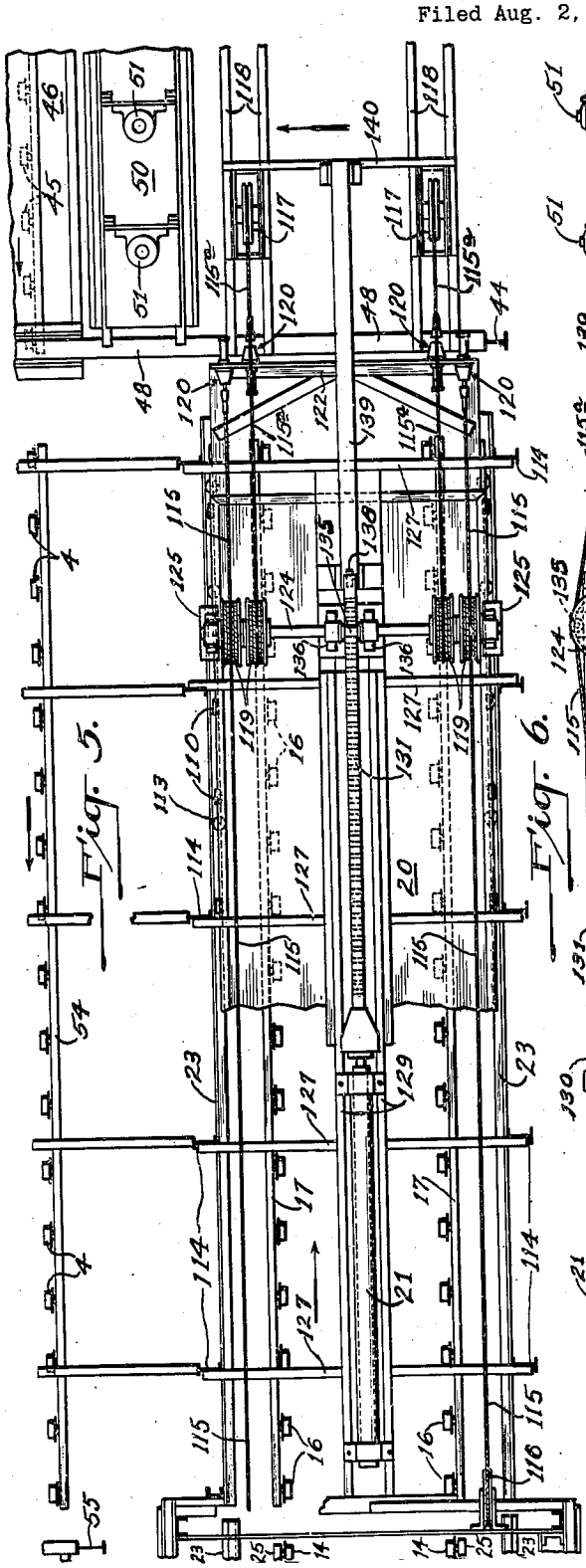


Fig. 5.

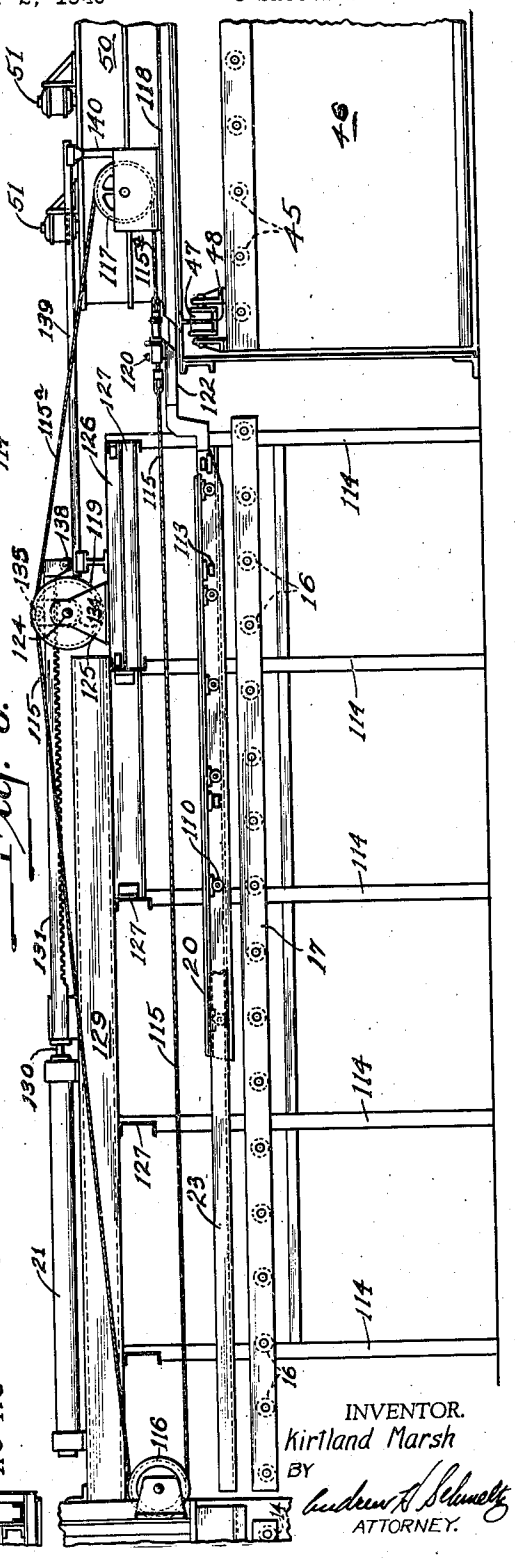


Fig. 6.

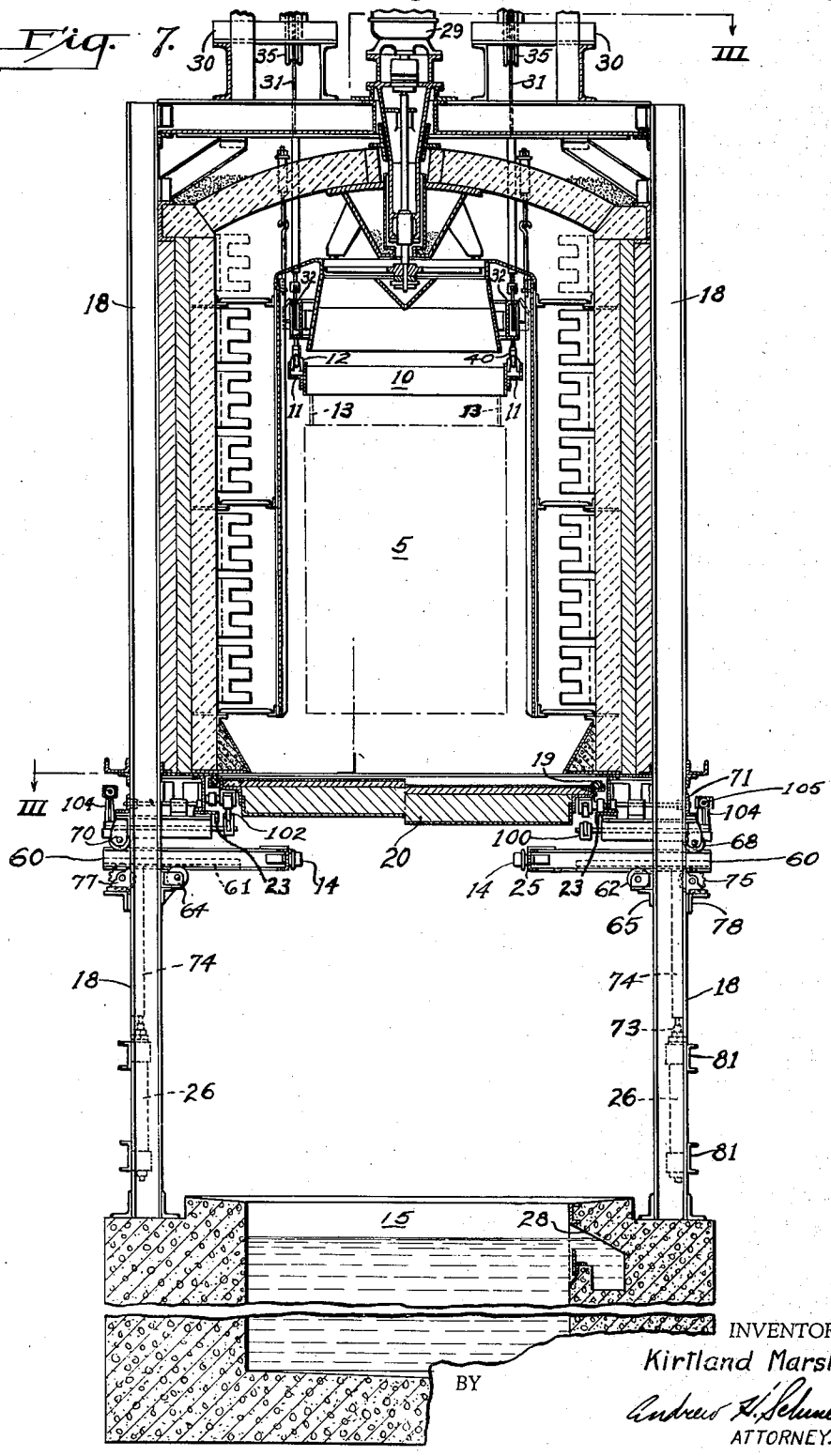
INVENTOR.
Kirtland Marsh
BY
Andrew A. Schmeltz
ATTORNEY.

Dec. 9, 1941. K. MARSH 2,265,849

HEAT TREATING APPARATUS

Filed Aug. 2, 1940 6 Sheets-Sheet 5

Fig. 7.



INVENTOR.
Kirtland Marsh
BY
Andrew H. Schmelz
ATTORNEY.

Dec. 9, 1941. K. MARSH 2,265,849

HEAT TREATING APPARATUS

Filed Aug. 2, 1940 6 Sheets-Sheet 6

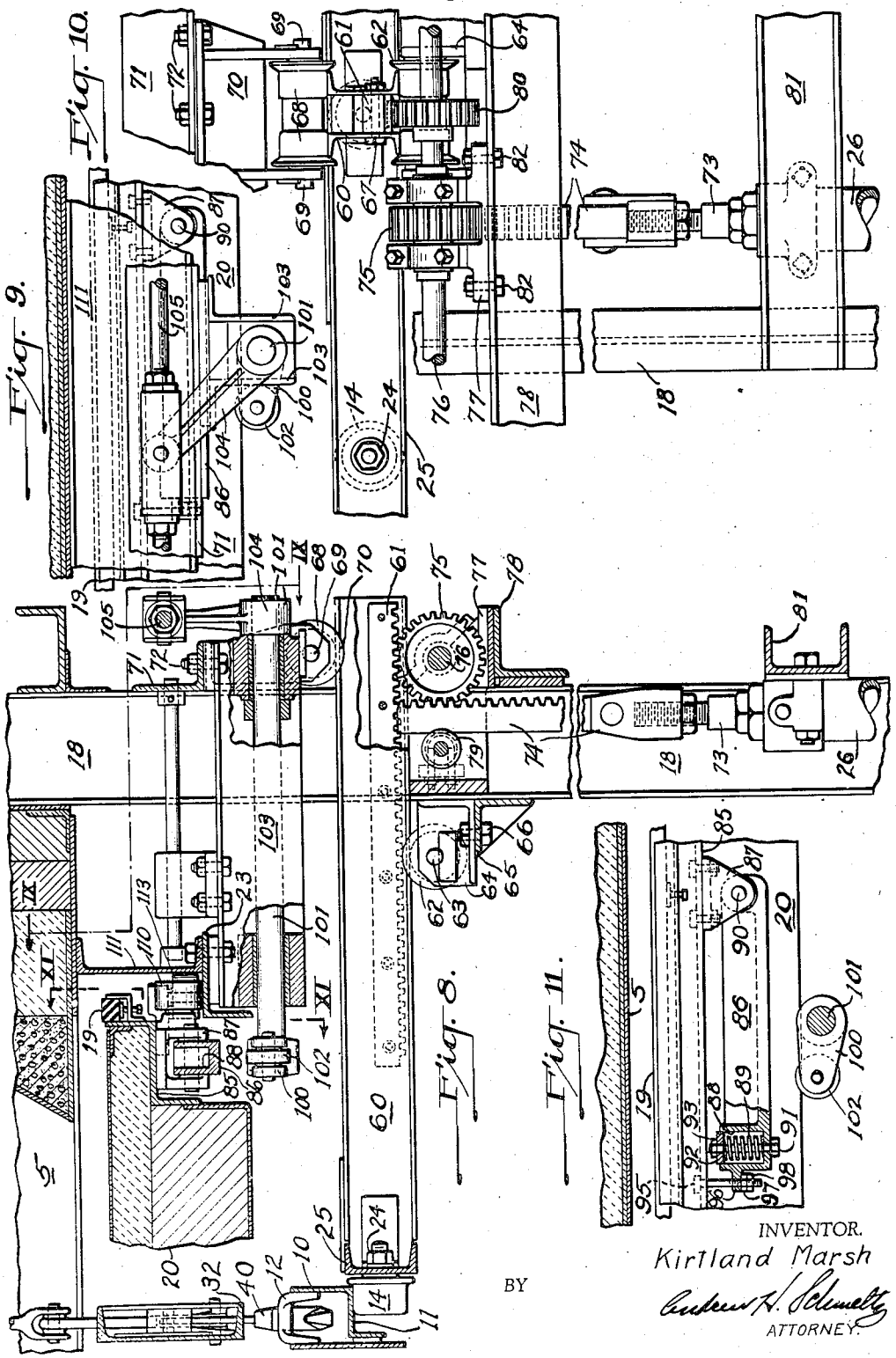


Fig. 9.

Fig. 10.

Fig. 8.

Fig. 11.

INVENTOR.
Kirtland Marsh

BY

ATTORNEY.

Patented Dec. 9, 1941

2,265,849

UNITED STATES PATENT OFFICE

2,265,849

HEAT TREATING APPARATUS

Kirtland Marsh, Pittsburgh, Pa., assignor to Aluminum Company of America, Pittsburgh, Pa., a corporation of Pennsylvania

Application August 2, 1940, Serial No. 349,676

16 Claims. (Cl. 266—4)

This invention relates to apparatus for heat treating metals and alloys. It pertains particularly to a system wherein apparatus is provided for handling, heating, quenching, and drying of metal which is to be subjected to a heat treatment process. It further relates to combinations and sub-combinations of such apparatus.

The invention will be described with reference to the heat treatment of metal sheets of aluminum alloys though it is in no way confined thereto. Heat treating is defined for purposes of this invention as heating metal to a desired elevated temperature, holding the metal at that temperature for a prescribed length of time, and then rapidly quenching or cooling the metal in a fluid coolant. In a furnace for heating the metal, accurate temperature control and uniformity of temperature throughout the furnace heating chamber are desired. Likewise, the ability to rapidly quench the metal after it has been subjected to the required amount of heating, without excessive loss of heat from the heating chamber, is desired. The invention, therefore, contemplates the provision of apparatus arranged to heat a load of metal economically, quickly, and uniformly, and to quench the heated load of metal with great rapidity. While the apparatus of the invention is particularly adapted to the performance of the above defined heat treating process, it will appear upon a reading of this specification that the invention may be useful in such other material treating processes as annealing, drying, baking, soaking, and preheating of metal or other materials. In many of such processes apparatus of the character here described and claimed may find utility.

Heat treating furnaces employed prior to this invention are characterized by numerous disadvantages. For instance, it has been known to so position a furnace heating chamber and a load quenching tank as to require that the load of metal be immersed in the water of the quenching tank before it is moved into the heating chamber. Such an arrangement is undesirable because it requires additional input of heat to the load to evaporate the water clinging thereto after it is drawn into the furnace chamber, and also because it results in a tendency for the load to be non-uniformly heated. With some materials such as aluminum and its alloys the presence of water on the surfaces of the metal being heated may even result in staining or marking of the metal, which is of course undesirable, if not detrimental.

Prior efforts to construct a furnace arranged to permit loading of the heating chamber without immersion of the load in the quench tank have met with difficulties in the design of furnace and load handling apparatus. Particular difficulties have been met with in constructing furnace heating chambers provided with a suitable door or doors, load supporting apparatus, and load hoisting apparatus for the rapid entry and removal of the load.

Noting the aforementioned disadvantages of prior furnaces, the general object of this invention may be stated as the provision of a heat treating apparatus having a heating chamber spaced from a quenching tank a distance sufficient to permit supporting of a load therebetween, and having improved load handling apparatus associated therewith.

A further object of the invention is the provision of heat treating apparatus adapted to dry charging of a load of metal and yet adapted to rapid quenching thereof.

Another object is the provision of a track-supported load carrier adapted for movement under a heating chamber and over a quenching tank. It is also an object to provide suitable load hoisting means for lifting a load carrier into a heating chamber and for lowering it into a quenching tank.

Another object is the provision of a retractable load carrier track under a heating chamber arranged to permit the lifting of a load of material into a heating chamber and lowering thereof into a quenching tank.

Another object is the provision of a slidable door for a bottom opening of a heating chamber. It is also an object to provide door traversing means adapted to withdraw a door from under a heating chamber, and to return the same, particularly in combination with yieldable door sealing means.

Another object is the provision of a track-supported slidable door for the bottom of a heating chamber adapted to be traversed lengthwise of the heating chamber to permit entry and removal of a load of metal.

Another object is the provision of suitable load drying apparatus inter-related with a heating chamber and a quenching tank of an improved heat treating apparatus. It is also an object to provide such drying chamber in cooperative relation to a circulating load carrier track.

It is another object to provide an improved heat treating apparatus adapted to the simultaneous or successive loading, heating, quench-

ing, drying, and unloading of one or more loads of metal.

The invention also has for an object the cooperative inter-relation of some or all of the aforementioned devices. It is particularly an object to provide a retractable load carrying track and a slidably removable door under the heating chamber of a heat treating apparatus having a quenching tank spaced therebelow a distance greater than the vertical height of a furnace load.

These and other objects will be appreciated more fully upon a reading of the following description of a preferred form of heat treating apparatus embodying the invention. The objects are to be taken either singly or in combination, and are to include such other advantages as are explained herein but not above particularly expressed.

In the drawings forming part of this specification:

Fig. 1 is a plan view of the heat treating apparatus constituting the preferred embodiment of the invention, showing the load handling means, the heating chamber, the drying chamber, and other parts thereof;

Fig. 2 is a side elevation of the apparatus of Fig. 1 (to the same scale), showing in addition thereto the quenching tank and other parts thereof;

Fig. 3 is an enlarged plan view taken on the line III—III of Fig. 7 and showing the heating chamber and part of the load handling means shown generally in Fig. 1, a portion of the heating chamber and hoisting means thereon being broken away to illustrate apparatus associated therewith;

Fig. 4 is a side elevation, with parts broken away, of that portion of the apparatus shown in Fig. 3 (to the same enlarged scale), showing in addition thereto the quenching tank and other parts thereof;

Fig. 5 is a plan of the door traverse mechanism, part of the load handling means, and part of the drying chamber shown generally in Fig. 1 (to the same enlarged scale), a portion of the door being broken away to illustrate other parts of the apparatus;

Fig. 6 is a side elevation of that portion of the apparatus shown in Fig. 5 (to the same enlarged scale);

Fig. 7 is a vertical section taken on line VII—VII of Fig. 3 and showing the heating chamber, bottom door therefor, load handling means, and quenching tank (to the same enlarged scale), the door being shown in sealed and unsealed positions on opposite sides of the center line;

Fig. 8 is an enlarged detail and sectional view of the door sealing means, retractable load carrier track, and operating mechanisms therefor;

Fig. 9 is an enlarged detailed view of the operating mechanism for the door sealing means, taken along the line IX—IX of Fig. 8;

Fig. 10 is an enlarged detailed view of the operating mechanism for the retractable load carrier track, taken at right angles to the view of Fig. 8; and

Fig. 11 is an enlarged detailed view of the door sealing means, taken along the line XI—XI of Fig. 8.

The furnace apparatus shown in the drawings was designed for the heat treatment of 6,000 pound loads of aluminum alloy sheet or plate made up of as many as 36 sheets, each 28 feet long and 75 inches wide. The sheets forming such loads may be supported on a load carrier in parallel spaced relation, the spacing between sheets being preferably at least 1½ inches from center to center. The above load specifications are set forth merely as exemplary of the purposes to which the invention may be applied.

The preferred apparatus may be generally identified as an elevator type of furnace with a quenching tank directly under a heating chamber, but with sufficient vertical height between the bottom of the heating chamber and the top of the quenching tank, at floor level, to permit a load of material of the character above described to be moved therebetween on an overhead roller track. One or more load carriers may be employed with this apparatus to support loads of sheets of the character above described, and a suitable track is preferably provided for movably supporting a load carrier under the heating chamber and for conveying a load carrier beyond the heating chamber to a drying chamber and back to a reloading position. The apparatus is preferably provided with suitable load hoisting means for lifting a load carrier and load supported dependingly therefrom into the heating chamber, lowering it into the quenching tank, and again raising it to the track under the heating chamber. A slidably removable door is preferably provided at the bottom of the heating chamber, with suitable mechanisms for opening and closing the same. The track for supporting the load carrier under the heating chamber is preferably made retractable to permit free passage of a load carrier into the heating chamber and into the quenching tank. Turning now to the drawings, particularly to Figs. 1 and 2 thereof, the preferred form of heat treating apparatus will now be described.

Loading transfer

To the left in Figs. 1 and 2 there is shown a loading transfer 1 manually or otherwise laterally movable on two transfer rails 2 between a position in alignment with a return load carrier track made up of rollers 4 (as in Fig. 1) and a position in alignment with a furnace heating chamber 5. This loading transfer 1 preferably consists of a frame fabricated from structural shapes and having longitudinal side members tied together by suitable lateral members. The loading transfer 1 is dependingly supported from the two transfer rails 2 by means of overhead transfer rollers 6 at each corner thereof, the rails 2 being supported from the floor at their ends by structural rail supporting columns 7. The longitudinal side members of loading transfer 1 each carry a longitudinally extending series of inwardly presented track rollers 8 which form a load carrier track serving as an extension of the return load carrier track, above generally referred to, when in alignment therewith.

The track rollers 8 of loading transfer 1 are arranged for the support and passage thereover of a load carrier 10 (see also Figs. 3 and 4) which consists of a frame similar in character to the frame of transfer 1. It is made up of longitudinal side members tied together at their ends and at intermediate points with suitable lateral members. The longitudinal side members of load carrier 10 are shouldered as at 11 (see Fig. 4) to fit the track made up of rollers 8. Thus, load carrier 10, through shouldered portions 11, is adapted to ride on the track rollers 8 of the transfer 1.

It will be noted that load carrier 10 is pro-

vided with a plurality of lifting handles or eyes 12 along each longitudinal side member thereof. The eyes 12 are adapted to be engaged by suitable attaching means, associated with hoisting apparatus, for lifting of the load carrier 10 into the heating chamber 5 and lowering thereof into a quenching tank 15 under chamber 5. Supported dependingly from load carrier 10 are a plurality of load hangers 13 arranged in a plurality of longitudinal rows and attached to longitudinal structural members (not shown) forming part of the load carrier 10. Each hanger 13 comprises a depending rod, cable, or wire and a suitable clip, clamp, or wedging gripper adapted to engage the upper edge of a metal sheet or plate. The details of the hangers 13 are not here important since any of various known devices of this character may be employed for attaching the metal sheets to be heat treated to the load carrier 10. By arranging hangers 13 in longitudinal rows a plurality of metal sheets may be hung from the load carrier 10 in parallel spaced relation. A large number of hangers 13 is employed to securely and uniformly support each sheet forming part of the load, since it is desirable to prevent sagging of the sheets during heat treatment and to keep one sheet from touching another as far as practicable.

In the practice of the invention a load carrier 10 is loaded with a plurality of sheets, by securing the same to hangers 13, when the loading transfer 1 is in the position shown in the upper left hand portion of Fig. 1. Thereupon the transfer 1 is moved in the direction indicated by the arrow on Fig. 1 to a position in alignment with the heating chamber 5. When the loading transfer 1 is aligned with the heating chamber 5 the track rollers 8 thereof form extensions or portions of a load carrier track comprised of retractable track rollers 14 under heating chamber 5 and delivery track rollers 16, the latter being supported by structural members 17 extending beyond the end of the heating chamber 5 opposite to loading transfer 1. It will appear then that a load carrier 10 may be manually or otherwise moved from the loading transfer 1 onto the retractable track rollers 14, under the heating chamber 5.

Furnace apparatus

The furnace apparatus proper includes the heating chamber 5 supported at an elevated position above the floor by means of structural heating chamber columns 18. The heating chamber 5 is located sufficiently above the traversing level of a load carrier 10 as it moves on retractable track rollers 14 to permit the sliding movement therebetween of a bottom door 20 for the heating chamber 5. The retractable rollers 14 and apparatus thereabove are located above the floor level sufficiently for the passage of a load to charging position, the quenching tank 15 being directly below the heating chamber 5 but depressed below the floor level.

The heating chamber 5 is provided with door 20 for the receipt and discharge of the load through the bottom thereof, door 20 being removable from under the heating chamber 5 by horizontal sliding movement to the right, as viewed in Figs. 1 and 2, where it is shown in open position. For supporting the door during opening and closing movements, there is provided a door track 23 formed of angles at either longitudinal side of heating chamber 5 and extending beyond the same at one end as above described. An operating cylinder 21 and mechanism associated therewith, which will be described later, are employed for effecting the movement of door 20 on tracks 23. An operating cylinder 22 is provided on each side of heating chamber 5 for actuating a door locking means, which will also be later described, adapted to seal the door against the bottom of the heating chamber 5. The aforementioned angles forming track 23 support the door 20 during its horizontal movement at positions above a load carrier 10 and track rollers 14 and 16 for supporting a load carrier 10.

The retractable track rollers 14 are mounted on two longitudinally extending structural members 25 (see Fig. 3), each of which is retractable to the side of the heating chamber 5 through the actuation of an operating cylinder 26 and mechanism associated therewith. This mechanism, to be later described in detail, is arranged to move the structural members 25 into and out of projected operative position. Fig. 3 shows structural members 25, carrying track rollers 14 in projected position.

As aforementioned, the quenching tank 15 is located beneath the floor level and below the heating chamber 5. It is of conventional construction and deep enough to accommodate a full load of maximum size sheets along with a load carrier 10 which supports the same (as in Figs. 2 and 4). The usual spill drain 28 is provided at the upper portion of the quenching tank 15.

The heating chamber 5 is preferably heated by electric resistance heaters in conventional fashion. Surmounting the chamber 5 are six furnace blowers 29 for the forced circulation of the furnace atmosphere. The details of apparatus for heating and circulating the furnace atmosphere are not important to the present invention, and will not be further described. Also, surmounting the heating chamber 5 there is provided a hoist frame 30 supporting a load hoist mechanism.

The hoist mechanism comprises eight hoisting cables 31 passing downwardly through the roof of the heating chamber 5 to a pair of interconnected longitudinally extending members which may be collectively referred to as a load lift beam 32. The cables 31 are secured at their upper ends by adjustable anchor connections 33 to the top of hoist frame 30. They each pass around two pulleys 34 and 35, the fixed pulleys 35 being suitably mounted on the base of hoist frame 30. The movable pulleys 34 are mounted on a movable carriage 36 so that they may be moved to the left or right (as viewed in Figs. 2 and 4) to, in effect, shorten or lengthen the hoisting cables 31. Carriage 36 is a fabricated structure supported by rollers 43 at the sides thereof (see Fig. 3) adapted to ride in guide rails 41 mounted on hoist frame 30. Forward position of carriage 36 is limited by a stop 42 (see Fig. 4), and rearward position thereof is limited by the upward position of load lift beam 32 in heating chamber 5, or by the stroke of the hoist operating cylinder 38. The carriage 36 is secured to the piston rod 37 of operating cylinder 38, by actuation of which the load lift beam 32 may be raised or lowered as is desired, in a known manner. Associated with the piston rod 37 and cylinder 38 there is provided a latch 39 to lock the hoisting apparatus when the load is within the heating chamber 5 so as to prevent accidental release thereof before retractable rollers 14 are retracted. The details of this latch 39 are not

essential to the invention, and will not be further described.

At the lower extremities of the hoist cables 31 on either side of the heating chamber 5 are secured, through suitable connecting links, the two longitudinally extending portions of the load lift beam 32 which may be, as is shown in Fig. 4, made up of a plurality of hingedly related beam sections disposed on opposite interior sides of the heating chamber 5, tied together by suitable cross members. The load lift beam 32 is, in effect, one simple frame but is constructed for slight hinged relation of the aforementioned sections to make it more easily attached to the load carrier 10, and to allow for variable heat expansion thereof. Depending from the load lift beam 32 along each longitudinal side portion thereof are a plurality of hooks 40 adapted to be engaged with the eyes 12 on a load carrier 10. A load carrier 10 is engaged with the load lift beam 32 by moving the load carrier on track rollers 14 a few inches beyond registering position with the load lift beam, then lowering the load lift beam. so that the hooks 40 are opposite the eyes 12, and then slightly moving the load carrier to place the eyes 12 over the hooks 40. Thereupon, the load lift beam 32 may be raised by the hoisting mechanism, actuated by the operating cylinder 38, to lift the load carrier 10 and load supported thereby. In this manner the load carrier 10 may be removed from its support on retractable track rollers 14. When it is desired to re-deposit the load carrier 10 upon the rollers 14, and disengage the load lift beam 32 from the load carrier 10, the reverse of the above described procedure may be employed.

Drying apparatus

Leaving for later discussion further details of the apparatus associated with the heating chamber 5 and quenching tank 15, it is pointed out that a load carrier 10 will be removed from under the heating chamber 5 by passage along the retractable track rollers 14 over onto the delivery track rollers 16. The load will be moved further along track rollers 14 and 16 manually, or by suitable mechanical means, onto track rollers 45 of a drying transfer 46, similar in many respects to the loading transfer 1. The drying transfer 46, as in the case of the loading transfer 1, is made up of longitudinal side members and suitable lateral members, the side members carrying the inwardly presented track rollers 45. It is dependingly supported by overhead transfer rollers 47 on three transfer rails 48 for movement from a position in alignment with the track formed by rollers 16 to a position in alignment with the aforementioned return track rollers 4. The transfer rails 48 are supported by suitable structural rail supporting columns 44. The lateral transferring motion of drying transfer 46 may be imparted manually or by suitable mechanical means. Further associated with the drying transfer 46 is a U-shaped enclosing shell, having a partial top and no bottom, and having an open end for receipt and delivery of the load. The loading transfer, midway of its motion between the position in alignment with the track rollers 16 and the position in alignment with track rollers 4, is adapted to be stopped and located under a drying apparatus 50 mounted on transfer rails 48, so that the drying apparatus 50 and transfer 46, in cooperation with the floor, form a drying chamber open only, if desired, at the left end (as viewed in Figs. 1 and 2). An aperture 49 is provided in the partial top of drying transfer 46 for cooperation with the drying apparatus 50. The drying apparatus 50 comprises suitably arranged blowers 51 adapted to blow air through electric or steam heaters, and through aperture 49 into drying transfer 46, to circulate heated air through the load for evaporating the quench water therefrom.

On completion of the drying operation a load carrier 10 on drying transfer 46 is adapted to be placed in alignment with return track rollers 4 and delivered therealong over to the loading transfer 1. The return track rollers 4 form a return load carrier track, the rollers 4 being mounted in structural members 54, supported from the floor by structural columns 55. Thus, it will be seen that the loading transfer 1, track made up of rollers 14 and 16, drying transfer 46, and return track made up of rollers 4 provide a load circulating track system capable of accommodating several load carriers 10. Load carriers are shown in various positions in the drawings for clarity in description. The load carriers may be unloaded and reloaded at any desired position along this track system. The preferred loading position is at the loading transfer 1, and the preferred unloading positions are along return track rollers 4.

Retractable track

The retractable track will now be particularly described with reference to Figs. 3, 4, 7, 8, and 10. Description of the retractable track made up of rollers 14 and structural members 25 will be confined to that portion thereof located on one side of the heating chamber 5, which will exemplify the operation of the retractable track as a whole. It will be noted that the track rollers 14 are pin supported in longitudinally extending structural members 25, being secured thereto by nuts 24 (see Figs. 8 and 10). The structural members 25 extend throughout the length of the heating chamber 5 and are secured by T connections to horizontally disposed rack members 60, perpendicular thereto. The rack members 60 are fabricated structural members made up of two back-to-back channels having secured therebetween, by bolts 67, and facing downwardly, a rack portion 61. Each rack member 60 is supported indirectly by structural heating chamber columns 18 through the medium of a pair of lower fulcrum rollers 62 and a pair of upper fulcrum rollers 68. The rollers 62 are placed over a pin 63 mounted in a bracket 64 secured by bolts 66 on an angle 65 connecting interiorly with and across the structural columns 18. These lower fulcrum rollers 62 support the rack member 60 on the side of the structural columns 18 facing the interior of the heating chamber 5. Similar upper fulcrum rollers 68 are placed over a pin 69 mounted in a bracket 70 secured by bolts 72 on an angle 71 connecting exteriorly with and across the structural columns 18. They support the outer end of each rack member 60 so that it functions as a lever fulcrumed at upper rollers 68 and lower rollers 62.

For commonly moving each rack member in and out to project or retract the track portion formed by a structural member 25 and rollers 14, there is provided the aforementioned operating cylinder 26, secured to channels 81 connecting a pair of structural heating chamber columns 18. The cylinder 26 has a piston rod 73 suitably connected to a rack 74 in engagement with a pinion 75. The pinion 75 is mounted on a shaft

76 extending the length of the heating chamber 5. Shaft 76 is supported in bearing brackets 77 secured by bolts 82 on an angle 78 connecting structural columns 18. The rack 74 is held against the pinion 75 by a suitable backing roller 79 opposite thereto suitably mounted and supported. Operation of the piston rod 73 causes the rack 74 to impart rotary movement through the pinion 75 to the shaft 76. Spaced opposite each rack member 60 is a suitably keyed pinion 80 on shaft 76 which engages the rack portion 61 of each rack member 60. Thus, rotation of shaft 76 imparts rotation to pinions 80 and thereby effects inward and outward movement of each rack member 60. Two cylinders 26, one at each side of the furnace, through the aforementioned linkages, are effective to commonly actuate all of the rack members 60 so as to project or retract the retractable track formed by rollers 14 at the desired times. The mechanism here described is duplicated on both sides of the furnace apparatus, and thus, the simultaneous operation or substantially simultaneous operation of two operating cylinders 26 is effective to project the rollers 14 so as to form a load carrier track, or to retract the same for the vertical raising or lowering therebetween of the load carrier 10 and load supported thereby.

Door operating mechanisms

Referring particularly to Figs. 3, 4, 5, 6, 7, 8, 9, and 11 the heating chamber door and its operating mechanisms may be particularly described. The door 20 is made up of suitable structural members forming a hollow frame that is filled with suitable insulating material, and is adapted for closing off the opening in the bottom of the heating chamber 5 and sealing the same. To effect the sealing action a suitable gasket 19 is provided around the upper edges of door 20 so that sealing pressure on the bottom of the door 20 may yieldably seal the door 20 against the bottom of the heating chamber 5. The longitudinal sides of the door 20 are provided with shouldered recesses 85 (see Fig. 8) containing yieldably mounted spring holders 86. Each spring holder 86 is pivotally secured on a pin 90 to a bracket 87 (see Fig. 11) attached to the door 20 in one of the two shouldered recesses 85. Each spring holder 86, at the other end thereof, is provided with a cylindrical socket 88 adapted to receive an adjustably compressible spring 89. The spring is held in socket 88 by means of a bolt 91 passing through the lower end of socket 88 and by a washer 92 and nut 93 at the top thereof, these means being arranged to confine the spring between the washer 92 and the bottom of socket 88. The upper end of bolt 91 is adapted to bear against a recess 85 of door 20. The socket 88 of each spring holder 86 is provided with a lug or ear 96 through which a bolt 95 loosely passes. The bolt 95 is carried by the door frame and has adjusting nut 97 and locking nut 98, whereby the spring holder 86 may be adjustably positioned with respect to the door frame. When the spring holders are moved upwardly, the spring pressed bolts 91 engage the bottom of the door frame, and the door 20 is raised thereby to sealing position under a pressure determined by the pressure of the springs 89. The length and load of each spring 89 may be suitably adjusted by tightening or loosening the nut 93 on bolt 91. Thus, it will appear that pressure upwardly exerted on each spring holder 86 will be adapted to yieldably and releasably seal door 20 and gasket 19 against the bottom of heating chamber 5.

As aforementioned, there are a plurality of spring holders 86 secured, as above described, along the shouldered recesses 85 on either side of door 20. A plurality of roller clamps 100 are adapted to press against the spring holders 86 to raise the door 20 into sealing position. These roller clamps 100 take the form of cranks, secured to stub shafts 101 that extend crosswise of the furnace from immediately under the longitudinal edges of the door 20 to the outside of the frame work of the apparatus. The roller clamps 100 extend normally parallel to spring holders 86 and are provided with pin supported clamping rollers 102 adapted to bear against the spring holders 86. The shafts 101 are mounted in suitable bearings in brackets 103 dependingly supported from door track angles 23 and angles 71 above mentioned.

On the outer end of each shaft 101 there is secured a crank lever 104. Each of the crank levers 104, along the length of each side of the furnace, is connected by suitable clevis and pin connection to an operating rod 105. The operating rods 105, at the end of the heating chamber 5 adjacent the loading transfer 1, are connected by links 106 to bell cranks 107 rotatably mounted on pins supported in brackets 109 (see Fig. 3) secured to structural columns 18. The other ends of bell cranks 107 are secured to piston rods 108 of the operating cylinders 22.

Thus, it will appear that motion of a piston rod 108 will impart rotary movement to a bell crank 107 which, through a link 106, will move an operating rod 105 lengthwise of the heating chamber 5. This motion of each operating rod 105 will simultaneously rotate the crank levers 104 secured to the shafts 101, and will thereby rotate the roller clamps 100. The roller clamps thereby are rotated from horizontal position shown in Figs. 8, 9, and 10 to inclined or vertical position, to move the spring holders 86 upwardly through rollers 102 and press the same against the door 20. The springs 89 are adapted to permit the necessary amount of overtravel inherent in the use of a plurality of commonly actuated roller clamps 100, and furthermore, by their adjustability are adapted to exert a predetermined sealing pressure on the door 20. The pressure exerted by each roller clamp 100 on the door 20 through each spring holder 86 will be determined by the amount of precompression of each spring 89 attained through the adjustment of each nut 93.

What has been just described is the actuating mechanism for vertically moving the door into and out of sealing position. In its lower open position, the door is supported on the heretofore mentioned track 23 by means of a series of rollers 110 disposed along each lateral edge of the door, as best seen in Figs. 7 and 8. The track rails 23 are secured to the lower flanges of channels 111 that are secured to the under side of the furnace structure. The door also is provided with guide rollers 113 that are journalled on vertical axes for engagement with the webs of the channels 111 during travel of the door on the track 23.

Referring now in particular to Figs. 5 and 6, the mechanism which may be employed for removing the door 20 from beneath the heating chamber 5 and returning the same will be described. The door 20 is arranged to be traversed on the track 23 beneath the heating chamber 5

over onto an extension of track 23 formed by similar angles supported upon structural members 114, which portion of track 23 extends beyond the heating chamber 5 on the end opposite to the loading transfer 1. In these figures, the door is shown so removed from under the heating chamber 5 and resting upon the extended track 23.

The traversing longitudinal movement of door 20 between its position under the heating chamber 5 and the position shown in Figs. 5 and 6 is effected by means of pairs of traversing cables 115 and 115*a*, respectively, passed over pulleys 116 secured to the base of heating chamber 5 and over pulleys 117 secured to cross pieces 118 mounted upon transfer rails 48 adjacent the drying apparatus 50. Each end of the upper strands of cables 115 and 115*a* is secured in multiple wraps over one of four driving drums or pulleys 119, the wrappings of the respective pairs of cables on their drums 119 being effected in opposite directions. Each end of the lower strands of cables 115 and 115*a* is secured through a suitable adjustable anchor connection 120 to a bracket extension 122 of the door 20 provided at the end thereof nearest the drying apparatus 50. Thus, it will appear that rotation of the driving drums 119 in one direction will effect winding of the cables of one pair and unwinding of the cables of the other pair upon their respective drums, whereby the door is moved longitudinally in one direction. Rotation of the drums in the opposite direction will effect travel of the door in the opposite direction.

The driving pulleys 119 are suitably keyed to a common shaft 124 mounted in bearing brackets 125. Brackets 125 are secured to beams 126 mounted on cross members 127 supported by the aforementioned structural columns 114. A pair of channels 129, likewise supported on cross members 127, supports the operating cylinder 21. This cylinder is disposed with its axis parallel to the longitudinal direction of motion of the door 20 and has a piston rod 130 secured to a rack 131, the latter meshing with a pinion 134 mounted centrally of the shaft 124. For holding the rack 131 against the pinion 134 an overhead backing or guide roller 135 is provided opposite the pinion 134, which guide roller 135 is secured in suitable retaining members 136. The end of the rack 131 is provided with a supporting roller 138 adapted to ride on a rail 139 mounted at one end on a beam 126 and extending over to a cross member 140 supported adjacent the drying apparatus 50. Cross member 140 is mounted on cross pieces 118 bridging transfer rails 48. From the foregoing description, it will appear that motion of the rack 131 imparted by operating pressure from cylinder 21 may be employed for rotating drive pulleys 119 and traversing the door 20 to and from its position beneath the heating chamber 5.

Operation

The preferred mode of operation of the heat treating apparatus herein described may be most easily set forth by making certain assumptions. It will be assumed that there is a load carrier 10 on loading transfer 1 in the loading position shown in Fig. 1, and that there is a load of material within the heating chamber 5 supported from a second load carrier 10 by the hoisting apparatus, as shown in Fig. 7, and that there is a load of material in unloading position supported from a third load carrier 10 on the return track formed by rollers 4.

The load carrier 10 on loading transfer 1 will be in the process of being loaded with sheets to be heat treated, these sheets being secured to the load hangers 13 depending from the load carrier 10. Likewise, at the same time, the load carrier 10 which is in unloading position on the return track may be in the process of being unloaded by removal of the metal sheets from the load hangers 13, which support the same. These loading and unloading operations will take place during the period of heat treatment including heating and quenching, if desired, of still another load in the furnace heating chamber 5 or in the quenching tank 15. Thus, a new load of material will be ready for entry into the heating chamber 5 as soon as the preceding load is removed from the furnace or the quenching tank, and an unloaded carrier 10 will be ready to be loaded immediately following the loading operation on the previous load carrier 10.

It is further assumed that the furnace door 20 is under the heating chamber 5 and sealed thereagainst. After the load in the heating chamber 5 has been raised to a heat treating temperature and retained at such temperature for the desired length of time, the following steps will be carried out. The retractable rollers 14 beneath the heating chamber 5 will be retracted to the sides of the heating chamber 5 by the operation of the operating cylinders 26 associated therewith. When the load track formed by retractable rollers 14 has been retracted, the door 20 will be moved to unseal the same from the heating chamber 5. To perform this operation, the operating cylinder 22 will be actuated to release and lower the door sealing roller clamps 100. Release of the roller clamps 100 will permit the door 20 to move downward until its rollers 110 engage the door track 23. Thereupon, the door 20 will be withdrawn from beneath the heating chamber 5 by actuation of the operating cylinder 21, exerting a pulling force through the traversing cables 115*a*. Thus, the door will be released and removed from beneath the heating chamber 5, and the retractable rollers 14 will be moved out of the way to permit the load to be lowered from the heating chamber 5.

Immediately following the above described operations, the load carrier 10 carrying the load which has been heated in heating chamber 5 will be quickly lowered to immerse the load in the quenching tank 15, the hoist operating cylinder 38 being actuated to permit lowering of the load carrier 10 and load lift beam 32 supported by the hoisting cables 31.

The load lift beam 32 is adapted to support the load carrier 10 and load dependingly hung therefrom in the quenching tank 15 for the desired quenching period. In cases where it may be desirable to do so, the load lift beam 32 may be disengaged from the load carrier 10 when it is in, or immediately above, the quenching tank 15. However, this is not the preferred cycle of operations. Such deviation from the preferred cycle of operations would probably require the provision of a load carrier rest in the quenching tank similar to the retractable rollers 14 adapted to support the load carrier 10 between the heating chamber 5 and the quenching tank 15.

When it is desired to raise the load out of the quenching tank 15, the hoisting cables 31 will again be raised by the operation of the operating cylinder 38. The lifting operation un-

dertaken by the hoisting cables 31 will be discontinued when the load carrier 10 is disposed slightly above the level of the retractable rollers 14. Thereupon, the retractable rollers 14 will be projected into their inward positions by the operation of operating cylinder 26, so that the rollers 14 will be in position under the load carrier 10 to support the same. Thereupon, the load carrier 10 will be deposited upon the retractable rollers 14 by slight lowering of the hoisting cables 31 through actuation of the operating cylinder 38. Following the depositing of the load carrier 10 on the retractable rollers 14, the hoisting cables will preferably be lowered a little so as to permit disengagement of the hooks 40 on load lift beam 32 from the eyes 12 of the load carrier 10. Thereupon, disengagement of hooks 40 and eyes 12 will be effected by slight horizontal motion of the load carrier 10 with reference to the load lift beam 32. Upon disengagement of the load lift beam 32 from the load carrier 10, as described, the load lift beam 32 will preferably be raised slightly above the load carrier 10 so as to permit the free passage of load carrier 10 over the rollers 14 and beyond the heating chamber 5 onto the rollers 16 forming a delivery track. The load will be moved over to the rollers 16 manually or by suitable mechanical devices.

If it is desired, the load lift beam 32 may be fully retracted within the heating chamber 5 to permit closing of the heating chamber by traversing the door 20 thereunder and sealing the same thereagainst. This may be desirable if there is to be appreciable time between the removal of one load and the insertion of another load.

As soon as the load, which has been above described, has been moved over onto rollers 16, the new load which has been secured to the load carrier 10 on loading transfer 1 will be moved from the loading transfer 1 onto the retractable rollers 14 under the heating chamber 5. If the door 20 has been closed, it will be opened to permit receipt of the newly placed load carrier 10. Assuming the door to be open, the load carrier 10 will be raised into the heating chamber 5 upon the performance of the following operations. The load lift beam will be lowered, through operation of the hoisting cables 31 and operating cylinder 38, so that the hooks 40 are again opposite eyes 12 of the load carrier 10. Thereupon, the load carrier 10 will be engaged with the hooks of the load lift beam 32, and the load lift beam 32 and load carrier 10 will be raised into the heating chamber 5, through operation of the operating cylinder 38 and hoisting cables 31. The lifting of the load into the heating chamber may be temporarily interrupted after partial lifting of the load carrier 10 to permit retraction of retractable rollers 14 in order to prevent any interference of the load thereof with load carrier 10 and its load as it passes into the load chamber 5. The retraction of the rollers 14 at this time, it is noted, does away with the necessity of retracting the same when it is desired to lower the load from the heating chamber 5 into the quenching tank 15.

When the load lift beam 32 has been raised to carry the load carrier 10 into proper position within the heating chamber 5, the door 20 will be traversed under the heating chamber 5 by operation of the operating cylinder 21. It will then be raised into sealing position by the operation of the operating cylinders 22, as above described.

Upon the sealing of the door 20, the heating portion of the heat treating process will be instituted, and upon its completion, the cycle of operations which has been hereinabove described will be again carried out with reference to the load within the heating chamber 5. At this time, the load carrier 10, which has been in unloading position on the delivery track 4, will be delivered onto the loading transfer 1 and there loaded.

The load carrier which was moved out onto delivery rollers 16 will be preferably immediately moved onto the rollers 45 of the drying transfer 46 and then laterally into drying position under the drying apparatus 50 where it will be held for a sufficient length of time to effect drying of the load of metal. The drying operation is effected by means of the blowers 51, circulating air through suitable heating apparatus so as to evaporate the water which clings to the metal sheets of the load.

Upon completion of the drying operation, the drying transfer 46 will preferably be moved laterally into alignment with the return track rollers 4. Thereupon, the load carrier 10 will be manually moved onto the return track and therealong to unloading position.

It will appear from the foregoing description of the heat treating apparatus, and the mode of its operation, that it lends itself to the rapid and convenient loading and unloading of material to be subjected to a heat treating process, and that it permits rapid entry of the material into the heating chamber and rapid delivery of the material from the heating chamber to the quenching tank. It will further appear that it presents an organization of apparatus particularly well adapted to the dry charging of a load into the heating chamber and to the rapid quenching thereof, as well as to the rapid removal and disposition thereof both in a drying chamber and to an unloading position, and that the several operations of the entire system can be carried out substantially concurrently.

While the invention has been described with reference to its adaptability to handle loads of metal to be heat treated, particularly loads made up of metal sheets, it will appear that it is adapted to the handling of other types of loads, and that the apparatus may be useful in the performance of other metal treating processes, or to the performance of processes on other materials.

Numerous modifications may be made in the mechanical structure of the apparatus described. Many of the details of the preferred form of apparatus have been only generally referred to since their design will become apparent to those skilled in the art upon the reading of this specification. The invention is therefore set forth in the appended claims with the intent that they be read broadly in the light of the objects of this invention, and with only such limitations as are imposed by the prior art.

What is claimed is:

1. In combination with a furnace having a heating chamber, a bottom door for said chamber, a tank located below said chamber a distance greater than the load height thereof, means for supporting a furnace load between said chamber and said tank, said load supporting means being retractable from supporting position, and means for lifting a furnace load from said load supporting means into said chamber, said lifting means being adapted to lower the lifted load into said tank when said load supporting means are retracted.

2. In combination with a furnace having a heating chamber, a bottom door for said chamber, a tank located below said chamber a distance greater than the load height thereof, a load supporting track beneath said door for horizontal delivery therealong of a furnace load, said load supporting track being retractable toward at least one side of said chamber, and means for lifting a furnace load from said load supporting track into said chamber, said lifting means being adapted to lower the lifted load into said tank when said load supporting track is retracted.

3. In combination with a furnace having a heating chamber, a bottom door for said chamber, a tank located below said chamber a distance greater than the load height thereof, a load supporting track beneath said door for horizontal delivery therealong of a furnace load, said load supporting track being retractable toward at least one side of said chamber, hoist means for raising, lowering, and holding a furnace load between and at positions in said chamber, in said tank, and on said load supporting track, and means for retracting said load supporting track to permit raising or lowering of a furnace load and for projecting the same to receive and support a furnace load.

4. In combination with a furnace having a heating chamber, a horizontally movable bottom door for said chamber, means for opening and closing said door by sliding movement, a tank located below said chamber a distance greater than the load height thereof, means for supporting a furnace load between said chamber and said tank, said load supporting means being retractable from supporting position, and means for lifting a furnace load from said load supporting means into said chamber, said lifting means being adapted to lower the lifted load into said tank when said load supporting means are retracted.

5. In combination with a furnace having a heating chamber, a horizontally movable bottom door for said chamber, means for opening and closing said door by sliding movement, a tank located below said chamber a distance greater than the load height thereof, a load supporting track beneath said door for horizontal delivery therealong of a furnace load, said load supporting track being retractable toward at least one side of said chamber, and means for lifting a furnace load from said load supporting track into said chamber, said lifting means being adapted to lower the lifted load into said tank when said load supporting track is retracted.

6. In combination with a furnace having a heating chamber, a horizontally movable bottom door for said chamber, means for opening and closing said door by sliding movement, a tank located below said chamber a distance greater than the load height thereof, a load supporting track beneath said door for horizontal delivery therealong of a furnace load, said load supporting track being retractable toward at least one side of said chamber, hoist means for raising, lowering, and holding a furnace load between and at positions in said chamber, in said tank, and on said load supporting track, and means for retracting said load supporting track to permit raising or lowering of a furnace load and for projecting the same to receive and support a furnace load.

7. In combination with a heat treating furnace having a heating chamber, a horizontally movable door adapted to be upwardly sealed against the bottom of said chamber, yieldable means for releasably pressing said door into sealing position, means beneath said chamber and extending beyond at least one end thereof for supporting said door for horizontal opening and closing movement when released, means for moving said door along said door supporting means, a quenching tank located below said chamber a distance greater than the load height thereof, means for supporting a furnace load between said chamber and said tank, said load supporting means being retractable from supporting position, and means for lifting a furnace load from said load supporting means into said chamber, said lifting means being adapted to lower the lifted load into said tank when said load supporting means are retracted.

8. In combination with a heat treating furnace having a heating chamber, a horizontally movable door adapted to be upwardly sealed against the bottom of said chamber, yieldable means for releasably pressing said door into sealing position, means beneath said chamber and extending beyond at least one end thereof for supporting said door for horizontal opening and closing movement when released, means for moving said door along said door supporting means, a quenching tank located below said chamber a distance greater than the load height thereof, a load supporting track beneath said door for horizontal delivery therealong of a furnace load, said load supporting track being retractable toward at least one side of said chamber, and means for lifting a furnace load from said load supporting track into said chamber, said lifting means being adapted to lower the lifted load into said tank when said load supporting track is retracted.

9. In combination with a heat treating furnace having a heating chamber, a horizontally movable door adapted to be upwardly sealed against the bottom of said chamber, yieldable means for releasably pressing said door into sealing position, means beneath said chamber and extending beyond at least one end thereof for supporting said door for horizontal opening and closing movement when released, means for moving said door along said door supporting means, a quenching tank located below said chamber a distance greater than the load height thereof, a load supporting track beneath said door for horizontal delivery therealong of a furnace load, said load supporting track being retractable toward at least one side of said chamber, hoist means for raising, lowering, and holding a furnace load between and at positions in said chamber, in said tank, and on said load supporting track, and means for retracting said load supporting track to permit raising or lowering of a furnace load and for projecting the same to receive and support a furnace load.

10. A heat treating apparatus comprising a heating chamber elevated above floor level, a quenching tank under said chamber but depressed below floor level, said chamber and said tank being vertically separated a distance greater than the load height of said chamber to provide therebetween a loading space at and above floor level, a load carrier track extending through said loading space for movably supporting a load carrier, a load carrier adapted to move along said load carrier track and to carry a furnace load of metal sheets dependingly hung therefrom, a door in the bottom of said heating chamber adapted

to be opened and closed for the receipt and discharge of a load carrier, hoisting means withdrawable into said chamber and extendable into said tank, means for attaching said hoisting means to said load carrier, and means for retracting at least that portion of said load carrier track which is directly under said chamber to at least one side of said chamber after engagement of said hoisting means with said load carrier, said retracting means being adapted to subsequently project said portion of said load carrier track to load supporting position, whereby the load carrier and its load may be withdrawn into said chamber, lowered into said tank, and returned to said load carrier track by said hoisting means, and whereby said load carrier track provides delivery and removal means for said load carrier.

11. A heat treating apparatus comprising a heating chamber elevated above floor level, a quenching tank under said chamber but depressed below floor level, said chamber and said tank being vertically separated a distance greater than the load height of said chamber to provide therebetween a loading space at and above floor level, a load carrier track extending through said loading space for movably supporting a load carrier, a load carrier adapted to move along said load carrier track and to carry a furnace load of metal sheets dependingly hung therefrom, a door in the bottom of said heating chamber adapted to be opened and closed for the receipt and discharge of a load carrier, yieldable means for releasably pressing said door upwardly against the bottom of said chamber and into sealing engagement therewith, a door supporting track above said load carrier track extending under said door and beyond one end of said chamber, means for horizontally moving said door when released onto said door supporting track to and from a position under said chamber, hoist means for raising, lowering, and holding a furnace load between and at positions in said chamber, in said tank, and on said load carrier track, and means for retracting said load supporting track to permit raising or lowering of a furnace load and for projecting the same to receive and support a furnace load.

12. A heat treating apparatus comprising a heating chamber elevated above floor level, a quenching tank under said chamber but depressed below floor level, said chamber and said tank being vertically separated a distance greater than the load height of said chamber to provide therebetween a loading space at and above floor level, a load carrier track extending through said loading space for movably supporting a load carrier, a return load carrier track along one side of said heating chamber and substantially parallel to said first mentioned load carrier track, transfer tracks movable for alignment with either of said load carrier tracks at each end thereof for transferring a load carrier from one to the other of said load carrier tracks, a load carrier adapted to move along said load carrier track and to carry a furnace load of metal sheets dependingly hung therefrom, a door in the bottom of said heating chamber adapted to be opened and closed for the receipt and discharge of a load carrier, hoisting means withdrawable into said chamber and extendable into said tank, means for attaching said hoisting means to said load carrier, and means for retracting at least that portion of said load carrier track which is directly under said chamber to at least one side of said chamber after engagement of said hoisting means with said load carrier, said retracting means being adapted to subsequently project said portion of said load carrier track to load supporting position, whereby the load carrier and its load may be withdrawn into said chamber, lowered into said tank, and returned to said load carrier track by said hoisting means, and whereby said load carrier tracks provide a circulatory load delivery and removal system.

13. A heat treating apparatus comprising a heating chamber elevated above floor level, a quenching tank under said chamber but depressed below floor level, said chamber and said tank being vertically separated a distance greater than the load height of said chamber to provide therebetween a loading space at and above floor level, a load carrier track extending through said loading space for movably supporting a load carrier, a return load carrier track along one side of said heating chamber and substantially parallel to said first mentioned load carrier track, transfer tracks movable for alignment with either of said load carrier tracks at each end thereof for transferring a load carrier from one to the other of said load carrier tracks, one of said tansfer tracks having means substantially enclosing the same to provide a load drying chamber, means for directing a flow of heated air through said drying chamber to evaporate clinging quench water from a furnace load carried by a load carrier on said transfer track, a load carrier adapted to move along said load carrier track and to carry a furnace load of metal sheets dependingly hung therefrom, a door in the bottom of said heating chamber adapted to be opened and closed for the receipt and discharge of a load carrier, hoisting means withdrawable into said chamber and extendable into said tank, means for attaching said hoisting means to said load carrier, and means for retracting at least that portion of said load carrier track which is directly under said chamber to at least one side of said chamber after engagement of said hoisting means with said load carrier, said retracting means being adapted to subsequently project said portion of said load carrier track to load supporting position, whereby the load carrier and its load may be withdrawn into said chamber, lowered into said tank, and returned to said load carrier track by said hoisting means, and whereby said load carrier tracks provide a circulatory load delivery and removal system.

14. In a heat treating system of the type described, the combination comprising an elevated track structure, a plurality of carriers movable along said track and adapted for upward movement with respect thereto, a portion of said track being laterally retractable for movement of a carrier below the plane of said track, a heating chamber above said portion of said track, a tank spaced below said heating chamber a distance greater than the load height thereof to permit movement of a loaded carrier therebetween, means engageable with said loaded carrier beneath said chamber for raising the same into said heating chamber and for lowering the same into said tank, means for actuating said retractable portion of said track when the loaded carrier is disposed above or below the plane of said track, a bottom closure for said chamber, and means for actuating said closure for entry and discharge of said loaded carrier into and out of said chamber.

15. In a heat treating system of the type de-

scribed, the combination comprising an elevated track structure, a plurality of carriers movable along said track and adapted for upward movement with respect thereto, a portion of said track being laterally retractable for movement of a carrier below the plane of said track, a heating chamber above said portion of said track, a tank spaced below said heating chamber a distance greater than the load height thereof to permit movement of a loaded carrier therebetween, means engageable with said loaded carrier beneath said chamber for raising the same into said heating chamber and for lowering the same into said tank, means for actuating said retractable portion of said track when the loaded carrier is disposed above or below the plane of said track, a bottom closure for said chamber, and means for actuating said closure for entry and discharge of said loaded carrier into and out of said chamber, said track structure being arranged to accommodate said plurality of carriers simultaneously at a loading station, at an unloading station, and at a treating station located at said heating chamber for movement through a path extending from each of said stations to the next station.

16. A heating treating mechanism comprising in combination, a heating chamber disposed and aligned above a quenching tank, a track extending between charging and discharging stations at opposite ends of the heating chamber, said track lying in a plane directly below the heating chamber and above the quenching tank, a second track in the same plane but spaced from and parallel to the first-mentioned track, at least one carriage adapted to be translated along said tracks, cross rails adjacent the charging and discharging stations for connecting the parallel tracks, whereby a carriage may be laterally shunted from one to the other of the parallel tracks, means for hoisting and lowering a carriage from the track immediately below the heating chamber, a section of said last-mentioned track being adapted to be spread sufficiently to permit lowering a carriage through the same into the quenching tank, and said parallel track arrangement providing storage for a number of carriages.

KIRTLAND MARSH.