United States Patent

Reber et al.

[15] **3,659,831**

[45] **May 2, 1972**

[54] INTEGRAL QUENCH FURNACE AND TRANSFER MECHANISM

[72] Inventors: **Russell H. Reber**, Orange; **Harold E. Mescher**, Pico Rivera, both of Calif.

[73] Assignee: **Pacific Scientific Company**, City of Commerce, Calif.

[22] Filed: **Aug. 25, 1969**

[21] Appl. No.: **852,671**

[52] **U.S. Cl.** .....**266/4 A**, 148/153, 214/18 R, 214/26

[51] **Int. Cl.** **C21d 1/66**

[58] **Field of Search** .....148/153, 155; 214/18 R, 23–26, 214/32; 266/4 R, 4 A, 4 B, 6 R

[56] **References Cited**

UNITED STATES PATENTS

1,840,327	1/1932	Paulsen	214/26
1,848,898	3/1932	McFarland	214/26
2,681,136	6/1954	Ipsen	266/4 R
2,747,855	5/1956	Ipsen	266/4 R
2,965,369	12/1960	Acker et al	266/4 R
3,381,947	5/1968	Beggs	266/4 R
3,410,547	11/1968	Bielefeldt	266/5 R
3,441,452	4/1969	Westeren	266/4 R

FOREIGN PATENTS OR APPLICATIONS

987,910	8/1951	France	266/4 R

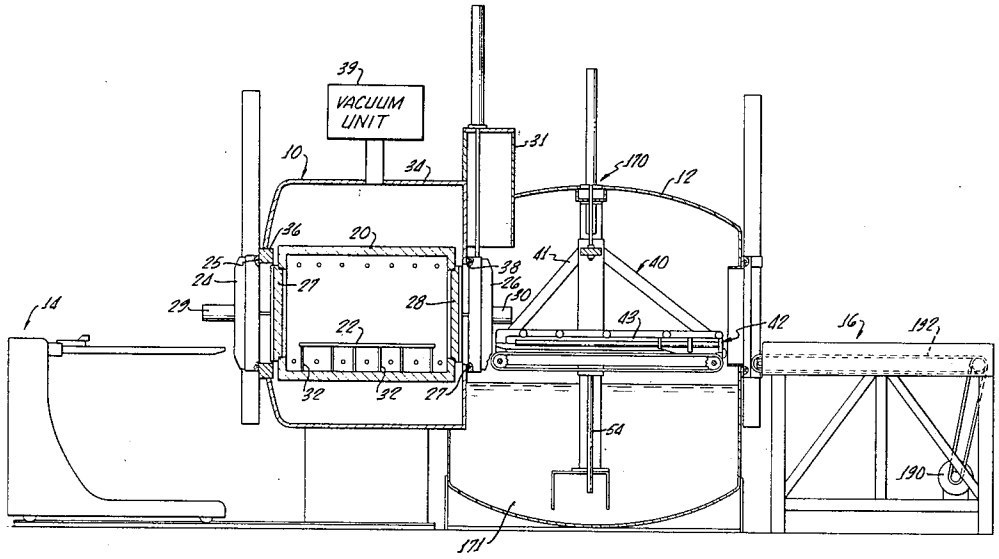
Primary Examiner—Gerald A. Dost

Attorney—Fowler, Knobbe & Martens

[57] **ABSTRACT**

An integral quench furnace system and transfer mechanism for removing a heat treated charge from the furnace chamber into the quench media and onto an unloading platform. The transfer mechanism includes a forked loading cart mounted on the quench chamber A-frame for movement into the furnace and onto the unloading platform through a hydraulic motor driven chain and sprocket arrangement.

22 Claims, 13 Drawing Figures



Patented May 2, 1972 3,659,831

10 Sheets-Sheet 1

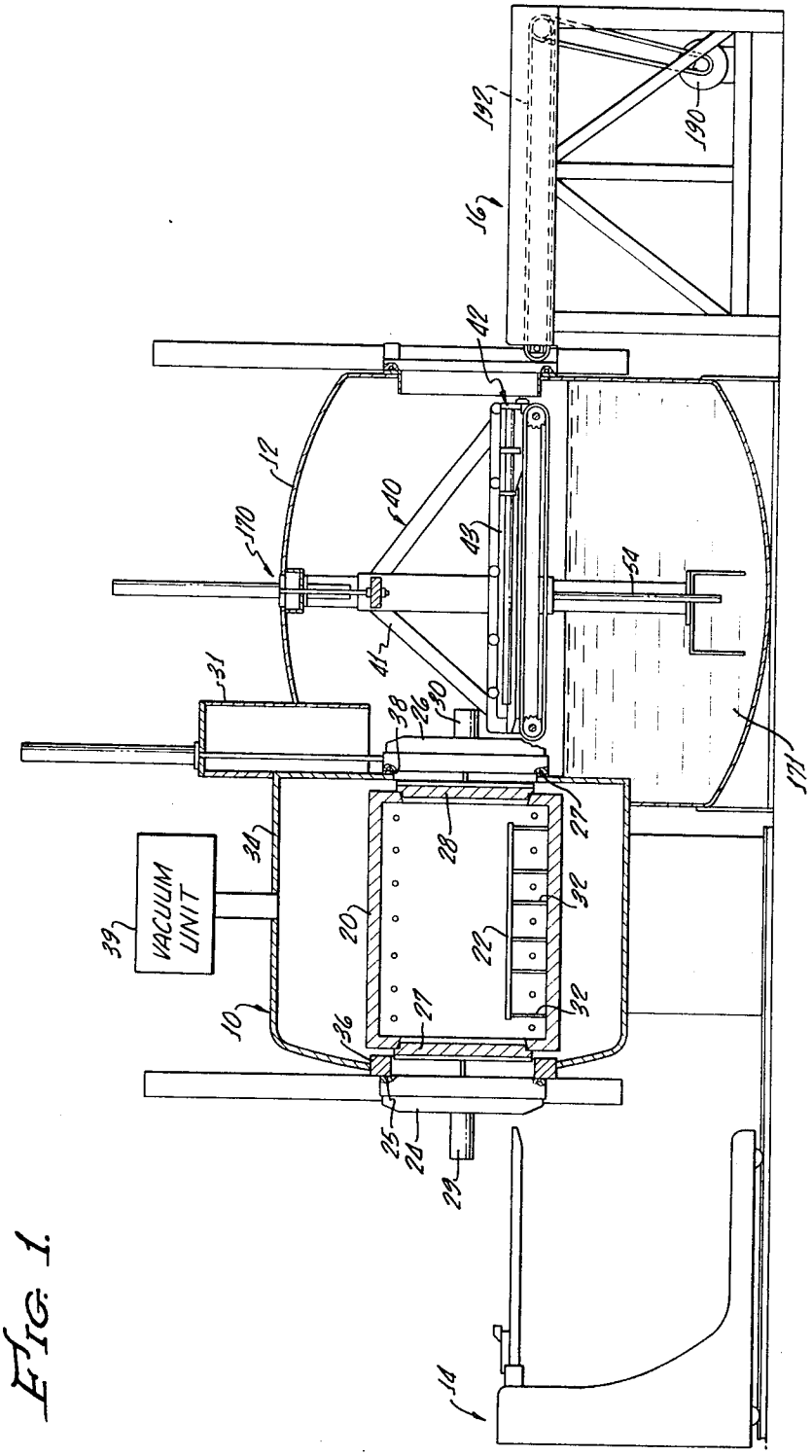


FIG. 1.

INVENTORS.
RUSSELL H. REBER
HAROLD E. MESCHER
BY
FOWLER, KNOBBE & MARTENS
ATTORNEYS.

Patented May 2, 1972

3,659,831

10 Sheets-Sheet 2

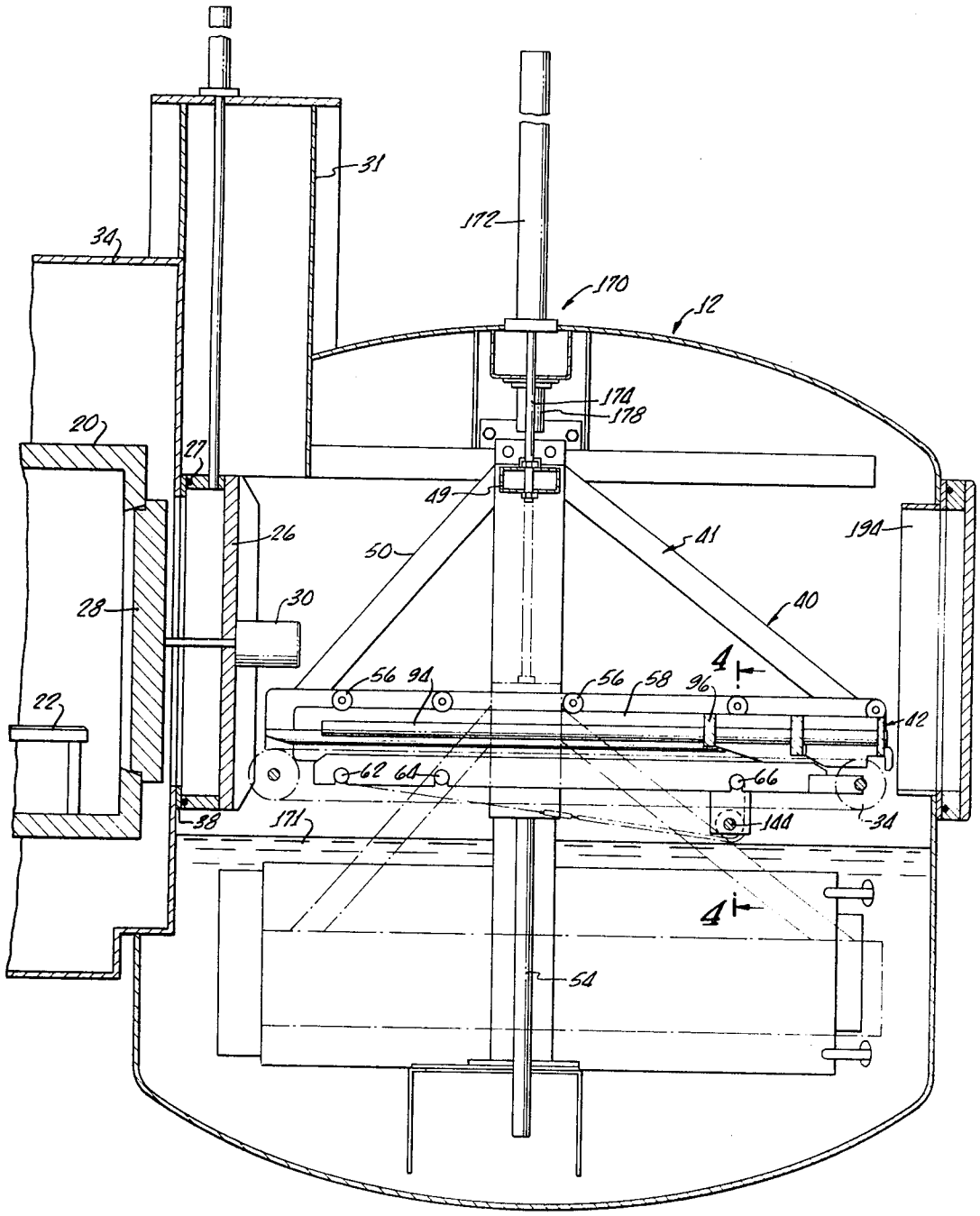


FIG. 2.

INVENTORS.
RUSSELL H. REBER
HAROLD E. MESCHER
BY
FOWLER, KNOBBE
& MARTENS
ATTORNEYS.

FIG. 3.

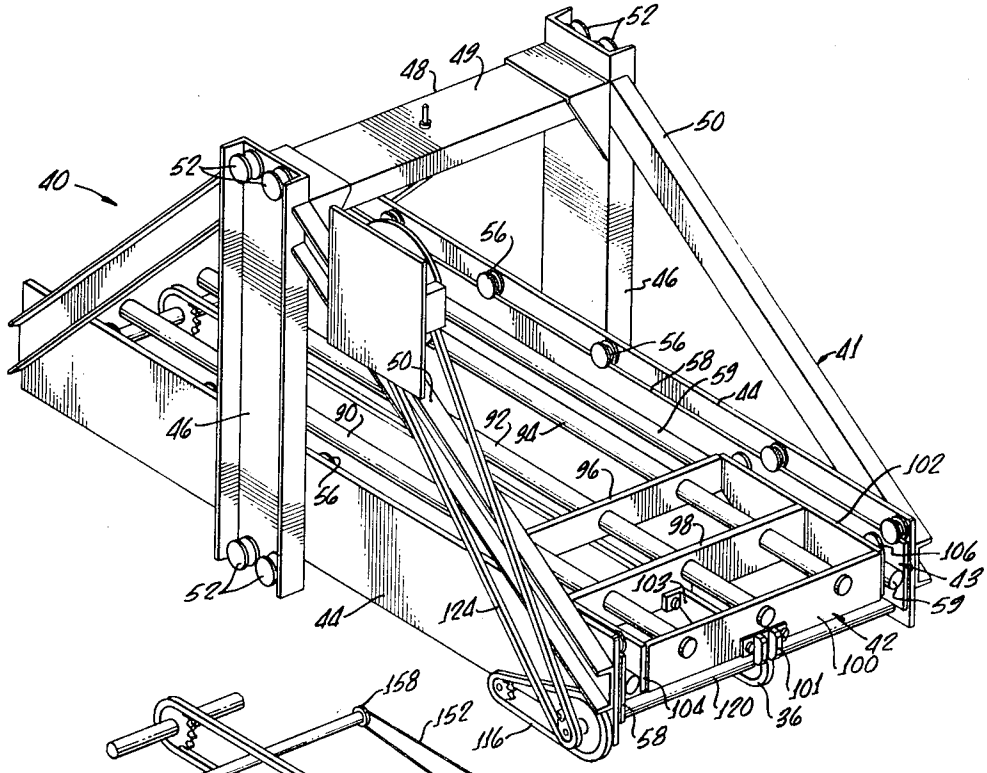
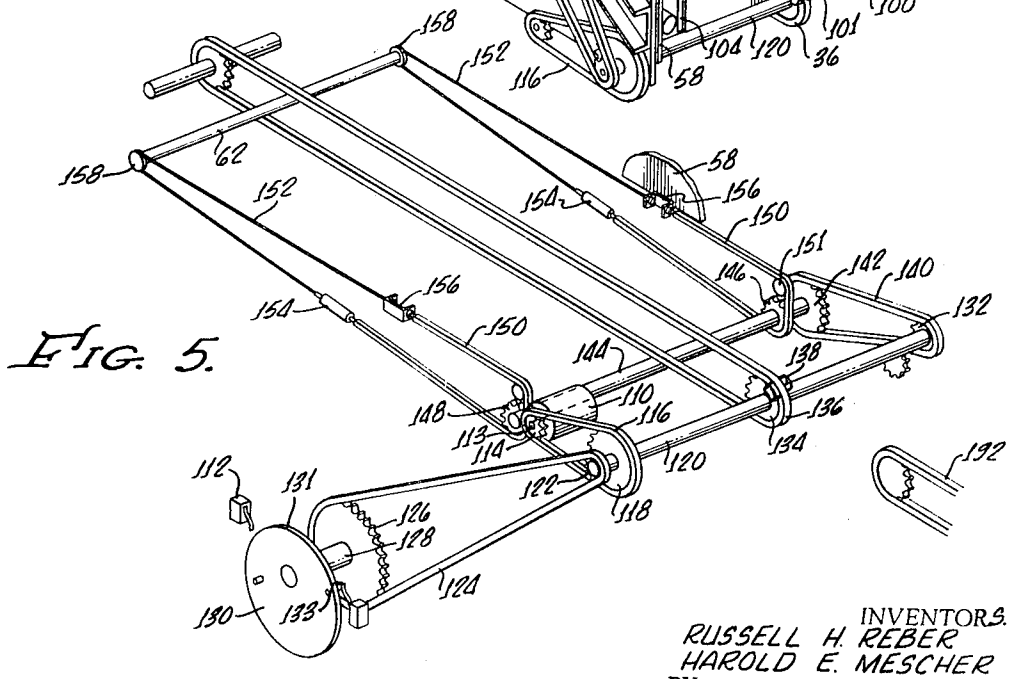
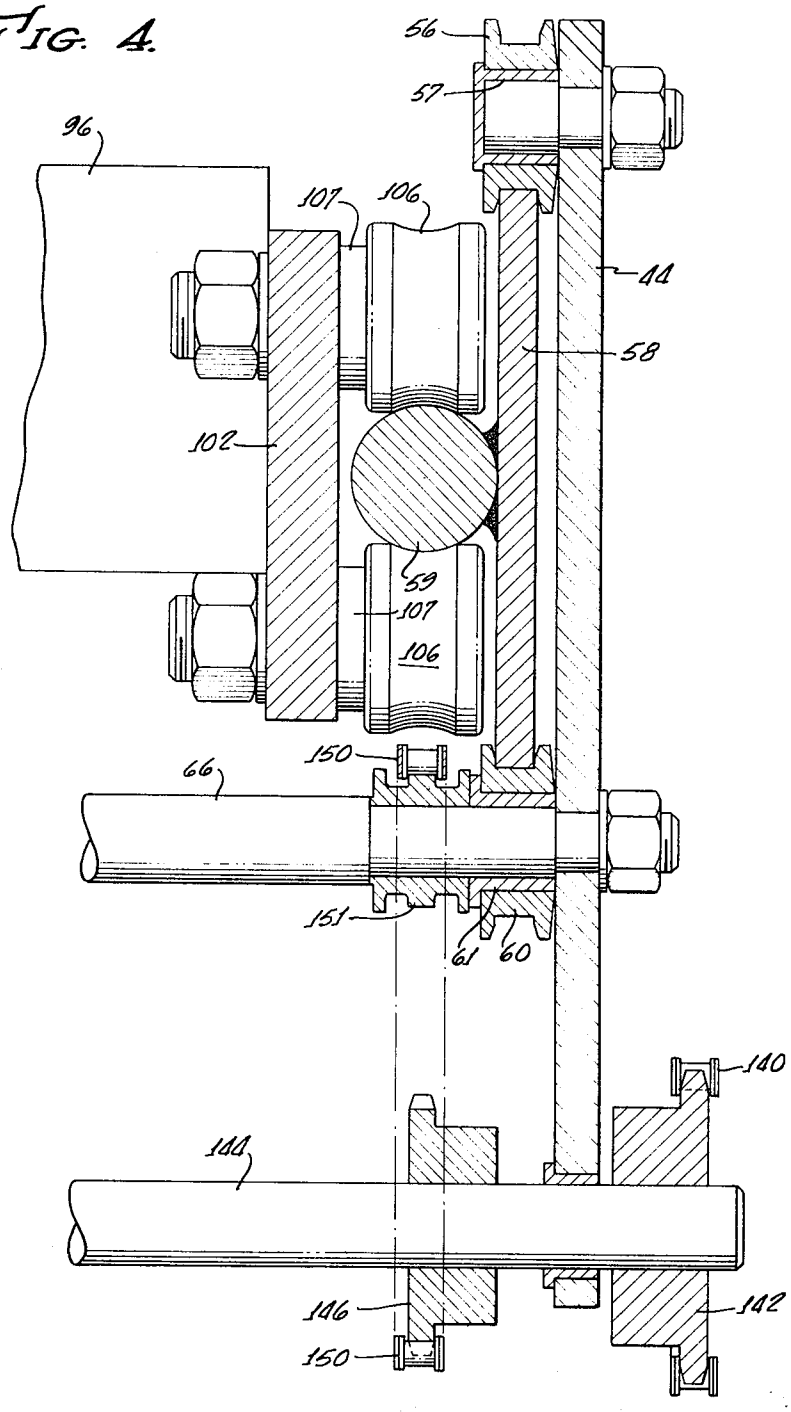


FIG. 5.



INVENTORS.
RUSSELL H. REBER
HAROLD E. MESCHER
BY
FOWLER, KNOBBE
& MARTENS
ATTORNEYS.

FIG. 4.



INVENTORS.
RUSSELL H. REBER
HAROLD E. MESCHER
BY
FOWLER, KNOBBE
& MARTENS
ATTORNEYS.

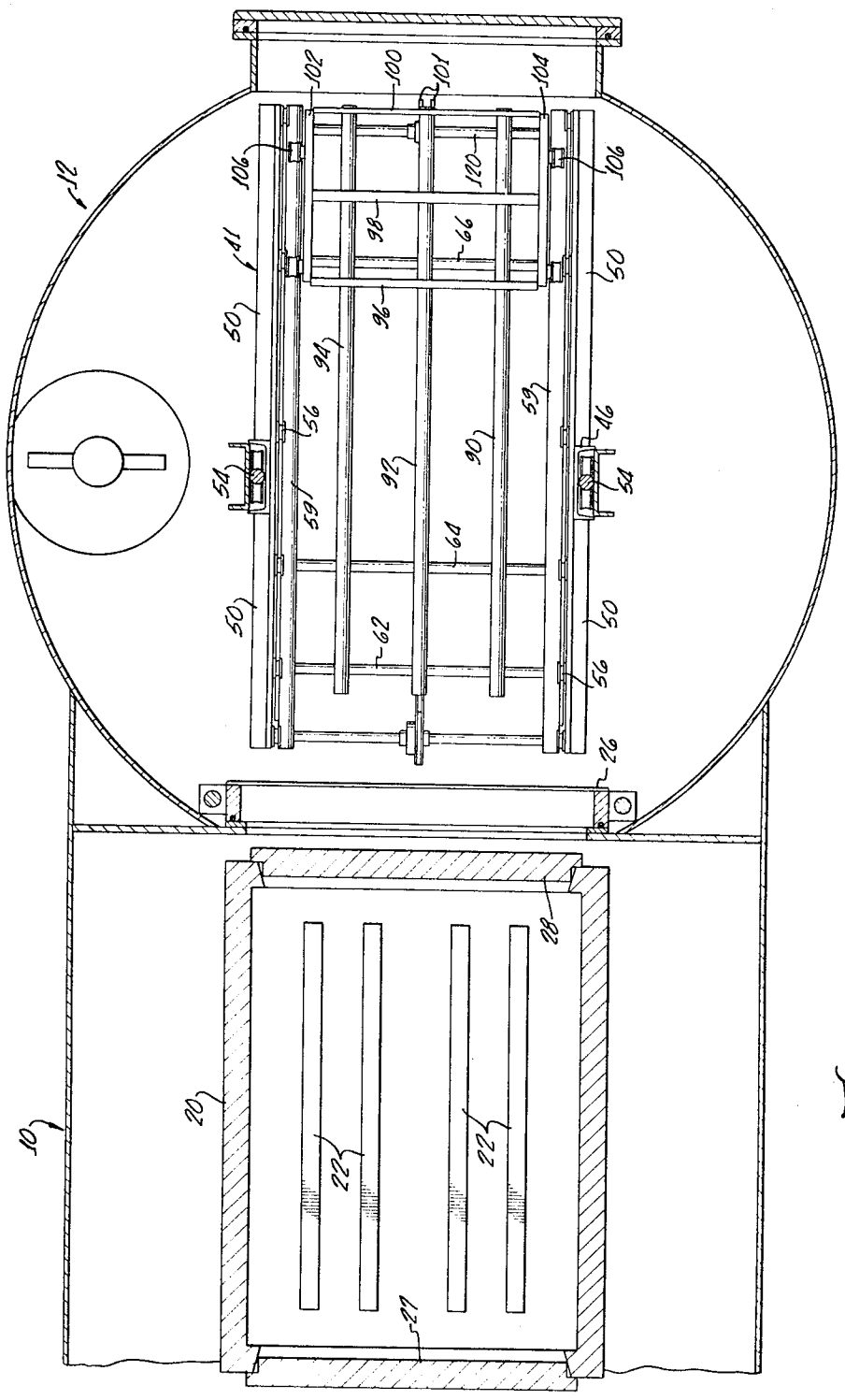


FIG. 6.

INVENTORS.
RUSSELL H. REBER
HAROLD E. MESCHER
BY
FOWLER, KNOBBE
& MARTENS
ATTORNEYS.

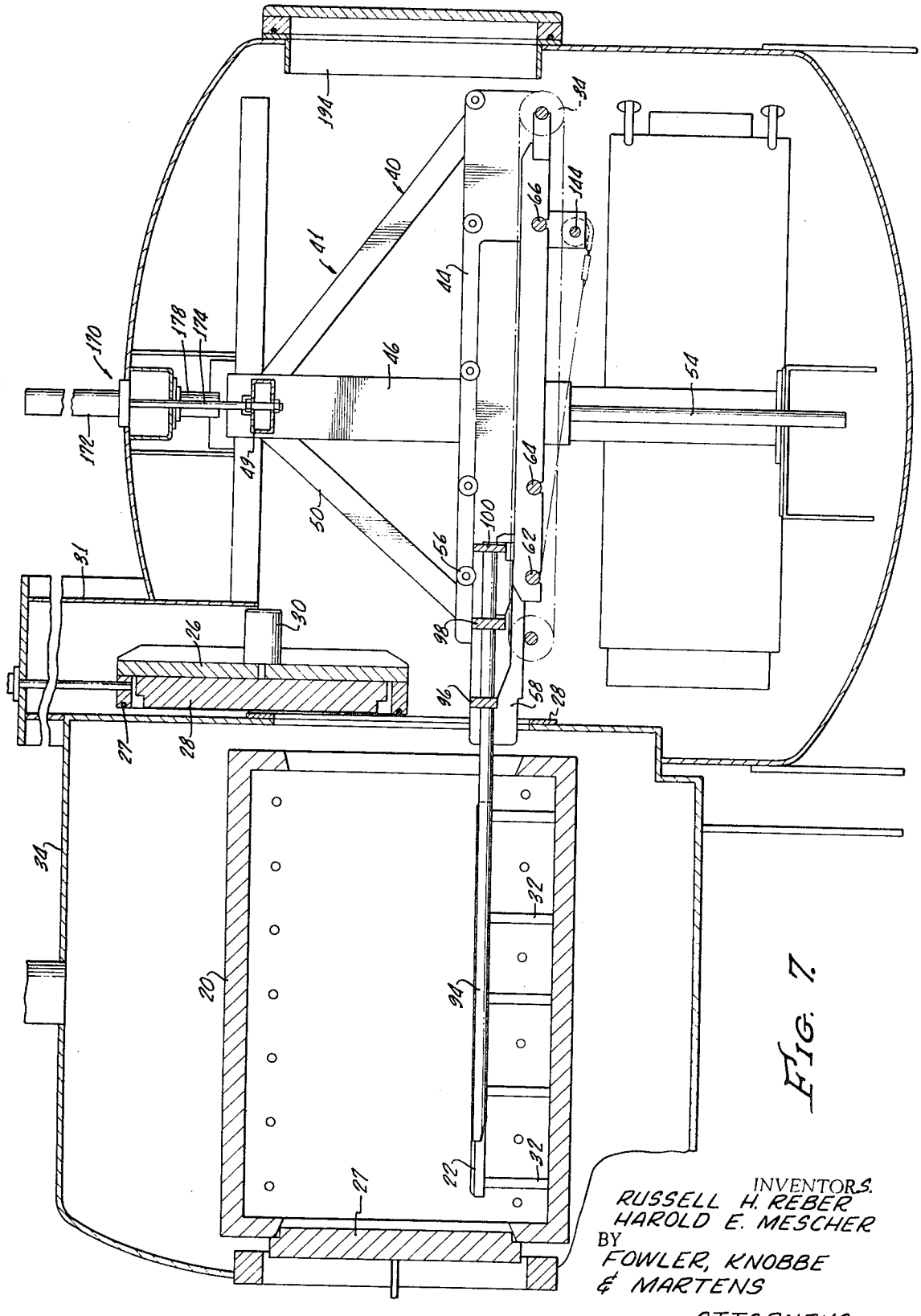


FIG. 7.

INVENTORS.
RUSSELL H. REBER
HAROLD E. MESCHER
BY
FOWLER, KNOBBE
& MARTENS
ATTORNEYS.

FIG. 9.

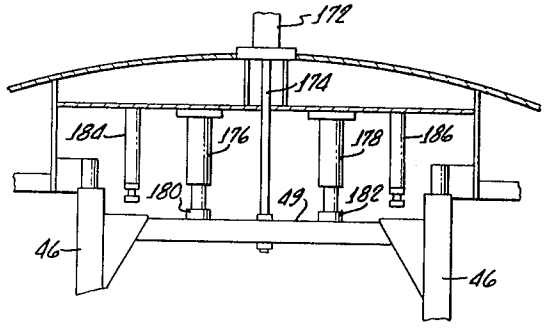
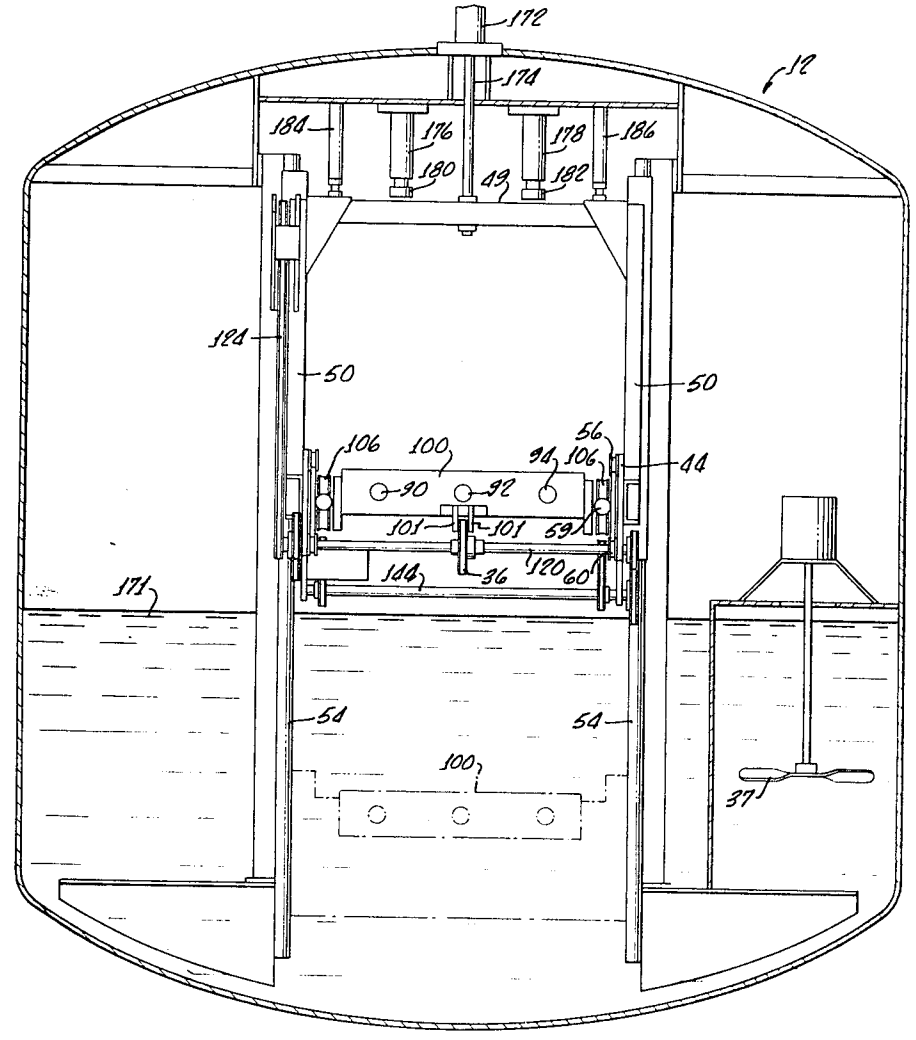
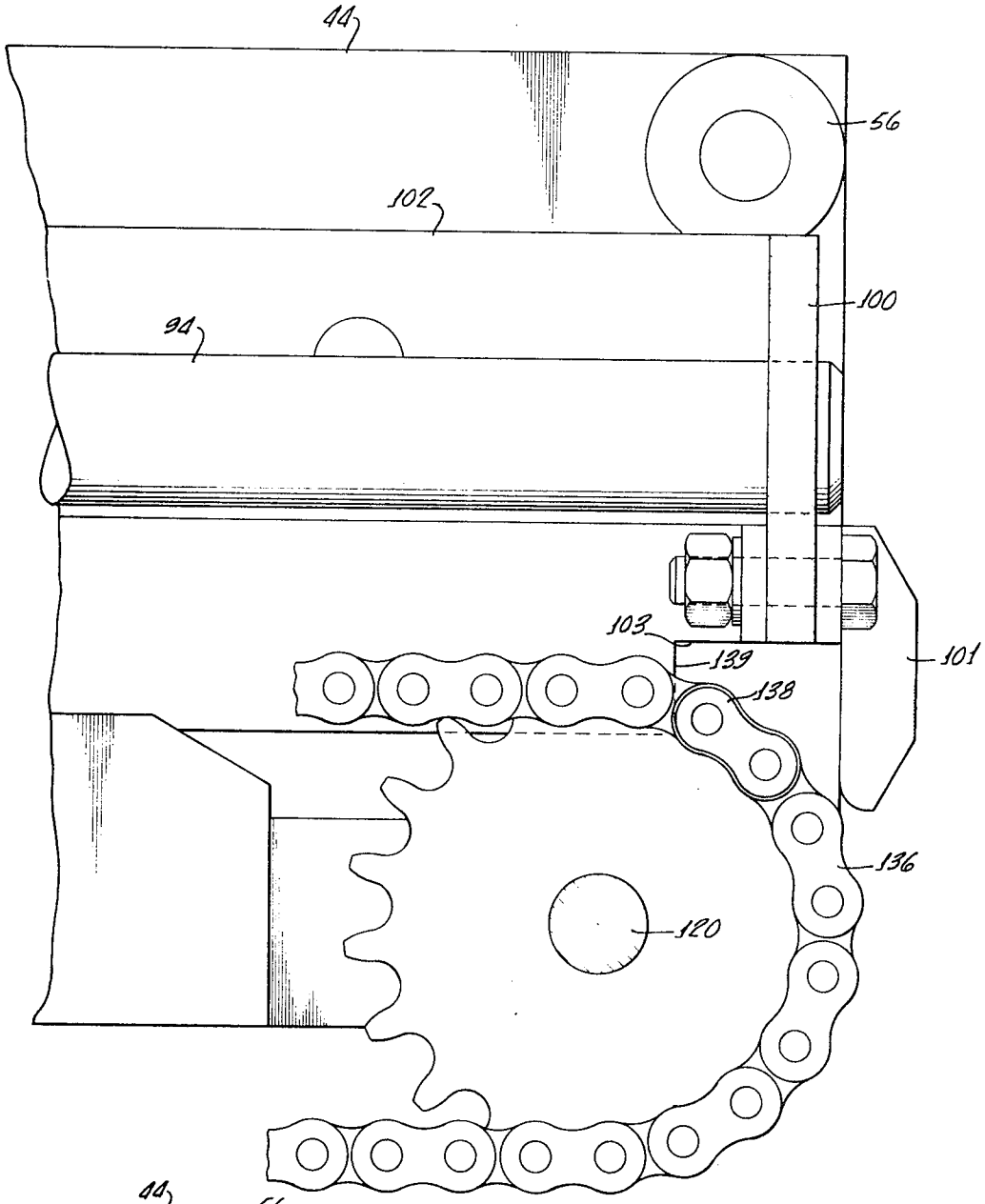


FIG. 8.



INVENTORS.
RUSSELL H. REBER
HAROLD E. MESCHER
BY
FOWLER, KNOBBE
& MARTENS
ATTORNEYS.

FIG. 10.



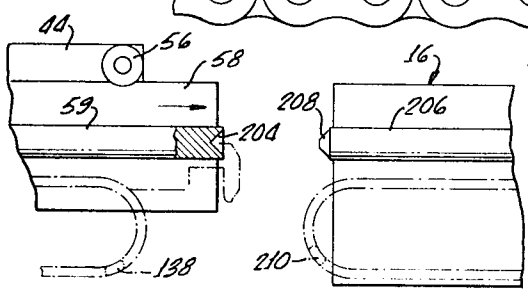
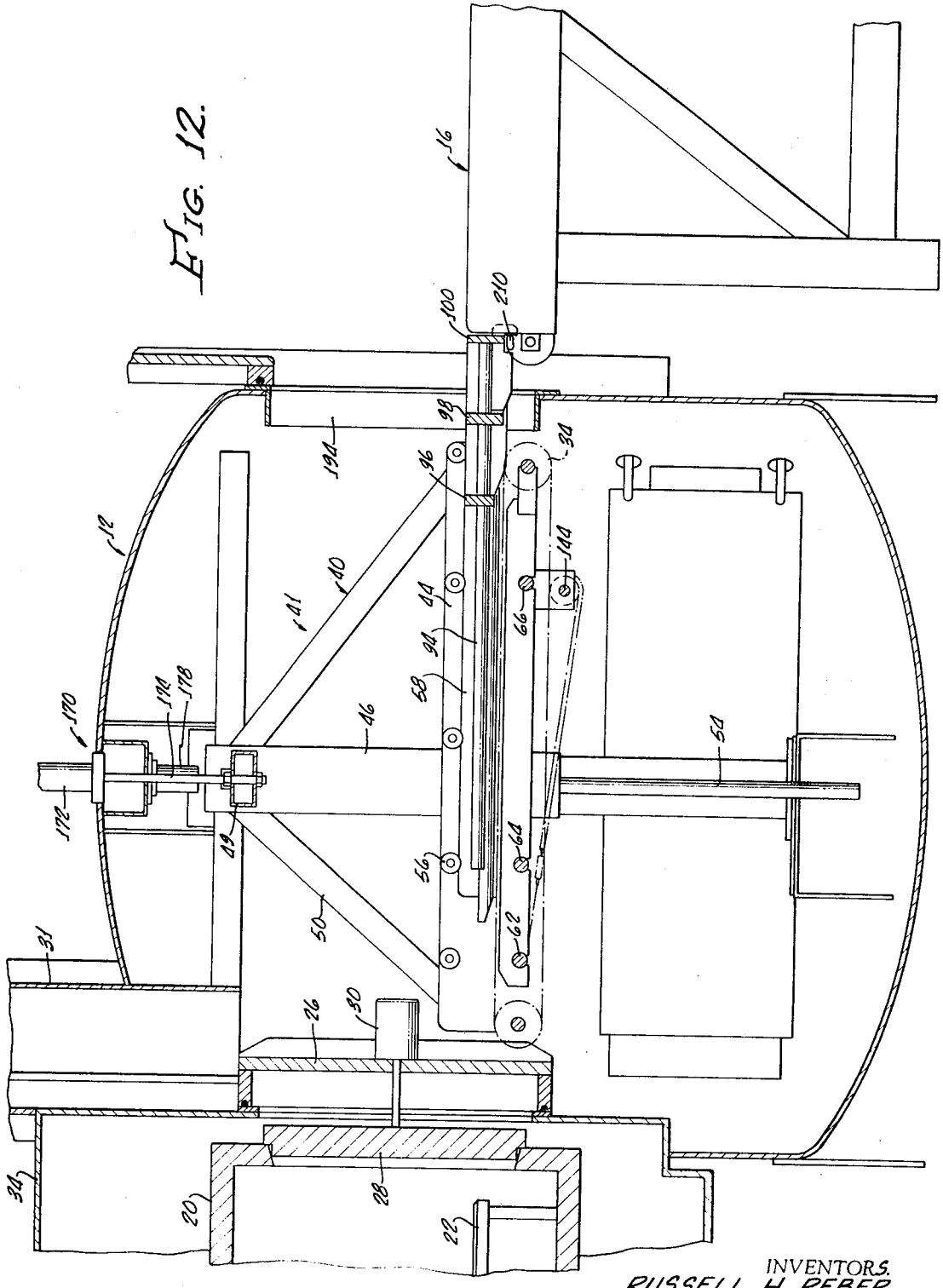


FIG. 11.

INVENTORS.
RUSSELL H. REBER
HAROLD E. MESCHER
BY
FOWLER, KNOBBE
& MARTENS
ATTORNEYS.

FIG. 12.



INVENTORS.
RUSSELL H. REBER
HAROLD E. MESCHER
BY
FOWLER, KNOBBE
& MARTENS
ATTORNEYS.

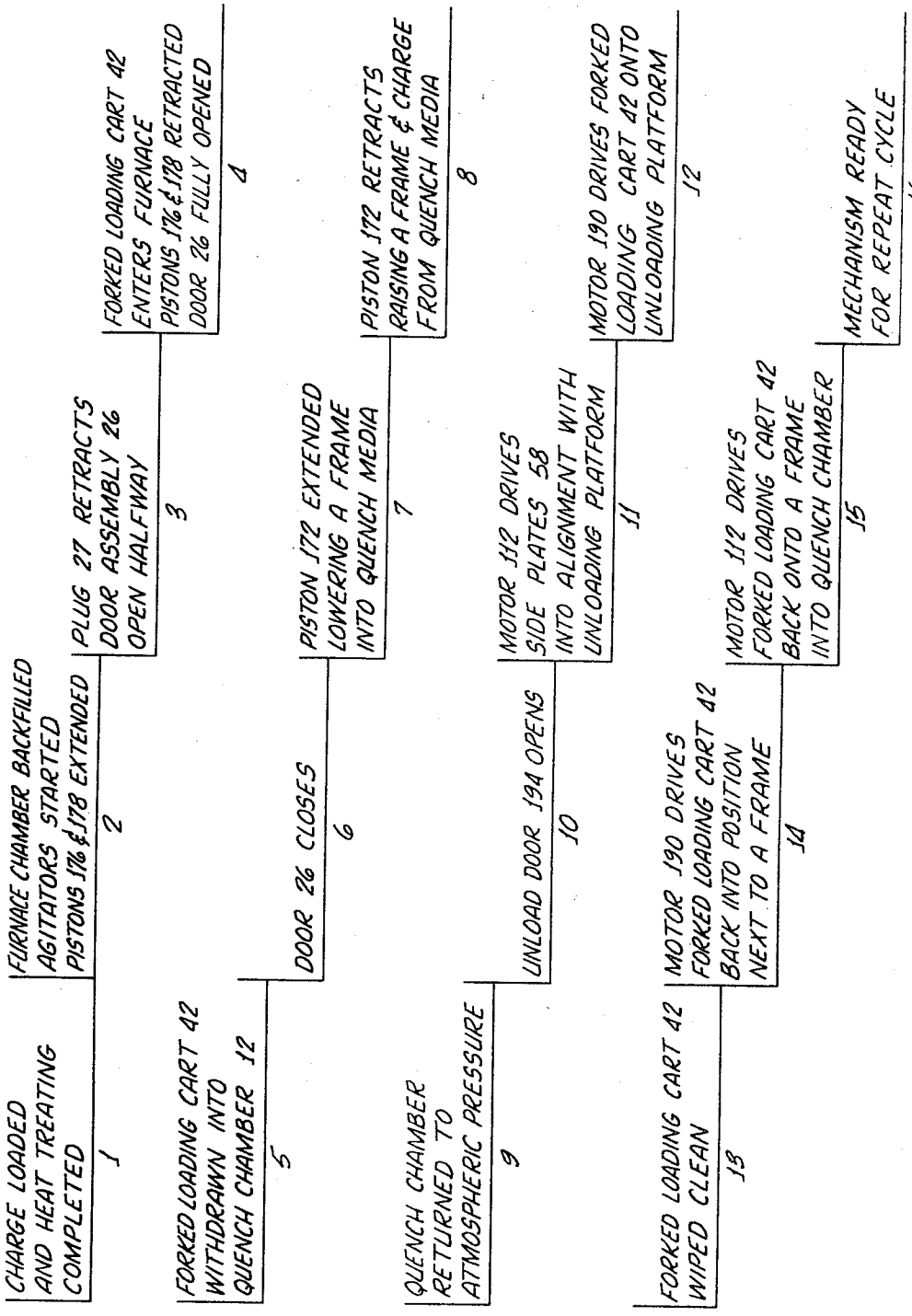


FIG. 13.

INVENTORS
RUSSELL H. REBER
HAROLD E. MESCHER
BY
FOWLER, KNOBBE
& MARTENS
ATTORNEYS.

INTEGRAL QUENCH FURNACE AND TRANSFER MECHANISM

This invention is directed to metallurgical heat treating equipment and more specifically to a transfer mechanism for use with integral quench vacuum or atmosphere furnaces.

Prior art heat treating furnaces which combine a quench chamber and furnace heating chamber are generally incapable of rapidly transferring the charge being heat treated from the furnace chamber into the quench media without dropping the charge into the quench tank. Such uncontrolled movement of the charge may cause distortion of the workpiece and usually cannot be tolerated. Additionally the prior equipment generally leaves a portion of the transfer mechanism in the furnace during the heat treating cycle and then immerses this same portion of the mechanism into the quench fluids. Usually no effective means is provided for cleaning the quench fluids from this portion of the transfer mechanism before it is reinserted into the furnace. This portion, whether it be support rollers, pallets or other equipment, due to the continuous thermal stress cycling and exposure to the high temperature of the furnace chamber may eventually contaminate the heat treating furnace or become corroded or cracked. Any time that extraneous materials, such as portions of the transfer mechanism, are left in the furnace chamber, the danger of outdiffusion and contamination of the atmosphere or the charge is present. Even small amounts of contamination cannot be tolerated for high quality heat treating work such as with vacuum or atmosphere furnaces.

Additionally, in the prior art furnaces it sometimes is necessary to slide the charge on the refractory hearths while at temperature. This may cause defacing of the hearths and the charge or introduce distorting stresses into the charge metals.

Another difficulty with integral quench vacuum or atmosphere furnaces presently available is that the furnace chamber and the quench chamber are generally separated by a hinge-mounted door which swings into the quench chamber. Such doors are provided since they must prevent radiation losses from within the furnace insulation lining and seal the heat treating chamber from the partial pressure of the quenching chamber. Because the entrance to the furnace housing is not flush with the entrance to the furnace chamber, the radiation seal protrudes beyond the vacuum seal. Consequently, it has been thought that the hinged doors were the only type usable. Such swing-in doors consume a large amount of space when opened causing unnecessary lengthening of the quench chamber.

In integral quench vacuum furnaces the transfer mechanism for transferring the heat treated charge into the quenching media must be capable of rapidly moving into the heat treating chamber once the heat treat is completed and the door has been opened, picking up the charge, and returning the charge into position over the quenching media. The return stroke of the transfer mechanism, however, must not be so rapid that the heated charge is jarred, slid or distorted by jerking movement or quick stops.

To be completely acceptable, the transfer mechanism must also provide an effective means for removing the charge from the quenching media and the quench chamber onto an unloading platform where any portion of the transfer mechanism which may enter the furnace chamber can be wiped clean of the quenching fluids after the quench has been completed. This requires some precise manner of alignment of the transfer mechanism with the unloading platform which enables the charge to be correctly positioned on the unloading platform after removal.

From the requirements for the transfer mechanism, it is clear that the mechanism must be capable of both horizontal and vertical translation. The vertical translation must be accurately controlled in a stepped fashion so that the transfer mechanism can be stepped vertically to enter the furnace chamber beneath the charge and be raised to pick up the charge. During unloading, however, the transfer mechanism must be aligned with the unloading platform at a level which most conveniently is even with the level of the transfer

mechanism after the charge has been picked up. This enables the mechanism to transfer directly from the heat treating chamber onto the unloading platform omitting the quench if desired. A third vertical position that the transfer mechanism must assume is a position which places the heat treated charge within the quenching media.

This invention is basically an integral quench furnace system and a transfer mechanism which is designed for use in conjunction with integral quench metallurgical heat treating furnaces, i.e., furnaces which are divided into a quenching chamber and a heating or holding at temperature chamber. The transfer mechanism comprises a loading cart which is horizontally translatable and a vertically translatable support frame which mounts and supports the loading cart. The support frame thus determines the vertical position from which the loading cart will translate horizontally. The heat treating equipment and transfer mechanism also includes a horizontally translatable alignment and unloading frame. Reversible means are provided for driving the loading cart and the alignment frame at different speeds in a loading and a reverse direction so that the loading cart can rapidly move from the quench chamber enabling a portion of it to enter the furnace chamber and retrieve the heat treated charge without having the alignment frame enter the furnace chamber.

The integral quench furnace system of this invention further includes control means for accelerating and then decelerating the loading cart as it retrieves the heat treated charge from the furnace chamber and returns it to position over the quenching media in the quench chamber. Actuatable pistons are provided for vertically positioning the support frame for the leading cart to enable the loading cart to be translated horizontally from various vertical levels to enter the furnace chamber, lift the heat treated charge, and immerse the charge in the quenching media.

After the quenching has been completed, the loading cart may be vertically returned to its initial or "home" position within the quench chamber and both the loading cart and the alignment and unloading frame may be translated horizontally away from the furnace toward an unloading station. During this translation the loading cart is disengaged from its drive mechanism until alignment with the unloading platform has been achieved by the alignment frame. Means are then provided on the unloading platform for engaging the loading cart and translating the loading cart horizontally out of the quench chamber onto an unloading platform where the charge can be removed and the portions of the cart which enter the high temperature chamber can easily be wiped clean.

One feature of the apparatus of this invention is that a rapid translation of a heat treated charge from the furnace into the quenching media can be obtained without distortion, sliding, or uncontrolled movement of the heat treated charge.

Another feature of the heat treating furnace system of this invention is that the heat treatment and quenching of the heat treated charge can be accomplished rapidly in a controlled manner within a closed system.

Another feature of the apparatus of this invention is that it is not necessary to leave any portion of the transfer mechanism in the heat treating chamber during heat treatment of the charge so that contaminants are not thereby introduced into the heat treating chamber.

Yet another feature of the heat treating furnace and transfer mechanism of this invention is that the apparatus can be readily automated for heat treating a series of charges in a programmed heat treating, quenching and removal cycle.

Still another feature of the heat treating furnace of this invention is that the furnace chamber is separated from the quench chamber by means of vertically sliding gates which do not require elongation of the quench chamber to maintain a vacuum within the furnace chamber and to permit automatic translation of the heat treated charge from the furnace chamber into the quench chamber.

Yet another feature of the heat treating equipment of this invention is that the charge transfer mechanism lifts the

charge off of the furnace hearth and accelerates and then decelerates in transferring the charge to the quench chamber.

Still another feature of the heat treating equipment of this invention is that atmosphere facing seals are eliminated by the use of hydraulic actuators to operate the furnace mechanism.

These and other features of the heat treating furnace and transfer mechanism of this invention will become more readily apparent from a consideration of the following detailed description and the appended claims when taken in conjunction with the attached drawings which may be briefly described as follows:

FIG. 1 is a partially sectioned view taken vertically through a plane substantially parallel to the longitudinal axis of an integral quench furnace system constructed in accordance with this invention;

FIG. 2 is an enlarged partially sectioned view through a plane substantially parallel to the longitudinal axis of the quenching chamber showing a transfer mechanism constructed in accordance with this invention;

FIG. 3 is a perspective view of an A-frame charge support member from the quench chamber, a forked loading cart, and an alignment frame of a transfer mechanism constructed in accordance with this invention;

FIG. 4 is an enlarged transverse sectional view taken substantially along lines 4—4 of FIG. 2;

FIG. 5 is a somewhat diagrammatic view of the drive system for a transfer mechanism as shown in FIG. 3;

FIG. 6 is a horizontal sectional view taken along the longitudinal axis of the furnace system showing the relationship between the hearth members and the transfer mechanism;

FIG. 7 is a partial sectional view taken through a vertical plane substantially parallel to the longitudinal axis of the system showing the furnace chamber and the quench chamber showing a transfer mechanism constructed in accordance with this invention in the charge pick up position;

FIG. 8 is a transverse sectional view through the quench chamber showing a transfer mechanism constructed in accordance with this invention with the support A-frame in the fully upward position;

FIG. 9 is an enlarged view of the vertical positioning mechanism for the transfer mechanism shown in FIG. 8 showing the pistons position when the A-frame support is in position for the loading cart to enter the furnace chamber;

FIG. 10 is an enlarged partially sectioned view of the drive chain and loading cart engaging mechanism used with the transfer mechanism constructed in accordance with this invention;

FIG. 11 is an enlarged segmental view of the alignment members for the transfer mechanism and loading platform constructed in accordance with this invention;

FIG. 12 is a vertical sectional view taken through a plane substantially parallel to the longitudinal axis of the integral quench furnace showing the transfer mechanism as the loading cart begins to be driven onto the unloading platform in accordance with the mechanism of this invention; and

FIG. 13 is a time sequencing diagram for operation of an integral quench furnace having a transfer mechanism constructed in accordance with this invention.

Referring now to FIG. 1, the basic construction of the integral quench vacuum or atmosphere furnace with the transfer mechanism of this invention can be seen in cross-section. While the furnace can readily be adapted for vacuum or selected atmosphere heat treatment, it will be discussed for use with vacuum alone. The integral quench furnace system comprises a furnace chamber **10** and an integrally attached, horizontally disposed quench chamber **12**. A horizontally and vertically translatable fork-type charge loading platform **14** is positioned adjacent the entrance door to the furnace chamber and an unloading platform **16** is spaced near the discharge door from the quench chamber **12** in fixed relationship with the quench chamber.

The furnace chamber includes a refractory insulating lining **20**, a set of longitudinally extending elevated hearth members **22** (see FIG. **6**), a vertically slideable furnace entrance door **24** and a vertically slideable furnace exit door **26**. The doors **24** and **26** are juxtaposed in sealing relationship with the entrance and exit to the furnace chamber **10** by means of resilient sealing members **25** and **27** mounted in appropriate grooves in the doors so as to slide into sealing relationship with the entrance and exit framework, respectively. The doors **24** and **26** include retractable refractory radiation shields or plugs **27** and **28** which are extendible by means of hydraulic piston actuators **29** and **30** into closing relationship with the refractory lining of the furnace as shown in FIG. 1. The actuators **29** and **30** in the piston extended position maintain plugs **27** and **28** in contact with the lining **20**. The shields and the furnace lining, for example, may be graphite or other refractory material.

A vacuum tight compartment **31** is integrally connected to the furnace chamber **10** and the quench chamber **12** for receiving the door **26** when it is opened.

The hearth, as best shown in FIG. **6**, actually in the preferred embodiment comprises four refractory hearth members **22**. These hearth members **22** are constructed of a suitable metal having a refractory material liner and mounted on vertically extending support bars **32** above the radiant heaters of the furnace (not shown). Any conventional radiant heating units may be used. For example these may be the tubular resistant heating elements disclosed in U.S. Pat. No. 3,368,022 to Mescher et al. or other similar resistant type heating elements.

The heat treating chamber **10** includes a vacuum tight, cold wall housing **34**. The housing **34** includes the entrance and exit frames **36** and **38**, respectively, which sealingly engage the resilient seals **25** and **27** for providing an airtight seal between the vertically slideable doors **24** and **26** and the furnace **10**. A vacuum pump **39** with appropriate exhaust conduit is provided for evacuating the furnace **10**. Conventional cooling fans (not shown) may be provided intermediate the housing **34** and insulated lining **20**. Additionally, an agitator **37** may be provided within the quench chamber **12** (see FIG. **8**).

The transfer mechanism **40** is mounted within the quench chamber **12** and basically comprises a vertically translatable quench chamber A-frame charge support member **41** which carries a horizontally translatable forked charge loading cart **42** and a horizontally translatable guide and alignment frame **43** (see FIG. 3).

The vertically translatable A-frame charge support member **41**, as best shown in FIGS. **2**, **3** and **4**, includes a pair of longitudinally extending rectangular side base plates **44** which are each connected at about their centers to a vertically extending angle iron support beam **46**. The vertical support beams **46** are connected to each other by a transversely extending support beam **48** which has a flat upper surface **49**. Four support struts **50** are connected to the upper end of the vertical support beams **46** and are inclined downwardly where they are attached to the opposite end portions of the side base plates **44** to form the typical A-frame configuration. The entire A-frame **41** may be made from heavy gage angle irons and plate stock joined by welding, bolting or any other conventional manner.

The vertical support beams **46** are provided in their outer channels with two pairs of longitudinally spaced, peripherally grooved rollers **52** near their upper and lower ends for riding on vertical guide bars **54** (see FIG. **6**) within the quench chamber **12**.

With continued reference to FIGS. 3 and 4, the horizontally extending side plates **44** of the A-frame charge support member **41** on their inwardly facing surfaces near their upper and lower edges are provided with a series of longitudinally spaced, rotatably mounted, alignment frame guide rollers or wheels **56** and **60** which are peripherally grooved. The upper guide rollers **56**, as shown in FIG. 4, are mounted for rotation on bushings **57** which are bolted or otherwise affixed to the side plates **44** of the A-frame. Some of the lower guide rollers **60** are mounted on bushings **61** which pass over cylindrical shafts **62**, **64** and **66** shown in FIG. **2**. The remainder of the

lower rollers 60 are bolted to the side plates 44 in a similar manner to rollers 56 so that they are rotatable. As shown in FIGS. 2, 3 and 4 there are five upper rollers 56 which are vertically spaced from five lower rollers 60. Both plates 44 are provided with these rollers. The exact manner in which the rollers are mounted may be varied as long as they can rotate.

The horizontally translatable guide and alignment frame 43 comprises a pair of substantially rectangular, transversely spaced, substantially parallel side guide plates 58 mounted between the upper and lower grooved wheels 56 and 60 on the A-frame side plates 44 for horizontal movement thereover. Each side guide plate 58 is a flat sheet of metal which is basically longitudinally coextensive with the side 44 of the A-frame of the transfer mechanism on which it is mounted. As best shown in FIG. 5, the side guide plates 58 are juxtaposed between upper and lower guide wheels 56 and 60 respectively so that the side guide plates 58 can be translated horizontally into and out of the A-frame. Each of the side guide plates 58 at about their centers mount a cylindrical, longitudinally extending guide rail 59. The rails 59 may be attached to the alignment frame side guide plates 58 by any conventional means such as by welding.

With continued reference to FIGS. 3, 4, 5 and 6, it will be seen that the forked loading cart 42 basically comprises three longitudinally extending, transversely spaced, cylindrical, bar-like prongs or lift members 90, 92 and 94. These prongs are connected to three transversely extending support plates 96, 98 and 100 (see FIGS. 3 and 6), which are connected to a pair of longitudinally extending side plates 102 and 104 to form the support structure for the prongs 90–94. The support plate 100 on its surface facing the unloading platform 16 fixedly mounts a pair of depending fingers 101. A pair of depending stop brackets 103 are mounted on support plates 98 and 100 to depend in transversely spaced relationship therefrom. The fingers 101 and brackets 103 may be bolted as shown in FIGS. 3 and 10.

Each of the side plates 102 and 104 carry two pairs of vertically spaced wheels or rollers 106 (see FIG. 4) which have concave peripheral grooves therein for riding on the guide rails 59 on the side guide plates 58. The rollers 106 are mounted for rotation on bushings 107 which are bolted to the side plates 58 as shown in FIG. 4. Alternatively these rollers may be journaled in the side plates or mounted in any other manner for facilitating movement of the forked loading cart 41 on the rails 59. In other words, the rollers 106 are mounted in a manner similar to the rollers 56 and 60 on the side guide plates 58. The rollers 106 not only permit easy horizontal movement of the forked loading cart 42, but also prevent pivotal movement of the loading cart when the cart is extended into the furnace chamber 10 and picks up a load on the prongs 90, 92 and 94 (see FIG. 7). The rollers 106 must, thus, be attached to the side plates 102 and 104 of the forked loading cart 42 by bolts which are sufficiently strong to resist the shear force momentum of a load on the prongs 90, 92 and 94.

With continued reference to FIG. 3 and with reference to FIG. 5, it will be seen that the drive mechanism for the transfer mechanism 40 comprises a series of continuous chains and sprockets driven by a hydraulic motor 110. The motor 110 is coupled to a linear operator motor speed control valve 112 which regulates the motor speed by controlling the flow volume of hydraulic fluid into the motor through conventional hydraulic circuitry. The drive shaft 113 of the motor 110 is rotatably connected to a sprocket 114. The sprocket 114 operatively engages a mechanism drive chain 116. The drive chain 116 passes over a larger sprocket 118 which is nonrotatably connected to a second shaft 120. One end of the shaft 120 is connected to another small sprocket 122 which drives a chain 124 connected to a cam shaft sprocket 126. The cam shaft 128 drives an eccentrically mounted circular cam disk 130 having a smooth peripheral surface 131 which rides on the linear operator of the control valve 112. A tab 133 is mounted on the cam 130 for operating a limit switch, as will be discussed.

The other end of the shaft 120 is nonrotatably connected to another small sprocket 132. The central portion of the shaft 120 nonrotatably mounts a forked charge loading cart drive sprocket 134 so that the sprocket 134 rotates with the shaft. The forked loading cart drive sprocket 134 drivingly engages a loading cart drive chain 136 for driving the forked loading cart 42 as will be discussed. A pair of transversely extending lugs 138 are mounted on the forked loading cart drive chain 136 as best shown in FIG. 5.

The small sprocket 132 on the other end of the shaft 120 is connected by means of a side guide plate secondary drive chain 140 to a larger side guide plate speed reducing sprocket 142 which in turn is nonrotatably connected to a side guide plate drive shaft 144. The shaft 144 carries a pair of side guide plate drive sprockets 146 and 148. The drive sprockets 146 and 148 each engage the same type of tension drive mechanism for the side guide plates 58 so that only one of these mechanisms will be discussed. Referring to sprocket 146 it will be seen that this sprocket drivingly engages a side guide plate primary linear drive chain 150. The linear drive chain 150 has one of its ends connected to a tension wire cable 152 by means of a turnbuckle 154 which enables the tension to be varied in the wire cable 152. The other of its ends is connected to the cable 152 by means of a U-shaped bracket 156 which is fixedly connected to both the chain 150 and the cable 152 by means such as bolting, welding, etc. The chain 150 also passes over an idler roller 151 on the stationary shaft 66 as shown in FIG. 4. The cable 152 also passes over a pulley idler roller 158 which may be rotatably mounted on the shaft 62 so that rollers 151 and 158 are in substantially horizontal alignment. The U-shaped brackets 156 are each fixed to one of the side plates 58 by welding or bolting so that when the drive chains 150 and consequently the brackets 156 move in response to operation of the motor 110 the drive chains 150 will horizontally drive the side guide plates 58 either toward the furnace 10 or toward the unloading platform 16. Due to the sprocket gear ratios of the various sprockets in the system, however, the side guide plates 58 of the alignment frame are driven much slower than the forked loading cart 42. Any desired drive speed ratio can be used. About a 3 to 1 ratio has been found to be satisfactory.

Referring again to FIG. 1 it will be seen that the transfer mechanism 40 in the quench chamber 12 is mounted on a hydraulic piston assembly 170 for vertical movement into and out of a liquid quench media 172 in the lower portion of the quench chamber 12. The piston assembly 170 is more clearly shown in FIGS. 8 and 9. It can be seen that the assembly includes a main piston 172 having a cylindrical piston rod 174 which extends downwardly into the quench chamber so that in its extended position, shown in phantom lines, the A-frame is in the quenching media 171 and in its retracted position the A-frame is at the same level as the unloading platform 16. A pair of auxiliary charge pick up pistons 176 and 178 are mounted on opposite sides of the main piston 172 and have pusher members 180 and 182 at the lower ends of the piston rods. The pusher members 180 and 182 have flat lower surfaces for contacting the upper surface 49 of the A-frame. The auxiliary charge pick up pistons 176 and 178 only extend a small distance sufficient to lower the A-frame into position for entrance into the furnace chamber beneath the charge so that the forklift members 90, 92 and 94 are intermediate the hearth members 22. The pistons 176 and 178 override the upward retracting action of the main piston 172 and in this fashion control the vertical spacing of the transfer mechanism below the charge as it enters the furnace chamber.

A pair of adjustable stop members 184 and 186 are mounted at opposite ends of the upper surface 49 of the A-frame so as to prevent the A-frame from canting when the main piston 172 is in its retracted position and the A-frame 41 is out of the quench media.

With reference to FIGS. 3, 4, 5, 6 and 7, the operation of the transfer mechanism will now be discussed. With pistons 176 and 178 fully extended, the motor 110 is activated to

drive the prongs **90, 92** and **94** of the forked loading cart **42** into the furnace chamber **10** by driving the sprocket **114** counterclockwise causing a counterclockwise movement of the chain **116**. This drives the sprocket **118** and the drive shaft **120** in a counterclockwise direction. Counterclockwise rotation of the shaft **120** similarly rotates the forked loading cart drive sprocket **134** counterclockwise thereby causing the loading cart drive chain **136** to move counterclockwise so that the lugs **138** which extend transversely from each side of the drive chain **136** move toward the left hand end of the system as shown in FIG. **5**. These lugs engage the downwardly and transversely extending fingers **101** and brackets **103** mounted on the transverse support plate **100** of the forked charge loading cart **42**. The lugs **138** engage a shoulder **139** on the brackets **103** and drive the empty cart in a "forward" direction toward the position in the furnace chamber shown in FIG. **7**. As shown in FIGS. **3** and **10** the bracket **103** is bolted to both transverse supports **98** and **100**.

At the same time, the sprocket **132** rotates counterclockwise with the shaft **120** driving the chain **140** and the sprocket **142** counterclockwise but at a much slower rate due to the gear ratio between the sprockets **132** and **142**. The rotation of the sprocket **142** additionally causes a counterclockwise rotation of the shaft **144** and the side guide plate drive sprockets **146** and **148**. Rotation of these sprockets drives the chain **150** and, concomitantly, through the brackets **156** synchronously drives the side guide plates **58** to the left as shown in FIGS. **6** and **7** toward the furnace chamber **10** but at a much slower speed than that with which the forked loading cart **42** is driven. The forked loading cart **42** and the side guide plates **58** of the alignment frame **43** are shown in their fully extended charge pick up position in FIG. **7**. Only the prongs **90, 92** and **94** of the loading cart **42** enter the furnace chamber **10**, thereby reducing the possibility of contamination.

At the same time the sprocket **122** on the shaft **120** through chain **124** drives the sprocket **126** and the cam **130** so that when the loading cart has reached a predetermined position in the insulated furnace chamber the cam **130** through tab **133** may trip a limit switch causing the motor **110** to stop (the position of the forked loading cart may also be controlled by manual control of motor **110**). The forks of the loading cart **42** at this time are positioned beneath the charge in the furnace chamber **10**.

The pistons **176** and **178** are at this time returned to their retracted position as shown in FIG. **9** causing the forks **90, 92** and **94** to lift the charge off the hearth. The motor **110** is then reversed, the respective drive chains, sprockets and shafts are all driven in the opposite direction causing the lugs **138** to engage the fingers **103** and return the forked loading cart **42** from the furnace chamber into the quench chamber **12**. The side guide plates **58** are also returned from their position adjacent the furnace chamber (see FIG. **7**) into the quench chamber but again at a much slower speed. During return of the forked loading cart **41** and the alignment frame **43** from the pick up position to the quench chamber, however, the peripheral surface **131** of the eccentrically mounted cam **130** first rides out of contact with the motor control **112**, causing acceleration of the motor, then after a short period out of contact, depresses the motor speed control valve **112** as the cam rotates clockwise (FIG. **5**) so that the motor decelerates as the forked loading cart **42** and the alignment frame **43** return into the quench chamber **12**. This controlled acceleration, fixed speed operation and controlled deceleration of the transfer mechanism prevents distortion of the charge and damage to the charge due to jerking movement of the transfer mechanism which might otherwise occur.

While the horizontally translatable loading cart **42** and alignment frame **43** are operated by the motor **110** a synchronized vertical movement of the A-frame itself must be accomplished to enable the transfer mechanism to enter the furnace, lift the charge off the furnace hearth and return the charge to the quench chamber and then lower the charge into the quenching media. This is accomplished as discussed with reference to FIGS. **8** and **9** by means of the main piston **172** and the auxiliary charge pick up pistons **176** and **178**. Immediately prior to the time the forked loading cart **42** is to enter the furnace chamber **10** the pistons **176** and **178** are extended, as shown in FIG. **9**, to lower the A-frame **41** by about 2 inches so that the straight cylindrical forklift members **90–94** can just pass under the load sitting on the hearth pallet members **22**.

As shown in FIG. **6**, there are four hearth members **22** and the three forklift members **90, 92** and **94** are spaced to fit intermediate the hearth pallets. When these forklift members are lowered by action of the pistons **176** and **178** they can enter the furnace chamber intermediate the hearth pallets **22** and be raised to pick up the charge. The forked loading cart can then be returned without touching the hearth on sliding the charge across the hearth pallets **22**.

Once the forked loading cart **42** is returned to its "home" position within the A-frame **43**, the main piston **172** is fully extended so that the A-frame **43**, the forked loading cart **42**, the alignment and unloading frame **41** and the charge are all quenched in the quench bath **71**. The only portions of the transfer mechanism actually in the furnace, however, were the cylindrical forklift members **90, 92** and **94**.

It has been found that this system can be automatically preprogrammed with conventional circuitry and limit switches to perform the necessary functions or the various functions can be manually controlled by the use of conventional hydraulic and electrical switching. It has been found that the total time for movement of the forklift loading cart **42** into the furnace chamber, picking up the charge, returning it to the quench chamber, closing the furnace exit door **26** and vertically descending into the quench media can be maintained at about 5 seconds with little difficulty with the apparatus of this invention.

After the quench has been completed the piston **170** is again activated to return the rod **174** to its retracted position. In this position the forked loading cart **42** is substantially coplanar with the unloading platform **16** shown in FIG. **1**. The unloading platform **16** is provided with a separately operable motor **190** which drives an unloading drive chain **192**, as shown in FIG. **1**, by means of a sprocket and drive shaft arrangement similar to that of the loading cart **42**. To accomplish unloading the exit door **194** from the quenching chamber is opened and the motor **112** is reversed so that the sprocket **118** is driven clockwise (FIG. **5**). This causes the lugs **138** to pass beneath the depending fingers **101** on the transverse support plate **100** (see FIGS. **10** and **12**) thereby disengaging the forked loading cart **42** from its drive chain **136**. The side guide plates **58** of the alignment frame **43**, however, are still engaged (see FIG. **5**) through the drive shaft **120**, the sprocket **132**, the drive chain **140**, the sprocket **142** and the drive shaft **144** so that the side guide plate drive chains **150** and the tension cables **152** advance the side plates **58** to the right as shown in FIG. **12** toward the unloading platform **16**.

Referring to FIG. **11**, the rails **59** on the side plates **58** of the alignment and unloading frame **43** are each provided with axially extending conical indentations **204**. Similarly a pair of cylindrical axially extending alignment rails **206** are provided on the unloading platform **16** (see also FIG. **6**). Each of the unloading platform rails **206** is provided with an axially extending conical end portion **208** which is adapted to mate with the conical indentation **204** on the side guide plate rails **59** of the alignment frame **43**. As the side guide plates **58** are advanced toward the unloading platform **16** positive alignment is obtained by alignment of the end portions **204** and **208**. The side guide plates **58** by means of rollers **106** and rails **59** (see FIG. **4**) guide the forked loading cart **42** toward the unloading platform **16**. The depending fingers **101** on the forked loading platform are transferred to a position where they depend on each side of the platform unloading drive chain **192**. At the same time the motor **190** on the unloading platform **16** is energized to cause a clockwise rotation of the drive chain **192**. Drive chain **192** is also provided with a pair of transversely ex-

tending lugs **210**, best shown in FIGS. **6**, **11** and **12**, which engage with the depending fingers **101** on the forked loading cart transverse support plate **100**. The drive chain **192** thus continues movement of the loading cart **42** off the A-frame structure **41** and onto the unloading platform **16**. The rollers **106** move out of engagement with the rails **59** and into operative engagement with the unloading platform rails **186** as the loading cart moves fully onto the platform **16**. The charge is now in position to be removed from the forked loading cart **42** and the forklift members **90**, **92** and **94** can be wiped clean before being returned into the quench chamber **12** and into the furnace chamber **10** to retrieve the next heat treated charge.

There are several advantages to using a forked loading cart such as used herein. For example each of the prongs or cylindrical lift members on the fork can easily be wiped clean of the quench media so that these members do not carry a corrosive or contaminant surface coating which is transferred into the furnace chamber during charge pick up. The door **26** is closed immediately after the charge is removed and the refractory plug **27** is extended into radiation tight relationship with the furnace chamber. Thus the furnace chamber can be backfilled immediately with the desired gaseous atmosphere and cooled so that the charge receiving door can be opened to receive the next charge. Closing of the door **26** also prevents splashing of the quenching media into the furnace chamber.

After the forked loading cart has been wiped clean the motor **190** on the unloading platform **16** is reversed causing the drive chain **192** to drive the loading cart **42** back onto the side guide plates **58**. Alignment of the forked loading cart with the drive chain of the unloading platform is assured by means of the positive alignment of the rails **59** on the side plates **58** and the rails **206** on the unloading platform **16**.

The overall operation of the integral quench furnace of this invention and the transfer mechanism can perhaps better be described by discussing a time sequence of functions being performed during transfer and unloading, as shown generally in FIG. **13**. Again these functions may be manually or automatically controlled. For example, conventional circuitry may be actuated by a series of limit switches which are located physically within the furnace and which are closed by the position of the various members of the transfer mechanism and the furnace or manual controls may be provided for mechanically accomplishing each of the various functions by operating the appropriate drive motor or actuator for the element being driven. The first step in heat treatment with the furnace of this invention is to load the charge on the forked front end loader **14** shown in FIG. **1**. The charge is placed on the refractory hearth members **22** by opening the front door **24** and actuating the motor for the loader **14** to raise the loader and advance the loader on its tracks into the furnace chamber. The loader is then lowered to place the charge on the refractory hearth members **22** and the loader **14** is retracted. The door **24** is closed. This completes the charge loading step **1**. If an atmosphere is to be used the appropriate atmosphere can be directed into the furnace through a conventional inlet (not shown). After the proper condition either atmosphere or vacuum has been attained in the furnace chamber and the treating temperature has been reached, the charge is maintained in the furnace chamber **10** for the necessary length of time for the desired heat treatment.

As shown in FIG. **13** step **2**, after the heat treatment has been completed since the quench chamber is evacuated to the partial pressure of the quench media, the furnace is backfilled to compensate for the pressure in the quench chamber **12** and the quench agitator starts agitation of the quenching media. The A-frame assembly **41** is then lowered to the charge retrieval position by extension of the pistons **176** and **178** to their fully extended positions in the upper portion of the quench chamber. Activation of pistons **176** and **178** lowers the A-frame by approximately 2 inches so that the lift members **90**, **92** and **94** can pass beneath the charge in the furnace chamber intermediate the hearth pallets **22**.

In step **3**, which may be manually controlled or activated by a stepping switch, the insulated door **27** intermediate the quench chamber and the furnace chamber is retracted into the intermediate solid door **26** by means of the hydraulic actuator **30** which may be manually controlled through an appropriate hydraulic circuit or automatically activated. The intermediate door **26** with the insulated door **27** retracted therein is then lifted to approximately a half open position as best shown in FIG. **7**. When the door is in the half open position, step **4** is performed. The forked loading cart **42** is activated, as explained, to enter the furnace chamber, as shown in FIG. **7**, the pistons **176** and **178** are fully retracted and the door **26** is fully opened. In step **5**, the forked loading cart is withdrawn into the quench chamber **12**, as shown in FIG. **2**, with the heat treated charge thereon. The loading cart undergoes controlled acceleration and then deceleration in this step due to cam **130**, as explained.

In step **6** the door **26** is closed. Next, in step **7**, the piston **172** is activated to its fully extended position so that the transfer mechanism and charge are immersed in the quenching media **71** as shown by the dashed lines of FIGS. **1**, **2** and **8**. The charge is maintained in the quench media for the desired time. During the quench, the furnace may be backfilled, cooled and reloaded with the next charge.

In the eighth step, the piston **172** is returned to its fully retracted position raising the A-frame **41** and the charge from the quenching media. In step **9**, the quench chamber is returned to atmospheric pressure and in step **10** the unloading door **194** is opened to atmosphere. Step **11** is the activation of the motor **110** in the unload direction to align the forked loading cart **42** for egress onto the unloading platform **16**. In step **12** the unloading platform motor **190** is activated to drive the cart **42** onto the unloading platform. The forklift members **90**, **92** and **94** of the loading cart **42** can then be wiped clean before step **14** in which the motor **190** returns the forked loading cart **42** back into position adjacent the A-frame **41**. In step **15**, the lugs **138** of the drive chain **136** are driven counterclockwise to engage the depending shoulders **139** on brackets **103** and return the cart **42** onto the A-frame **41**. The mechanism and furnace are now ready for the next heat treatment to be completed so that the quench cycle can begin.

As can be seen from FIG. **13** the operation of the furnace and transfer mechanism can be easily automated through conventional circuitry using a main stepping switch controlled by function or time operated limit switches. The functionally operated limit switches in conventional manner may be placed conveniently within the apparatus for tripping by its moving parts.

Among the many advantages of the integral quench furnace mechanisms of this invention is that mechanical rotary or linear seals which face the atmosphere are eliminated by the use of hydraulic drive motors and actuators throughout the system. This prevents the possibility of air leaking into the system through worn seals. The hydraulic fluids generally are compatible with the quenching media so that worn seals do not ruin the charge being treated but yet can be easily detected.

What is claimed is:

1. A metallurgical furnace having a quench chamber and an elevated temperature heat treating chamber comprising:

means for dividing said quench chamber from said heat treating chamber; and

transfer means in said quench chamber for entering said heat treating chamber at the completion of the heat treating cycle, lifting the charge vertically and transferring the charge being heat treated into a quenching media in said quench chamber without sliding and rolling said charge, said transfer means being maintained outside said heat treating chamber until time for quenching said charge, said transfer means comprises vertically translatable means mounted for movement within said quench chamber and horizontally translatable means mounted for horizontal translation from within said vertically translatable means.

2. A furnace as defined in claim 1 wherein said vertically translatable means is an A-frame support member.

3. A furnace as defined in claim 1 wherein said horizontally translatable means includes a forked loading cart mounted so that only the fork prongs enter said heat treating chamber.

4. A furnace as defined in claim 1 wherein said horizontally translatable means comprises an alignment frame mounted for horizontal translation from within said vertically translatable member and a loading cart mounted for horizontal translation from within said alignment frame, said furnace further including drive means operatively connected to said vertically and horizontally translatable means.

5. A furnace as defined in claim 4 wherein said alignment frame comprises:

a pair of spaced guide plates;

a pair of longitudinally extending guide rails attached to the opposing inner surfaces of each of said guide plates; and

said loading cart comprises:

a plurality of axially extending cylindrical members;

a plurality of transverse support members spacedly mounting said cylindrical members, a pair of loading cart side plates, and a plurality of spaced roller pairs mounted on the outer surfaces of said loading cart side plates for movably mounting said loading cart on said guide rails.

6. A furnace as defined in claim 1 further including hydraulically actuated drive means for said vertically translatable member and for said horizontally translatable member, said hydraulic drive means having no seals which interface with the atmosphere.

7. A furnace as defined in claim 6 wherein said drive means comprise:

a hydraulic motor;

a chain and sprocket drive system connected to said horizontally translatable member for driving said member in a forward and reverse direction; and

a hydraulic piston attached to said vertically translatable member for vertically driving said vertically translatable member.

8. A furnace as defined in claim 7 wherein said drive means further comprise a pair of overriding auxiliary pistons mounted in said quench chamber for lowering said vertical translatable member by a sufficient distance to permit at least a portion of said horizontally translatable member to enter said heat treating chamber beneath the charge being heat treated, said auxiliary pistons being selectively actuatable to vertically translate said vertically translatable member so that said horizontally translatable member picks up said charge.

9. A furnace as defined in claim 7 further including means for accelerating and then decelerating said horizontally translatable member in a predetermined manner when it is driven from said heat treating chamber to said quench chamber.

10. A furnace as defined in claim 9 wherein said accelerating and decelerating means comprises a hydraulic control valve for varying the speed of said hydraulic motor.

11. A furnace as defined in claim 10 wherein said accelerating and decelerating means further comprises a cam member operatively connected to said chain and sprocket drive system for controlling acceleration and deceleration of said horizontally translatable member.

12. In a metallurgical furnace having a heat treating chamber and a horizontally adjacent quench chamber, a transfer mechanism comprising:

a vertically displaceable support member mounted within said quench chamber;

a drive assembly connected to said support member and to a wall of said quench chamber for moving said support member into a charge pick up position, a quench position and an unload position;

an alignment frame mounted within said support member for horizontal movement from within said support member;

a loading cart mounted within said alignment frame for horizontal movement between a charge pick up position, a quench position and a charge unload position, said support member and said loading cart positions determining the vertical and horizontal positions of said loading cart during charge pick up, quench and unload;

means for driving said loading cart to said positions; and

means for driving said alignment frame.

13. A transfer mechanism as defined in claim 12 wherein said alignment frame comprises:

a pair of spaced guide plates, a pair of longitudinally extending guide rails attached to the opposing surfaces of said guide plates, and means for attaching said alignment frame drive means to said alignment frame; and said loading cart comprises longitudinally extending side members, means on said side members for riding on said guide rails, longitudinally extending charge pick up members for extending into said heat treating chamber and lifting said charge, and

means for connecting said loading cart drive means to said loading cart.

14. A transfer mechanism as defined in claim 13 wherein said loading cart has drive engaging members depending therefrom and said loading cart drive means comprises a motor driven chain having transversely extending members thereon for engaging said depending members to drive said loading cart into said charge pick up position and return said loading cart to said quench position.

15. A transfer mechanism as defined in claim 14 further including an unloading platform positioned adjacent said quench chamber and means on said unloading platform for moving said loading cart into the unload position.

16. A transfer mechanism as defined in claim 15 wherein said means on said unloading platform comprises:

a motor, an unload drive chain operatively connected to said motor and members on said chain for engaging said depending members to drive said loading cart into said unload position after said alignment frame has been driven toward said unload position.

17. A transfer mechanism as defined in claim 16 wherein said unloading platform further comprises means for aligning with said alignment frame when said alignment frame is driven toward said unloading platform.

18. A transfer mechanism as defined in claim 12 wherein said loading cart and alignment frame driving means comprise a motor driven chain and sprocket arrangement wherein said loading cart is driven at a faster rate toward said charge pick up position and quench position.

19. A transfer mechanism as defined in claim 18 further including means for disengaging said loading cart from its drive means after said loading cart is driven toward said unloading platform and means on said unloading platform for driving said loading cart thereon after said alignment frame has positioned said loading cart.

20. A metallurgical furnace having a quench chamber and a heat treating chamber and a transfer mechanism comprising:

a horizontally translatable loading cart;

a horizontally translatable alignment frame for mounting said loading cart;

means for vertically lifting said loading cart when said cart is placed beneath a load; and

means for driving said loading cart and said alignment frame at different speeds.

21. A transfer mechanism as defined in claim 20 wherein said driving means comprises:

a motor;

a shaft operatively connected to said motor for rotation therein;

a first sprocket connected to said shaft for rotation therewith;

a drive chain mounted over said first sprocket for engaging said sprocket and said loading cart for driving said loading cart;

a pair of second sprockets attached to said shaft; and

a pair of second drive chains connected to said second sprockets and to said alignment frame for translating said alignment frame.

22. A transfer mechanism as defined in claim 21 wherein said first sprocket is larger than said second sprockets so that said loading cart is translated at a faster rate than said guide rails.

* * * * *