

July 8, 1958

G. M. TAUBER

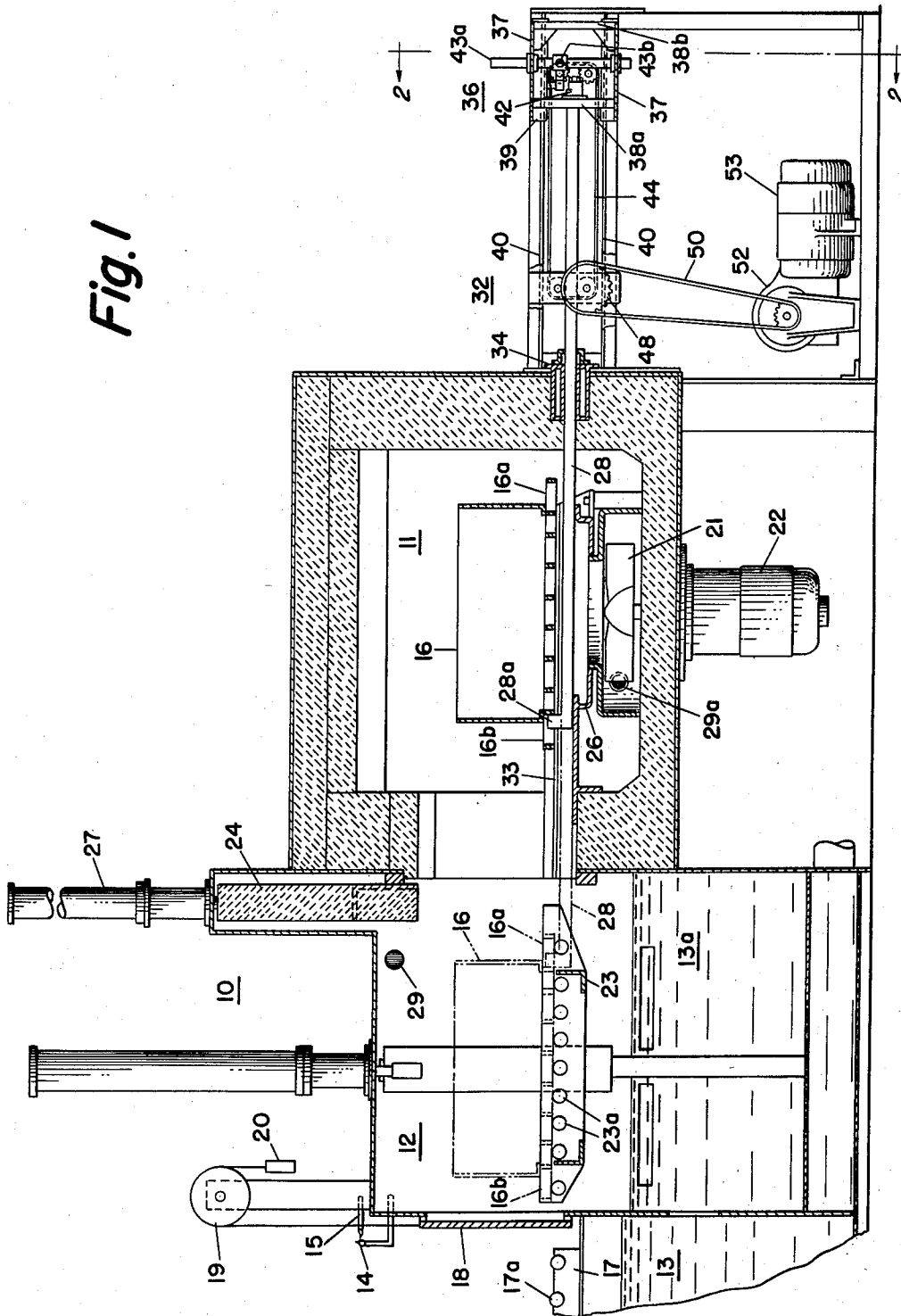
2,842,352

APPARATUS FOR HANDLING WORK IN A FURNACE

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Fig. 1



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Fig. 1A

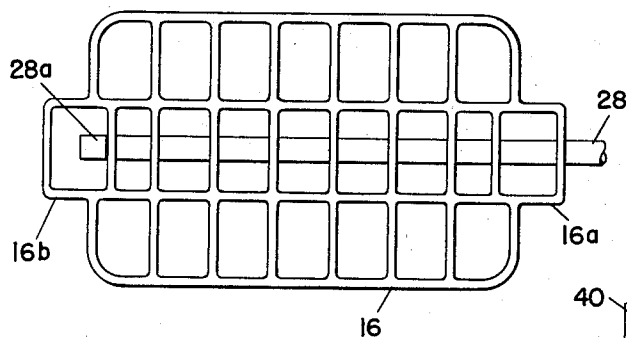


Fig. 1B

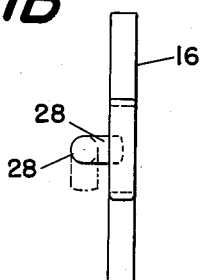
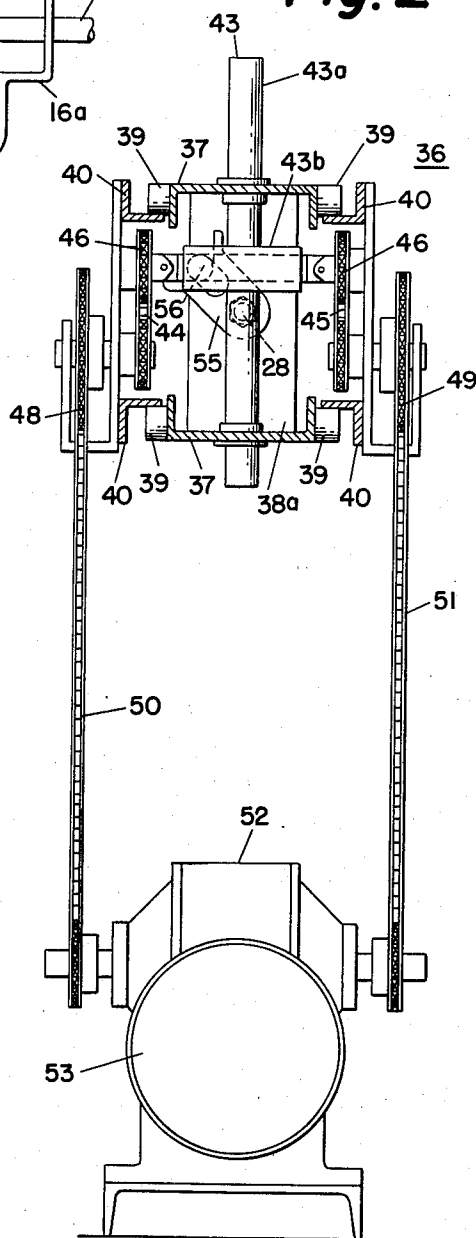


Fig. 2



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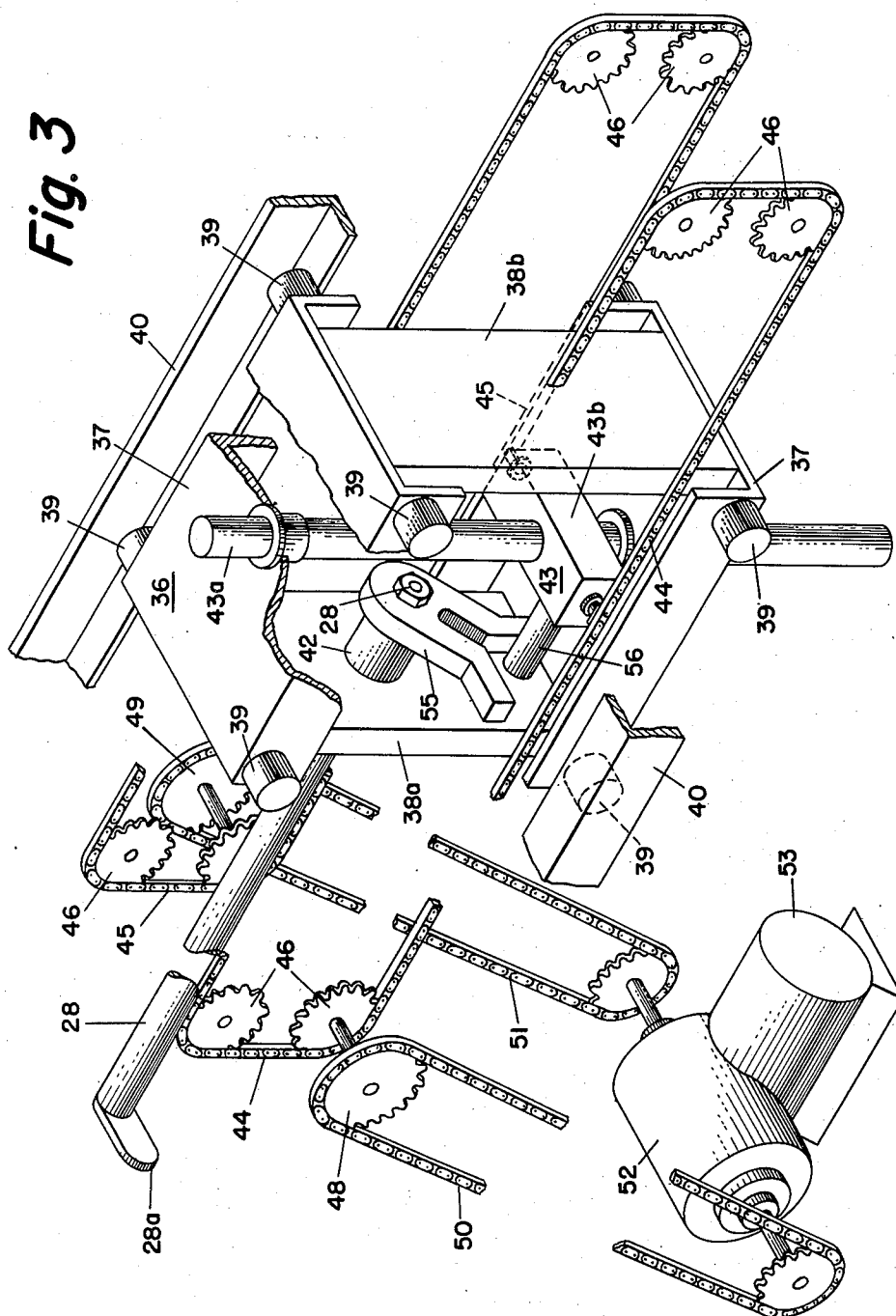
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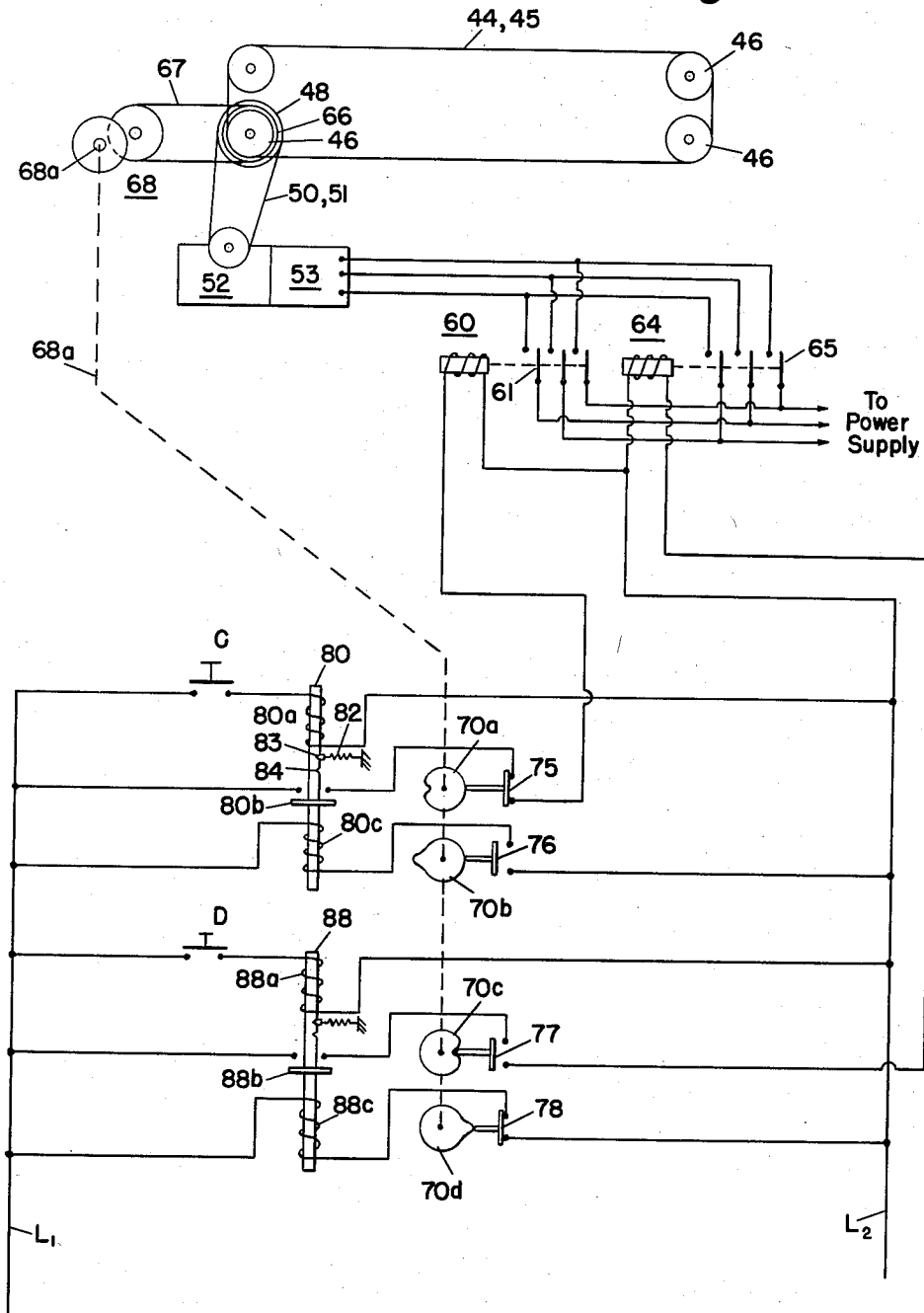
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Fig. 4



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Fig. 5

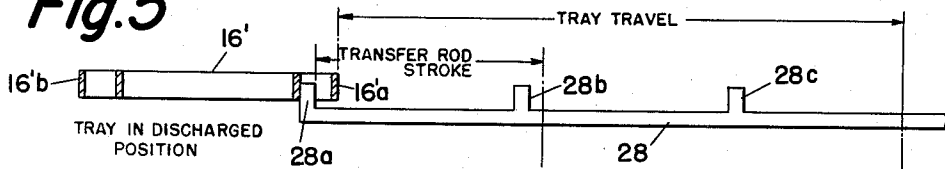


Fig. 5A

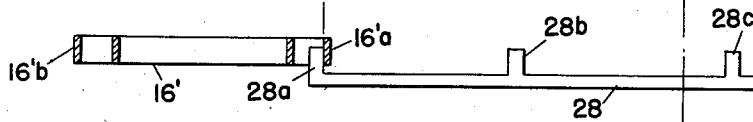


Fig. 5B

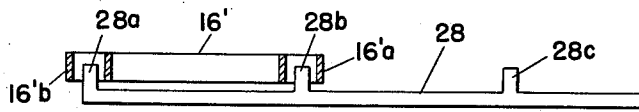


Fig. 5C

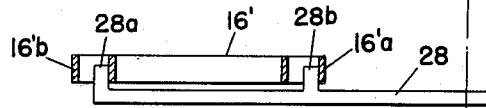


Fig. 5D

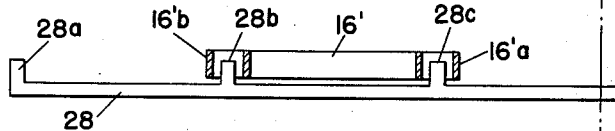


Fig. 5E

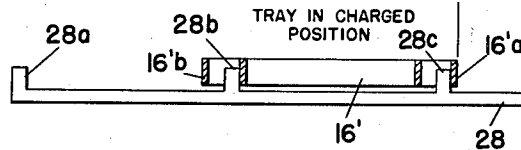


Fig. 6

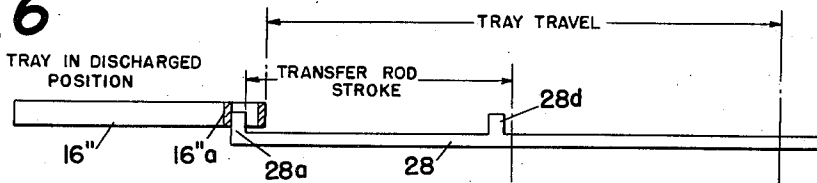


Fig. 6A

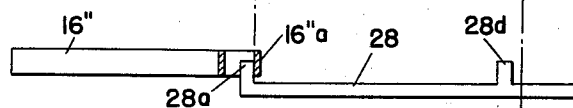


Fig. 6B

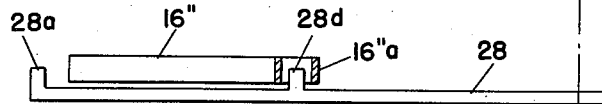
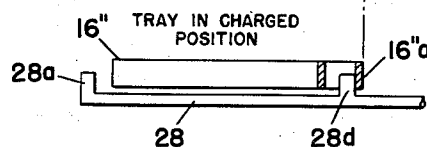


Fig. 6C



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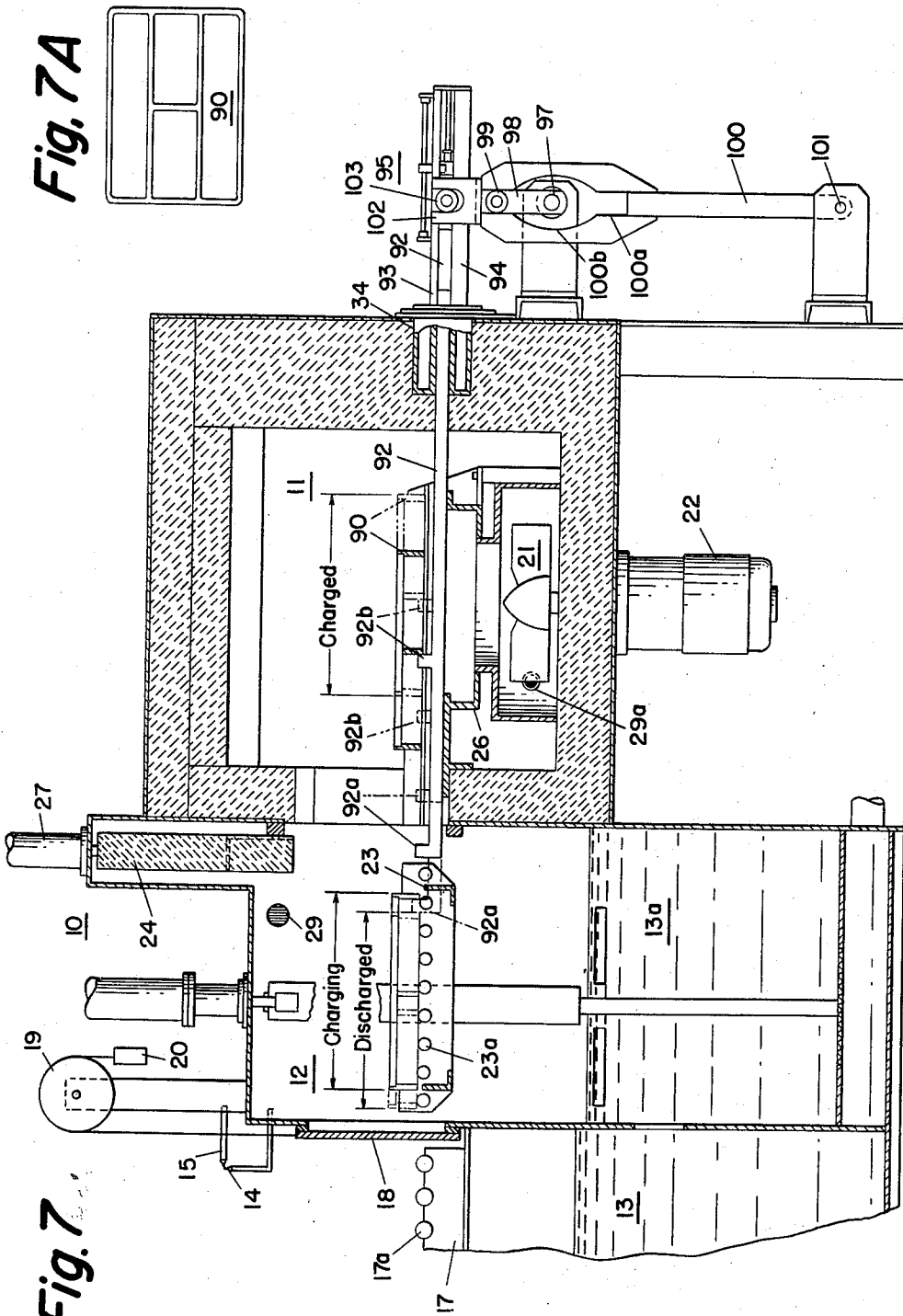
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Fig. 7A



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Fig. 8

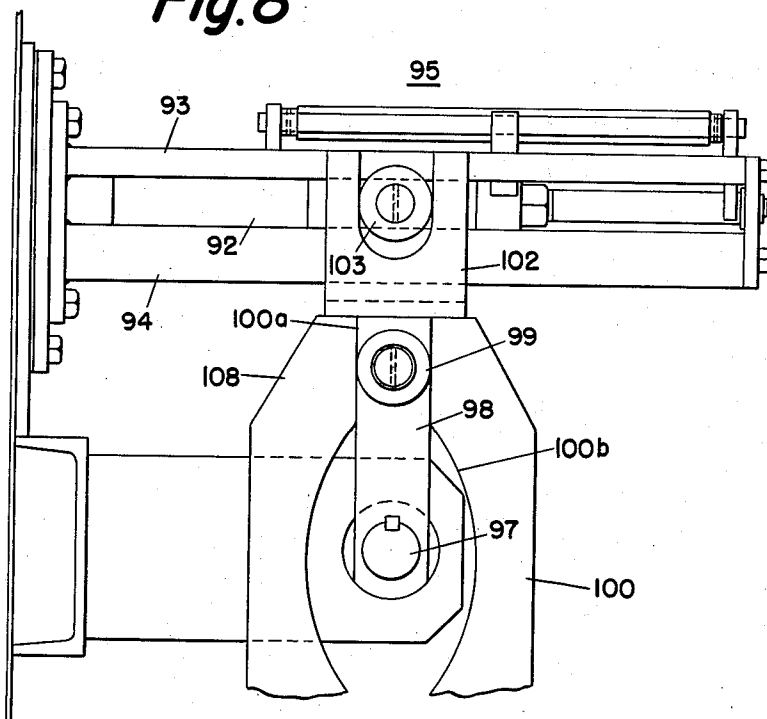
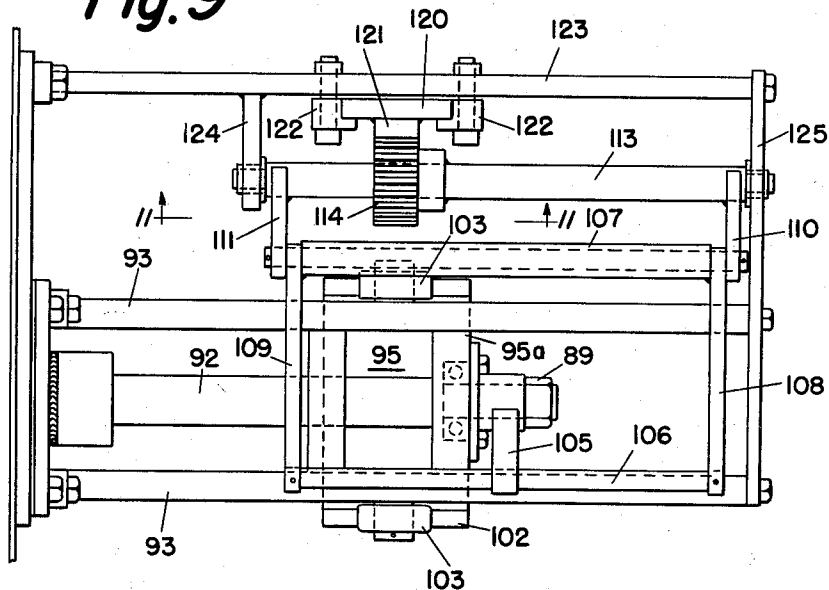


Fig. 9



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Fig.10

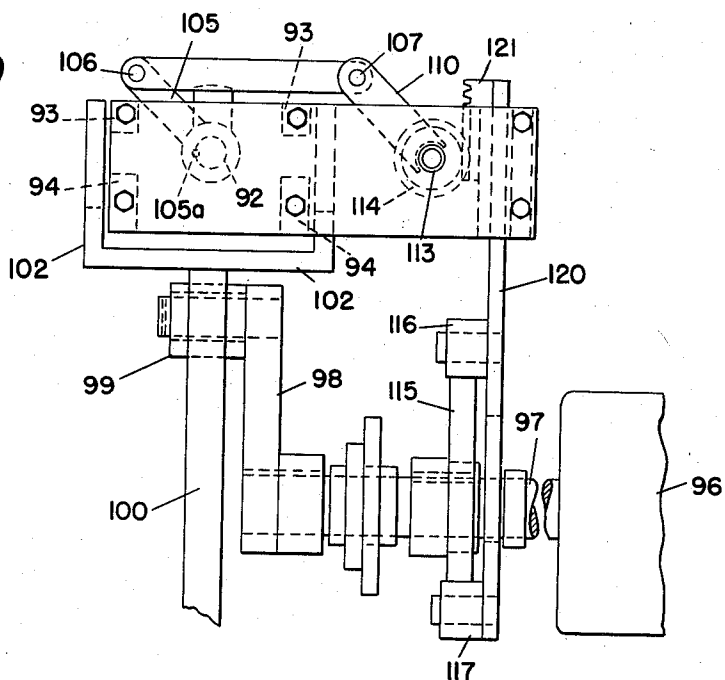
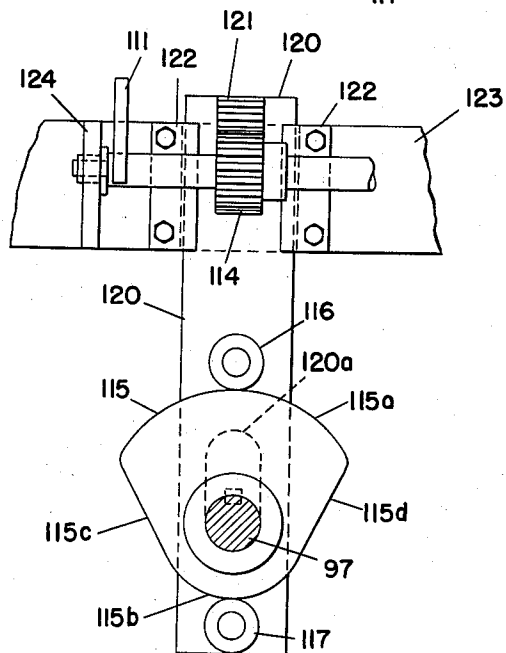


Fig. 11



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APPARATUS FOR HANDLING WORK IN A FURNACE

Gustave M. Tauber, Philadelphia, Pa., assignor to Leeds and Northrup Company, Philadelphia, Pa., a corporation of Pennsylvania

Application November 5, 1953, Serial No. 390,339

20 Claims. (Cl. 266-4)

This invention relates to apparatus for transferring work loads from one work station to another and return and has for an object the provision of novel apparatus for handling heavy work loads such as loading and unloading heat-treating furnaces where it is desired to maintain the work under atmosphere control both during and after completion of the heating part of the cycle.

The present invention is particularly applicable to annealing, normalizing, hardening, case carburizing, carbon restoration and to homogeneous carburizing, and the heat-treating apparatus may preferably be of the type disclosed in United States Letters Patent 2,752,147 granted June 26, 1956 upon copending application, Serial No. 201,906, filed December 21, 1950, by the applicant and coemployees Wayne Leo Besselman and James Henry Somerset.

In furnaces of the foregoing type, it is important that during the heating of the work a non-oxidizing atmosphere be maintained, as for example, one with a carbon content, and that such protective atmosphere be further maintained during transfer of the work from the heating chamber to a quenching chamber. In said foregoing application, provision has been made not only for uniformity of atmosphere within the heating chamber as regards the transference of a constituent thereof to and from the work, but also an atmosphere of known and predetermined composition is maintained within a vestibule or loading chamber associated with the heating chamber, control of said atmosphere within the vestibule being regulated by the constituent-controlling means of the heating chamber. Whenever a door of the heating chamber is opened there is established an auxiliary supply to the heating chamber of constituent material which compensates for any dilution of the atmosphere of the heating chamber; but the introduction of the added constituent material may not increase the constituent-potential of the furnace atmosphere materially above its preselected value since the constituent-controlling means acts to decrease the supply thereof as soon as the constituent-potential within the heating chamber tends to rise above its selected value.

Heretofore furnaces of the aforesaid type have been manually loaded and unloaded. For example, the door to the vestibule was opened and the work was pushed into the vestibule adjacent the closed furnace door. After this, the vestibule door was closed and the furnace door was then opened. A rod was inserted through a small aperture or opening, normally closed, in the vestibule door, and the work was pushed from the vestibule through the furnace door into the heating chamber of the furnace after which the furnace door was closed and the work heated. After completion of the heating step of the heat-treating cycle the furnace door was opened and the work was withdrawn through the opened door into the vestibule or discharge chamber. This was done without encountering a change in the atmosphere within the vestibule which was solely dependent upon that of the heating chamber. The furnace or inner door was then closed

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and the work was then brought to rest on an elevator in a position to be directly lowered into a quench tank.

While the foregoing method of transferring work loads into and out of the heat-treating furnace has been satisfactory for relatively light loads that may be handled manually, such method is not practical when it is desired to heat treat heavy work loads that are better handled by power driven mechanism. Furthermore, when the rod was inserted through the opening in the vestibule door there was a certain amount of clearance around the rod that provided a direct path from outside atmosphere to the heating chamber and thus it was necessary to provide compensation for maintaining constant the composition of the atmosphere in both the furnace and the vestibule.

In accordance with one aspect of the invention there is provided a transfer mechanism for moving work from one work station to another and return comprising reciprocal means operable through a predetermined cycle, coupling structure movable with the reciprocal means, the coupling structure being automatically operated into coupling and decoupling relation with the work at predetermined points in the operating cycle of the reciprocal means. There is further provided reversible driving means for operating the reciprocal means and controlling the operation of the coupling structure whereby the work in sequence is coupled to the reciprocal means at the one station, transferred to the other station and thereafter returned to the one station and decoupled from the reciprocal means to complete the predetermined cycle.

More particularly, and in accordance with another aspect of this invention there is provided transfer mechanism for moving work from a work vestibule to a heating chamber and return, comprising reciprocal means extending into the heating chamber and operable through a predetermined cycle, and coupling structure movable with the reciprocal means, the coupling structure being automatically operated into coupling and decoupling relation with the work at predetermined points in the operating cycle of the reciprocal means. There is further provided reversible driving means disposed externally of the heating chamber for operating the reciprocal means and controlling the operation of the coupling structure whereby the work in sequence is coupled to the reciprocal means at the work vestibule, transferred to the heating chamber for heat treatment and thereafter returned to the work vestibule and decoupled from the reciprocal means to complete the predetermined cycle.

For further objects and advantages of the invention, reference should be had to the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a side elevation partly in section of a heat-treating furnace of the horizontal sealed type with certain associated apparatus omitted, and provided with transfer mechanism embodying the invention for loading and unloading the furnace;

Fig. 1A is a plan view of a work tray shown in Fig. 1 and the associated rod structure;

Fig. 1B is an end view of Fig. 1A.

Fig. 2 is a sectional view along the lines 2-2 in Fig. 1, but on an enlarged scale;

Fig. 3 is a fractional perspective view of the transfer mechanism embodying the invention shown in Fig. 1;

Fig. 4 is a wiring diagram showing the electrical circuits for operating the transfer mechanism of Figs. 1-3 with certain of the mechanical parts shown diagrammatically;

Figs. 5-5E are diagrammatic views of a modification of the invention with the parts shown in different positions of operation during a cycle of the transfer mechanism;

Figs. 6-6C are diagrammatic views of another modification of the invention with the parts shown in different

position of operation during a cycle of the transfer mechanism;

Fig. 7 is a side elevation partly in section, of a metallurgical furnace embodying a further modification of the invention;

Fig. 7A is a plan view of the work tray shown in Fig. 7;

Fig. 8 is a fractional, elevation view on enlarged scale of the transfer mechanism shown in Fig. 7;

Fig. 9 is a plan view of the mechanism shown in Fig. 8;

Fig. 10 is an end elevation of the mechanism shown in Figs. 8-9; and

Fig. 11 is a sectional view taken along the lines 11-11 in Fig. 9.

Referring to Fig. 1 of the drawings, the invention in one form has been shown applied to a batch-type metallurgical furnace 10 having a heating chamber 11, a vestibule or entrance chamber 12, and a quench tank 13, having a quench zone 13a. The furnace 10 is of the type fully disclosed in the aforesaid copending application Serial No. 201,906. Before proceeding with a detailed explanation of the operation of the novel transfer mechanism, it is believed that a brief explanation of the general operation of the heat-treating furnace 10 will be helpful in understanding the invention. It will be assumed that the furnace is in readiness for the treatment of work, that its temperature is at the required point, and the desired atmosphere has been established in the heating chamber 11 and in the vestibule 12. Provision is generally made for an exhaust flame 14, ignited by a pilot burner 15, to consume the gases from the vestibule. The metallurgical furnace 10 of Fig. 1 is designed for use with trays for carrying the work such for example as trays 16 shown in full-line within the heating chamber 11 and in phantom within the vestibule 12, Fig. 1. A tray, such as tray 16, is first loaded with work and deposited on the rack 17, preferably provided with rollers 17a, disposed to one side of the path of an outer door 18 of the vestibule 12. The door 18 may be supported in any suitable manner and has been shown in Fig. 1 as of the sliding type, that may be raised and lowered with the assistance of a pulley 19 and counter-weight 20. In Fig. 1, the door 18 is illustrated in the closed position, and it will be noticed that there are no apertures in door 18 for rods or the like through which outside atmosphere may pass when the door is closed. When door 18 is raised to an open position a loaded work tray can be slid directly from the loading rack 17, through the open door 18 of vestibule 12 onto an elevator platform 23. At this time the inner door 24 to the heating chamber, shown in open position, Fig. 1, is then in its lowered or closed position. Thus there is no direct path from outside atmosphere to the interior of the heating chamber 11 when the vestibule door 18 is open to permit loading of work onto platform 23 in vestibule 12.

Preferably, provision is made for avoiding loss of protective atmosphere within the heating chamber 11 when door 18 is in the open position and for establishing forced flow of gases from the heating chamber 11 to the vestibule 12 upon closure of door 18, as fully explained in the aforesaid copending application. Briefly, a flow passage 29 may be provided interconnecting the heating chamber 11 and vestibule 12. The flow passage includes a valve which closes upon opening of the door 18, thus while door 18 is in the open position there is avoided loss of protective atmosphere within the heating chamber 11. However, upon closure of door 18, the valve in flow passage 29 is opened to establish forced flow of gases from the heating chamber 11 to the vestibule 12. The forced flow of gases is provided by a fan 21 located within the heating chamber 11 and driven by a motor 22 located outside the chamber. It is preferred that the fan 21 be disposed within a housing which includes a plurality of vanes extending substantially tangent to the fan di-

ameter to direct the furnace gases outwardly for circulation upwardly of the furnace walls and downwardly through the tray 16 for uniform mixing of the gases of the furnace and for uniformity of the heating of the work supported in the tray 16.

A detailed disclosure of the fan and of the preferred associated vanes is set forth in United States Patent 2,686,665 granted August 17, 1954 upon copending application, Serial No. 190,152 filed October 14, 1950, by the applicant and John J. Schultz, a coemployee, for Heat-Treating Furnace.

Advantage is taken of the fact that zones of high pressure are produced by a fan, as at certain of the adjacent directing vanes, that is, pressures higher than in other portions of the heating chamber 11. By disposing the inlet 29a of recirculating pipe 29 in a high-pressure zone adjacent the fan 21, there will be forced circulation of gases from the heating chamber 11 into the vestibule or loading chamber 12 so long as the door 18 is closed, the condition required for the valve in flow passage 29 to be in the open position. In this manner there is avoided the need for an additional motor and fan for withdrawing the gases from the heating zone for supply to the vestibule 12. In this connection, it is to be observed that gases from the heating chamber 11 are not returned thereto but form the supply of the gases for the exhaust flame 14.

The work tray 16 is then transferred from its position on platform 23 in vestibule 12 through door 24 now in open position, into the interior of heating chamber 11, and onto the tray support 26. The heating chamber 11 may be of the gas fired type or it may be provided with electrical heating coils. The door 24 is then closed, for example, by a suitable means such as an actuating cylinder 27. The door 24 when in its lowered position forms a substantially gas-tight seal for the heating chamber 11. After the work has been retained in the heating chamber 11 for a desired length of time determined by the nature of the treatment to which it is to be subjected, it is removed therefrom. The temperature in the heating chamber 11 is under the control of a suitable control system (not shown). An example of a suitable control system is one that may include a thermocouple mounted within a thermowell extending into heating chamber 11 and connected to a temperature controller which may be of the type fully disclosed in U. S. Patent No. 2,325,232, Davis. When the work is to be removed from heating chamber 11, the inner door 24 is opened and the tray 16 is moved back onto platform 23 of the elevator in vestibule 12 during which time the outer door 18 remains closed. The inner door 24 is then closed. The door 18 may then be opened and the work may then be removed directly from the elevator in vestibule 12 to loading rack 17 or before the door 18 is opened the work may first be lowered by elevator platform 23 into the localized quenching zone 13a after which door 18 is opened and the work removed from vestibule 12 to the loading rack 17.

When the work loads that are to be heat-treated are of a relatively large size, they become extremely difficult to handle manually due to their weight and thus it becomes necessary to use power operated mechanism for transferring the work trays into and out of the heating chamber 11. In using power operated mechanism it is necessary that the entrance to the vestibule 12 and the heating chamber 11 be maintained free from obstruction by the power driven apparatus in order to permit the work to be readily transferred into and out of vestibule 12 and heating chamber 11. In some prior art arrangements, it has been proposed to use power driven transfer mechanism located within the heating chamber 11. However, such arrangements have not been entirely satisfactory due to the many problems that arise in maintaining

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the mechanism in operative form at all times due to its being continually subjected to the high temperatures encountered in the heating chamber 11. In other prior art arrangements it has been necessary to manually assist the transfer of the work from the vestibule into and out of the heating chamber.

In accordance with the present invention, there is provided a rugged and simple mechanism for automatically transferring work loads of any size from the elevator in vestibule 12 into the heating chamber 11 and return with the only moving part of the transfer mechanism within the heating chamber 11 being conveyor means shown as a reciprocable shaft or rod 28.

As will be recalled to charge the furnace or heating chamber 11, the vestibule door 18 is opened and a loaded tray 16 is manually pushed from the outer roller rack 17, into position on elevator platform 23 in the vestibule 12. Platform 23, preferably, is equipped with rollers 23a. The rollers 23a are divided into two spaced rows to permit the rod 28 to pass therebetween. The door 18 is then closed and the inner door 24 to the heating chamber 11 is then opened preparatory to operation of the transfer mechanism in a loading direction to "charge" the heating chamber 11. At the beginning of the loading or charging cycle of the transfer mechanism 32, the reciprocable means, shown as rod 28 in Fig. 1, is disposed in its inner position as shown in full-line in Fig. 1. It will be understood that at that time there is no work tray in the heating chamber 11 and the work tray on the elevator platform 23 is outside of door 24. The transfer rod 28 is provided at its outer end with a coupling means which may be in the form of a hook 28a for moving outside of heating chamber 11 and engaging the work trays 16 in the manner shown in Figs. 1, 1A, and 1B. The transfer rod 28 and associated hook 28a are rotated through 90° as shown in Fig. 1B, after which they move from the inner position in Fig. 1 within heating chamber 11, to the outer position shown in phantom in Fig. 1, until the hook 28a is beneath the eye 16a at the end of the tray 16. The transfer rod 28 and its hook 28a are then rotated in a reverse direction through substantially 90° so that the hook 28a will be in a vertical position as shown in phantom in Fig. 1 for engaging the end or eye 16a of tray 16. The transfer rod 28 and hook 28a are then moved in reverse direction to their inner position within heating chamber 11. It will be observed from Fig. 1 that the foregoing reciprocating movement of rod 28 will move tray 16 from its outer position within vestibule 12 and outside of the chamber door 24 to a position approximately midway between vestibule 12 and heating chamber 11. The tray 16 and the transfer rod 28 are so dimensioned that at the end of the foregoing stroke of rod 28, the other end of tray 16 with its eye 16b will have been moved to the position previously occupied by eye 16a and eye 16a will now be located within chamber 11. The transfer rod 28 and its hook 28a are again rotated through 90°, lowering the hook 28a into a horizontal position out of engagement with eye 16a, after which rod 28 moves to its outer position where it is again rotated up into the vertical position so that it engages eye 16b. The transfer rod 28 and hook 28a are then moved back to their original positions within chamber 11, and at the same time cause the tray 16 to move a corresponding distance such that it will now be located within the chamber 11, as shown in full-line in Fig. 1. The tray 16 is now in the "charged" position on the tray support 26, and the transfer rod 28 and hook 28a remain at rest as hereinafter described. The door 24 to heating chamber 11 is then closed and the load heating cycle is initiated. To assist in moving the loaded work trays 16 from their outer position on platform 23 in vestibule 12 to their inner or "charged" positions within heating chamber 11, there are preferably provided spaced parallel rails 33 made of a heat resistant alloy or suitable refractory.

At the end of the heating cycle, the inner door 24 is

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opened and the load moving transfer mechanism is operated in reverse direction to "discharge" or unload the heating chamber 11. The transfer rod 28 and hook 28a have remained in the vertical position, as shown in full-line in Fig. 1, during the heat-treating cycle. Thus the hook 28a is in engagement with eye 16b and is ready to move the tray 16 outwardly of heating chamber 11 upon actuation of rod 28. When the rod 28 is moved to its outer position, as shown in phantom in Fig. 1, the tray 16 will be moved a corresponding distance to a position on rails 33 intermediate heating chamber 11 and vestibule 12. The transfer rod 28 is then rotated through approximately 90° to lower the hook 28a into a horizontal position out of engagement with eye 16b, Fig. 1B. The rod 28 is then moved in reverse direction to its position within heating chamber 11, after which it is rotated to bring the hook 28a into a vertical position for engagement with eye 16a. The rod 28 is again moved outwardly of heating chamber 11, moving the tray 16 a corresponding distance and depositing it on the elevator platform 23 in vestibule 12 outside of door 24, where it is ready for quenching or removal from vestibule 12. The hook 28a is then rotated into horizontal position out of engagement with eye 16a and rod 28 is withdrawn into heating chamber 11 at which time the transfer cycle is completed and the transfer mechanism 32 comes to rest. The inner door 24 to the heating chamber 11 is then closed, after which without further horizontal movement of tray 16 the elevator platform 23 and loaded work tray 16 may be lowered into the quenching zone 13a. After the quenching operation is completed, the elevator platform 23 and tray 16 are raised, the door 18 is opened and tray 16 is manually transferred from the elevator platform 23 to the outer roller rack 17. It is to be noted that it is not necessary to assist the automatic transfer mechanism in its transfer of the work tray 16 from the vestibule into and out of the heating chamber 11.

From the foregoing and from Fig. 1, it will be observed that the various transfer operations in the work treating cycle were performed entirely by a reciprocable means in the form of a simple rod structure that extends through the rear wall of the furnace 10 and is surrounded by a packing gland 34 which, preferably, is of the water-cooled type. The driving mechanism or motive means for actuating the transfer rod 28 is disposed entirely outside of the furnace and thus is not subjected to the high temperatures that would be encountered if it were disposed within the heating chamber 11. The high temperatures do not adversely affect the rod 28 as it is preferably constructed from a high temperature resistant alloy.

The transfer rod 28 and its associated hook 28a may be operated through the foregoing cycle of loading and unloading a furnace by various types of driving means as will now be described. The driving means, shown in Figs. 1, 2 and 3, is of the type that includes a trolley assembly 36, to which the rear end of rod 28 is connected in a manner such that it is free to rotate with relation to the trolley assembly 36 but any horizontal movement of the trolley assembly 36 will impart a corresponding horizontal movement to the transfer rod 28. The trolley assembly 36 includes a pair of upper and lower plates 37, interconnected by two vertical cross members, 38a and 38b, Figs. 1 and 3. The trolley assembly may be provided with eight rollers 39 adapted to ride on the four horizontally disposed tracks 40 that extend from the end of the furnace and surround the packing gland 34 and rod 28. The rear end of rod 28 extends through the forward vertical cross member 38a and is rotatably secured thereto by means of a collar member 42. Thus the rod 28 will move horizontally with the support 38a of trolley 36 but may be rotated relative to support 38a, as hereinafter described. To drive the trolley assembly 36 there is provided a crosshead member 43 that is positioned vertically within trolley assembly 36 and extends through opposed openings in the upper and lower plates 37,

The vertical member 43a of crosshead 43 is provided with a horizontal member 43b, the outer ends of which are adapted to be fastened to a pair of sprocket chains 44 and 45, each of which is arranged to run with a minimum amount of play over four sprocket wheels 46. It will be observed in Figs. 1, 2 and 3 that the sprocket wheels 46 are arranged in upper and lower pairs, at spaced locations along the angle tracks 40 such that the sprocket chains 44 and 45 move through a substantially rectangular path. The chains 44 and 45 and sprockets 46 are driven in unison by two sprockets 48 and 49 and associated sprocket chains 50 and 51 from a motor driven gear reducer unit 52.

As previously described, the vertical member 43a of crosshead 43 is mounted so that it may slide through the top and bottom members 37 of the trolley assembly 36. Thus when the crosshead 43 is moved in a horizontal direction, by the member 43b, connected to chains 44 and 45, the trolley assembly 36 will be driven horizontally a corresponding distance. When the member 43b follows the chains 44 and 45 in a vertical direction as it does at the ends of the stroke of rod 28, the trolley assembly 36 remains at rest while the crosshead 43 moves vertically with relation to the trolley assembly 36. In this manner the driving chains 44 and 45 impart the required horizontal reciprocating motion to the transfer rod 28 and its hook 28a.

The rotary motion of the transfer rod 28 and hook 28a takes place at the ends of the horizontal stroke and is accomplished in the following manner. The rear end of transfer rod 28 is provided with cam follower structure in the form of a forked arm 55. The forked arm 55 is fastened to rod 28 so that any rotation of the forked arm 55 is transmitted to rod 28 and its associated hook 28a. Mounted on the horizontal member 43b of crosshead 43 is a cam shown in the form of a roller 56 which is adapted for engagement with the forked arm 55. When the crosshead 43 follows the chains 44 and 45 in a vertical direction, as it does at the end of each stroke and the roller 56 moves vertically, the roller 56 engages the forked arm 55 rotating the latter through approximately 90° and likewise rotating transfer rod 28 and hook 28a the same amount. When the roller 56 and forked arm 55 are in the upper position as shown in Fig. 2, the hook 28a is in its upper vertical position as shown in Fig. 1. When the roller 56 and forked arm 55 are in the lower position, the hook 28a is down in its horizontal position as shown in phantom in Fig. 1B. Thus, it will be seen that the horizontal spacing between the pairs of sprocket wheels 46 determines the length of stroke of the transfer rod 28 and the vertical spacing between the upper and lower pairs of sprockets 46 determines the duration of the coupling and decoupling operations and extent of rotation of rod 28.

When the drive motor 53 operates its reduction gears 52 to drive chains 50, 51 and 44, 45 in a counterclockwise direction, the tray 16 will be discharged from heating chamber 11 in the following manner: The crosshead 43 moves to the left, Fig. 1, in its upper position. During this movement, the hook 28a is also in its upper vertical position and in engagement with eye 16b of tray 16. At the end of the forward horizontal stroke of rod 28 the crosshead 43 moves down vertically with chains 44 and 45 and causes cam roller 56 to rotate forked arm 55 downwardly in turn rotating hook 28a to horizontal position preparatory to being withdrawn with rod 28 on the reverse stroke to engage the other eye 16a at the opposite end of tray 16. The crosshead 43 then moves up vertically causing roller 56 to rotate forked arm 55 upwardly, thereby rotating hook 28a to the vertical position where it remains as the hook 28a and rod 28 are again moved to the left as shown in Fig. 1. At the end of this stroke, the crosshead 43 moves down to return hook 28a to a horizontal position and thus release it with respect to eye 16a of tray 16. The rod 28 is then withdrawn into the heating chamber 11 to permit the door 24 to be closed

preparatory to recharging the furnace with a new tray after the work in the preceding tray 16 has been quenched. When the transfer mechanism is operated in a charging direction to charge the furnace with a new tray of work, the crosshead 43 will be operated in a reverse path to that described above by reversing the motor 53 to run in a clockwise direction and thus drive chains 44 and 45 in an opposite direction to that described above.

In order to operate the transfer rod 28 through the desired charging and discharging cycles for loading and unloading the furnace in the above manner, there is preferably provided a control system of the following type. As shown in Fig. 4, motor 53 is of the reversible type and may be alternately connected to the power supply through a "charge" starter 60 and associated switch contacts 61 and a "discharge" starter 64 and associated switch contacts 65. The motor 53 operates the gear reducer unit 52, the latter being connected to sprockets 48 and 49 by chains 50 and 51. Mounted on the same shaft with sprocket 48 is another sprocket 66 around which passes a chain 67 which cooperates with a speed reducing gear train diagrammatically illustrated as 68, Fig. 4. The gear train 68 includes an output shaft 68a illustrated as a broken line in Fig. 4, on which are positioned a plurality of cams 70a-70d for operating associated switches 75-78 in control of the transfer mechanism 32. The cams and switches have been shown in Fig. 4 in positions ready for the initiation of a charging operation.

To start motor 53 and operate the transfer mechanism 32 in a charging direction to load the heating chamber 11, a "charge" pushbutton C is moved to closed position, thereby energizing "in" coil 80a of relay 80 to close its contacts 80b. It will be observed that when pushbutton C is closed a circuit will be completed from one side of the line L₁ through the contacts of pushbutton C and through the "in" coil 80a of relay 80 to the opposite side of the line L₂. When the relay contacts 80b are closed a circuit will be completed from line L₁ through contacts 80b, through the normally closed contacts of switch 75 and through the coil of charge starter 60 to the opposite side of the line L₂. Thus, when pushbutton C is closed, followed by the closing of contacts 80b, which are held in latched position by spring 82 biasing a ball 83 into detent 84, the coil of charge starter 60 is energized, closing the associated contacts 61 to energize motor 53 and drive chains 50 and 51 in a clockwise direction. Cam 70a holds the contacts of switch 75 in closed position until the charging or loading cycle, as described above, has been completed. At the end of the charging cycle the normally open contacts of switch 76 are closed by associated cam 70b at which time the "out" coil 80c of relay 80 is energized thereby opening contacts 80b and moving the relay 80 to the position shown in Fig. 4. When the contacts 80b are opened, the circuit through the coil of the charge starter 60 for motor 53 is broken and the transfer mechanism comes to rest. At the time the contacts of switch 76 are moved to closed position by cam 70b, the contacts of switch 75 are moved to open position by its cam 70a. By this time the contacts of switch 77 will have been moved to closed position by cam 70c and the contacts of switch 78 will have been opened preparatory to unloading the furnace.

To unload the furnace after the heating portion of the cycle has been completed, the motor 53 may be operated in a reverse direction by pushing the discharge pushbutton D to momentarily complete a circuit through the "in" coil 88a of relay 88, which is also of the latched-in type such as relay 80, from one side of line L₁ to the other side of the line L₂. When coil 88a is energized, it closes the contacts 88b of relay 88, completing a circuit from line L₁ through contacts 88b through the normally closed contacts of switch 77 through the coil of the discharge starter 64 to the opposite side of the line L₂. When the coil of discharge starter 64 is energized, the associated contacts 65 are closed, thereby energizing motor 53 for

rotation in reverse direction to that previously described. Motor 53 remains energized for reverse rotation as long as the contacts of switch 77 are held in closed position by cam 70c carried by shaft 68a. When the discharge or unloading cycle, as described above, has been completed, the shaft 68a will have rotated cam 70d to a position where the contacts of switch 78 are closed thus energizing the "out" coil 88c of relay 88 to open contacts 88b and thus break the circuit through the discharge starter 64, opening the contact 65 and deenergizing motor 53, to stop the transfer mechanism 32. When the normally open contacts of switch 78 are closed, the cam 70c permits the contacts of switch 77 to open, Fig. 4.

It will be noted that when the discharge pushbutton D was closed, the motor 53 was operated in reverse direction and thus shaft 68a also was operated or rotated in a reverse direction. Thus while the contacts of switches 75 and 76, in the charging circuit, were in open and closed positions, respectively, at the end of the charging cycle, they were immediately returned to their original positions with the contacts of switch 75 being closed and the contacts of switch 76 being opened upon the closing of pushbutton D to initiate the discharge cycle. Thus the contacts of switches 75 and 76 are in readiness to start a subsequent charging cycle when the discharge cycle is completed as shown in Fig. 4. It will also be noted that the contacts of switches 77 and 78 in the discharge circuit likewise will be returned to closed and open positions respectively after closing a pushbutton C to initiate a charging cycle so that they will be in readiness for the initiation of a subsequent discharge cycle after the completion of a charging cycle. It will further be observed that the charging and discharging cycles of the transfer mechanism may be controlled by the location of the cams about shaft 68a. In Fig. 4, the cams have been set for the use of a transfer mechanism that requires two complete strokes to move a work tray from the vestibule 12 into the heating chamber 11. As will hereinafter be described, this invention is not limited to a transfer mechanism that requires two equal strokes for loading and unloading the furnace.

With a transfer rod 28 of the type shown in Fig. 1 having a single hook 28a, and of a length which completely charges a tray in two strokes and completely discharges the tray 16 in two strokes, it is necessary that the length of the tray 16 be approximately one-half of the total distance that it must travel from one work station to the other. In order to provide for cases in which the tray length may not be equal to one-half the distance it travels, the transfer rod 28 may be provided with a plurality of hooks.

Referring to Figs. 5-5E, the rod 28 is provided with a hook 28a, at its outer end and intermediate hooks 28b and 28c. It will be noted that hook 28b is approximately one transfer rod stroke from outer hook 28a and that hook 28c is a like distance from hook 28b. As will hereinafter be pointed out, it is possible to omit either of hooks 28b or 28c. In Fig. 5, the tray 16' is shown in discharged position, with hook 28a in coupling engagement with eye 16'a. In Fig. 5A the tray 16' has been advanced a distance corresponding to one stroke of transfer rod 28. The transfer rod 28 is then rotated to bring the hooks into a horizontal position, as described above, and the rod 28 moves in a reverse direction to bring hook 28a into engagement with eye 16'b of tray 16'. At this time, hook 28b will be in engagement with eye 16'a as shown in Fig. 5B. The transfer rod is then moved in reverse direction to advance tray 16', a distance corresponding to another stroke of transfer rod 28, thus bringing tray 16' to the position shown in Fig. 5C. The rod 28 is again rotated to disengage the hooks 28a and 28b with respect to the corresponding eyes 16'b and 16'a of tray 16', and the rod is moved to the position shown in Fig. 5D. At this time, hook 28b will be in engagement with eye 16'b, and eye 16'a will be in engagement

with hook 28c. Transfer rod 28 is again operated in reverse direction to move the rod into charged position as shown in Fig. 5E. It will be observed that in the example shown in Figs. 5-5E, the transfer rod took about two and three-quarters strokes to move the tray 16' from discharged position to charged position. A similar number of strokes are required to move the tray from charged position to discharged position. While it was not necessary to complete the return stroke of the transfer rod 28 to charge or discharge the tray 16', this does not present any problem in the operation of the transfer mechanism as the transfer rod 28 may be stopped in any desired position by the limit switches 75-78, Fig. 4, provided the rod is retracted sufficiently to permit the inner door 24 of the heating chamber 11 to be closed. Thus, it will be seen from Figs. 5-5E that the furnace may be charged or discharged in a plurality of strokes of transfer rod 28 and these strokes need not be of equal length. It will further be observed in Figs. 5-5E, that either of hooks 28b or 28c may be omitted without disturbing the charging and discharging cycles disclosed in Figs. 5-5E as the movement of the tray in Figs. 5-5C may be accomplished by hook 28a and the movement of the tray in Figs. 5D-5E may be performed by either of hooks 28b or 28c.

Referring to Figs. 6-6C, the rod 28 is provided with a hook 28a at its outer end and it is also provided with a second hook 28d. These hooks are arranged to completely charge or discharge a tray in two strokes of transfer rod 28 and here, as in Figs. 5-5E, the tray length need not equal one-half the distance it travels. As shown in Fig. 6, the tray 16'' is in discharged position and hook 28a is in engagement with eye 16''a of tray 16''. At the end of one stroke of transfer rod 28, the tray 16'' is moved from the position shown in Fig. 6 to the position shown in Fig. 6A. The transfer rod 28 is rotated through approximately 90° to move the hooks 28a and 28d to a horizontal position and the transfer rod 28 is moved in reverse direction and rotated back through 90° to bring the inner hook 28d into engagement with eye 16''a of tray 16'', Fig. 6B. It will be noted that hook 28a need not engage an eye at the other end of tray 16''. The transfer rod is then operated in a reverse direction to bring the tray 16'' to a charged position as shown in Fig. 6C.

As described in connection with Figs. 5-5E, the stroke of the transfer rod 28 as shown in Figs. 6-6C may be controlled by the operation of limit switches 75-78, and their associated cams 70a-70d. The mechanism for moving the transfer rod 28 shown in Figs. 5-5E, and Figs. 6-6C, may be the same as that shown in Figs. 1-3, or it may be of the type now to be described as shown in Figs. 7-11.

Referring to Fig. 7, there is shown a furnace 10 including a heating chamber 11, and a vestibule 12, similar to that illustrated in Fig. 1. The work tray 90, Figs. 7 and 7A, is inserted in vestibule 12, Fig. 7, to the "charging" position shown in full-line and door 18 is then closed. Door 24 into the heating chamber 11 is then opened. The tray 90 is then transferred by successive steps from its "charging" position, through an intermediate position shown in phantom in heating chamber 11 into the "charged" position as shown in phantom within heating chamber 11 in Fig. 7. The tray 90 is transferred into chamber 11 by means of a transfer rod 92 which reciprocates in a similar manner to that previously described in connection with Fig. 1, with the exception that the strokes of transfer rod 92 are of shorter length and thus more strokes are required. The transfer rod 92 in transfer mechanism 91 is provided with a pair of spaced hooks 92a and 92b that may engage either the outer or inner ribs of tray 90 depending upon the location of the tray 90 and in the arrangement shown each stroke of the transfer rod 92 moves the work tray 90 about one-half of its length.

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The rear end of transfer rod 92 passes through the rear wall of heating chamber 11, and is connected to a trolley or sliding block assembly 95. The sliding block assembly 95, supported on horizontal rails or guides 93, 94, extending from the rear wall of furnace 10 is so constructed to reciprocate the transfer rod 92 horizontally and at the ends of the strokes to rotate the rod 92 to couple and decouple the hooks 92a and 92b with respect to the work tray 90. Driving power is supplied to the sliding block assembly 95, Figs. 7-8 and 10, by means of a geared head motor 96, Fig. 10, connected to the main drive shaft 97. Fastened to shaft 97 is a crank arm 98 carrying a roller 99 which swings in a circle, the radius of which is determined by the length of crank arm 98. The roller 99 engages a slot 100a in a reciprocating arm 100 which is vertically disposed and pivoted at its lower end at pivot 101. When the crank arm 98 is rotated by the main drive shaft 97, the roller 99, acting on slot 100a, causes the reciprocating arm 100 to swing back and forth through a predetermined angle. In one embodiment the angle of swing was about 16° causing a horizontal movement of the upper end of arm 100 along tracks 93, 94 of approximately ten inches. The upper end of the reciprocating arm 100 is provided with a forked section 102 which engages rollers 103 carried by the sliding block 95a of assembly 95 to which the rear end of transfer rod 92 is fastened by nut 89. Accordingly when arm 100 moves back and forth through the predetermined angle of rotation, a corresponding horizontal motion is imparted to the sliding block assembly 95 and transfer rod 92. The slot 100a in reciprocating arm 100, has its central portion 100b cut out with a radius on either side so that when the roller 99 is traversing these portions of the slot 100a, the reciprocating arm 100 will be at rest. These rest periods are provided at each end of the stroke of transfer rod 92 to permit the transfer rod 92 and its hooks 92a and 92b to be rotated into or out of engagement with the ribs of the work tray 90 at a time when the tray 90 is not being moved horizontally.

As may be seen in Fig. 9, the transfer rod 92 is connected to the sliding block assembly 95 in a manner such that it is free to turn on its axis relative to block assembly 95a. Secured to transfer rod 92, as by a key 105a, is a lever 105, Figs. 9 and 10, which slides back and forth on a horizontal connecting link 106. Horizontal connecting link 106 is connected to another horizontal connecting link 107 by a pair of transverse links 108 and 109. Linkage 106-109 is connected by arms 110 and 111, to a shaft 113 carrying a pinion 114. Mounted on the main drive shaft 97 is a cam 115, Figs. 10-11, which engages a pair of rollers 116 and 117 which in turn are mounted on a vertically sliding bar 120 having a section of a gear rack 121 at its outer end. Bar 120 includes a slot 120a and slides on a pair of guides 122 supported from the furnace wall by member 123 to which are connected the supports 124 and 125 for pinion shaft 113. The gear rack 121 engages pinion 114 on shaft 113 and through links 106-109 and arms 110-111 rotates the transfer lever 105. It will be noted that portions 115a and 115b of cam 115 are concentric. Cam 115 is mounted on the drive shaft 97, which extends through slot 120a, in such a position that the concentric portions 115a and 115b are in engagement with the cam rollers 116 and 117 while the transfer rod 92 is being moved horizontally so that there is no rotation of transfer rod 92 during this period, such period corresponding to either a forward or reverse stroke of transfer rod 92. However, at the ends of the stroke of rod 92, the horizontal movement of rod 92 stops, and at this time the eccentric portions 115c and 115d of cam 115 move into engagement with the rollers 116-117 causing vertical movement of sliding bar 120 and rack 121 and turning the pinion 114 with shaft 113, thereby transferring rotation through arms 110, 111, linkage 106-109 and lever 105 to transfer

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rod 92 to rotate its hooks 92a and 92b, either into or out of engagement with a work tray 90 as required.

The operation of the transfer mechanism 91 shown in Figs. 7-11, may be reversed by reversing the rotation of gear head motor 96, and thus the rotation of drive shaft 97, whereupon the foregoing cycle will be repeated but in reverse direction to transfer the tray 90 by the action of transfer rod 92 from the "charged" position shown in phantom within chamber 11 to the "discharged" position, shown in phantom in vestibule 12.

While the invention has been described primarily as utilizing a plurality of strokes either of equal or unequal length in charging and discharging the work load in the furnace, it is to be understood that the work load may be charged in a single stroke of the transfer rod and discharged in a single stroke of the transfer rod without departing from the spirit of the invention. This may be done by increasing the length of the stroke the necessary amount to correspond to the total distance that the work tray must travel from the vestibule 12 to the heating chamber 11. Such an arrangement requires the use of a longer transfer mechanism and thus in large equipment might be objectionable from the standpoint of requiring considerable additional floor space. However, this objection is minimized in connection with small heat-treating equipment where the additional space required is correspondingly small.

It will be seen that in accordance with the present invention during a heat-treating cycle the work, by means of the novel transfer mechanism, is automatically moved from its position on the elevator in the vestibule outside the heating chamber door through the door into the heating chamber and then back through and beyond the chamber door to a position on the elevator preparatory to a quenching operation. Such transfer movement of the work is accomplished entirely by the transfer mechanism without the necessity of any assistance such as additional pushing or pulling of the work by the operator to initiate removal of the work from the elevator to help it through the heating chamber door or to aid its return from the heating chamber to the elevator.

Summarizing the foregoing, there is provided a simple and rugged transfer mechanism suitable for moving work loads of any size from one work station to another and return, and particularly suitable for loading and unloading furnaces, having temperatures too high for many conventional types of load-moving mechanism. The only moving part that need be in the furnace is the transfer rod and its coupling structure that operate directly upon the work tray to be moved into or out of the furnace. This transfer mechanism is particularly applicable to furnaces that are sealed for controlled atmospheres, as there is only one point of entrance through the furnace wall and the mechanism is such that this point can be readily sealed by means of a packing gland, for example, of the water-cooled type. To install a transfer mechanism of this type there is only required a minimum amount of cutting away of furnace wall insulation. The transfer mechanism performs the dual function of both charging and discharging the work load by reversing the driving means. The positioning of the load may be automatically taken care of by means of control mechanism located externally of the furnace and without the need of any actuating arms extending into the furnace in addition to the transfer rod. If necessary, the transfer rod can be replaced without cooling down the furnace. It will be observed that the horizontal components and the rotational components of the transfer rod and hook do not overlap yet they follow each other in almost continuous sequence. This operation is accomplished in relatively simple manner with mechanism that is of sturdy construction and easy to maintain in proper adjustment.

It is to be understood that the wiring diagram of the automatic program control means of Fig. 4 has been

illustrated in simplified form and that in actual installation suitable interlock structure and circuits have been and normally are provided between the various parts of the system such as between the doors of the vestibule and the heating chamber, the elevator and the transfer mechanism. Likewise suitable timing means generally are provided to control the length of time the work remains in the heating chamber and in the quenching zone. Thus in actual practice the operation of the furnace is fully automatic from the time the work is placed in the vestibule and the door closed until it is time to remove the heat-treated work from the vestibule.

While there have been described preferred embodiments of the invention, it will be understood that further modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. Transfer mechanism for moving work from one work station to another and return comprising reciprocable means operable through a predetermined cycle, coupling structure movable in timed relation with said reciprocable means, means effective on said reciprocable means between reciprocable movements thereof automatically to produce rotation of said coupling structure into coupling and decoupling relation with said work at predetermined points in said operating cycle of said reciprocable means, reversible driving means for operating said reciprocable means, and automatic program control means for controlling the operation of said reversible driving means and said coupling structure to produce in sequence coupling of said work by said coupling structure to said reciprocable means at said one station and transfer thereof to said other station and thereafter upon subsequent operation of said reversible driving means the coupling movements are controlled to produce return of the work to said one station by said reciprocable means and decoupling thereof from said reciprocable means to complete said predetermined cycle.

2. Transfer mechanism for moving work from a work vestibule to a heating chamber and return comprising reciprocable means extending into the heating chamber and operable through a predetermined cycle, coupling structure movable in timed relation with said reciprocable means, means effective on said reciprocable means between reciprocal movements thereof automatically to produce rotation of said coupling structure into coupling and decoupling relation with said work at predetermined points in said operating cycle of said reciprocable means, and reversible driving means disposed externally of the heating chamber for operating said reciprocable means, said reversible driving means being constructed for operation in one direction to control the operation of said coupling structure relative to movement of said reciprocable means to produce in sequence coupling of said work by said coupling structure to said reciprocable means at the work vestibule and transfer thereof to the heating chamber for heat treatment and thereafter upon subsequent operation of said reversible driving means in the other direction the coupling movements are controlled to produce return of the work to the vestibule by said reciprocal means and decoupling thereof from said reciprocable means to complete said predetermined cycle.

3. Transfer mechanism according to claim 2 wherein said reciprocable means comprises a rod and said coupling structure comprises a hook carried by said rod.

4. Transfer mechanism according to claim 2 wherein said reciprocable means comprises a rod and said coupling structure comprises a plurality of projecting elements carried by said rod at predetermined spaced locations.

5. Transfer mechanism according to claim 2 wherein said reversible driving means is selectively controlled

from an electrical circuit including a plurality of switch means operated by said driving means.

6. Transfer mechanism according to claim 2 wherein said reciprocable means comprises rod structure extending through a wall of the heating chamber.

7. Transfer mechanism according to claim 6 wherein said driving means includes trolley structure operable through a predetermined path and connected to said rod structure.

8. Transfer mechanism according to claim 7 including spaced parallel horizontal tracks for said trolley structure and said trolley structure comprises a frame supported for reciprocation on said tracks, a pair of spaced endless chains extending along said tracks and carried by a plurality of pairs of spaced sprocket wheels, a member carried by said chains and extending into said frame for interconnecting the latter with said chains, and said driving means includes a controlled source of power for driving said sprockets, said chains and said member to reciprocate said frame and said rod through said predetermined cycle.

9. Transfer mechanism according to claim 8 wherein said tracks are disposed for horizontal reciprocation of said frame and said rod, and said member is disposed for vertical movement relative to said frame at the ends of each forward and reverse stroke of said rod to control the coupling and decoupling relation of said rod with respect to said work.

10. Transfer mechanism according to claim 8 wherein said sprocket wheels are disposed to move said chains and said member through a substantially rectangular path, one pair of said sprocket wheels being disposed at each corner of said rectangular path.

11. Transfer mechanism according to claim 8 wherein said sprocket wheels comprise two spaced pairs of upper sprocket wheels and two spaced pairs of lower sprocket wheels, the horizontal spacing between said pairs determining the length of stroke of said rod, and the vertical spacing between said upper and lower pairs determining the duration of said coupling and decoupling operations.

12. Transfer mechanism according to claim 7 including spaced parallel horizontal guides for said trolley structure and said trolley structure comprises a block assembly supported for reciprocation on said guides, a vertically disposed arm pivoted at its lower end and having its upper end in engagement with said block assembly, and said driving means includes a controlled source of power to rotate said arm back and forth through a predetermined angle to reciprocate said block assembly and said rod through said predetermined cycle.

13. Transfer mechanism according to claim 12, wherein said arm is provided with cam surfaces for cooperating with said block assembly to determine the periods of rest of the latter at the ends of each forward and reverse stroke of said block assembly within said predetermined cycle.

14. Transfer mechanism according to claim 13 including means for operating said coupling structure with coupling or decoupling relation with said rod at the ends of the strokes of the latter during said periods of rest when said cam surfaces are in engagement with said block assembly.

15. Apparatus for moving a load into and out of a batch type metallurgical furnace of the type including a vestibule and a heating chamber, said vestibule having a door providing exterior communication for ingress and egress of work to and from the vestibule and a door communicating with the heating chamber of said furnace, comprising a horizontally reciprocable shaft slidable through a sealing aperture in one wall of said furnace, structure associated with the end of said shaft within said furnace for cooperating with work to be transferred within said furnace, means for producing reciprocatory motion of said shaft, and means automatically controlling

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rotation of said reciprocable shaft between reciprocatory motions thereof so that for furnace loading operations said shaft is moved forward by said reciprocatory motion producing means with said end structure positioned free of coaction with said work by said automatic controlling means and is moved backwards with said end structure in engaged relation with said work and during furnace unloading movements said reciprocatory motion of said shaft as produced by said motion producing means takes place with reverse actuation of said end structure as produced by said automatic controlling means.

16. Material or article handling means for a furnace comprising shaft structure entering through one wall of said furnace, engaging means associated with said shaft structure on the end thereof interior of said furnace and positionable between material or article engaging and disengaging positions, means exterior of said furnace for producing controlled reciprocatory movements of said shaft, cam and cam follower structure cooperating with said reciprocatory means and said shaft to control engaging and disengaging operations of said engaging means, and automatic program control means controlling said reciprocatory motion producing means in a sense to produce engaging operation of said engaging means only on forward operation of said shaft structure for a furnace loading or unloading operation and operation in the reverse sense for unloading or loading of said furnace.

17. Apparatus for charging or discharging work to or from the heating chamber of a furnace comprising a shaft axially related for reciprocatory motion in line with the charging and discharging path of said furnace, hook structure associated with the furnace end of said shaft, motive means exterior of said furnace for producing reciprocatory motion of said shaft through a predetermined path, cam structure coacting with said shaft and said motive means to produce a partial rotation of said shaft when said shaft has reached the extremities of the path through which said shaft is reciprocated to move said hook into work engaging or disengaging relation for periodic pushing or pulling movements on each stroke of said shaft, and automatic means for selectively controlling the direction of operation of said motive means to produce said rotational movement of said shaft in timed relation to the reciprocation thereof to turn said hook by a predetermined amount into work engaging position only on backward strokes of said shaft or only on forward strokes thereof.

18. Transfer mechanism for automatically moving work from a vestibule to a heating chamber and return comprising conveyor means extending into the heating chamber and operable through a predetermined cycle to move a work load through a reciprocatory path, coupling structure movable in timed relation with said conveyor means, means effective on said conveyor means between reciprocal movements thereof automatically to produce rotation of said coupling structure into coupling and decoupling relation with said work at predetermined points in said operating cycle of said conveyor means, and re-

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versible driving means disposed externally of the heating chamber for operating said conveyor means, said reversible driving means comprising a reversible electric motor the operation of which is controlled by cam operated switches and constructed for operation in one direction to control the operation of said coupling structure relative to movement of said conveyor means to produce in sequence coupling of said work by said coupling structure to said conveyor means at the vestibule and transfer thereof to the heating chamber for heat treatment and thereafter upon subsequent operation of said reversible driving means in the other direction the coupling movements are controlled to produce return of the work to the vestibule by said conveyor means and decoupling thereof from said conveyor means to complete said predetermined cycle.

19. Transfer mechanism according to claim 18 wherein said conveyor means comprises reciprocable rod structure normally extending through one wall of the heating chamber and periodically movable through a door adjacent said vestibule to move said coupling structure into engagement with the work in said vestibule.

20. Transfer mechanism for moving work in substantially a straight line from one work station to another and return comprising reciprocable shaft-like structure, guide means for said structure, reversible power supplying means having a driving connection with and for either direction of a period of continuous operation thereof producing motion of said structure longitudinally with relation to the path through which work is moved for a predetermined cycle, a work engaging element carried by said reciprocable shaft-like structure, and said work engaging element having a driving connection with means automatically operating in timed relation with and in a predetermined phase relation with said reversible power supplying means dependent upon the direction of operation thereof to move said element into engaging and disengaging relation with said work at predetermined points in said operating cycle of said reciprocable shaft-like structure, the direction of operation of said reversible power supplying means automatically controlling the phase relation of the operation of said engaging means to transfer said work in sequence from said one station to said other station and thereafter returning said work to said one station.

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