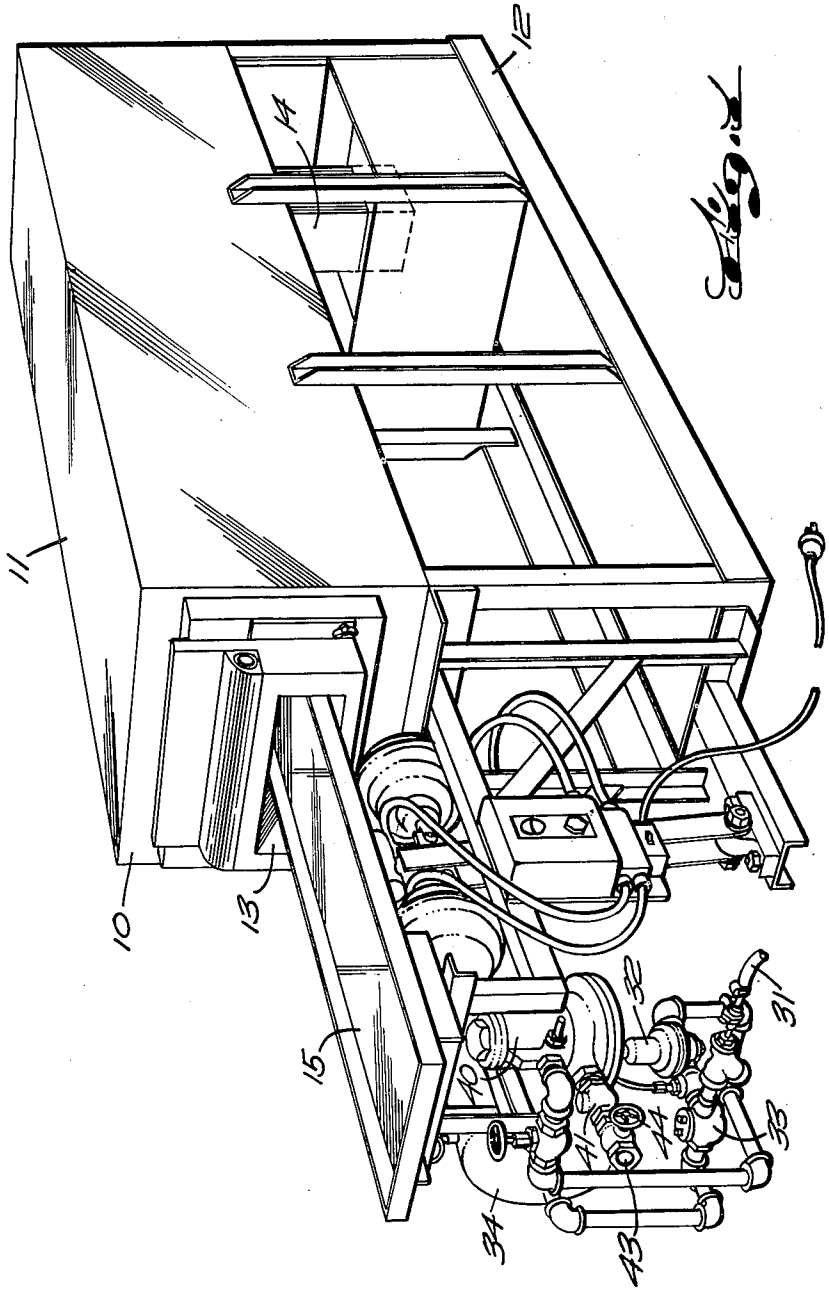
June 17, 1952 W. R. GILBERT 2,600,401

RECIPROCATING HEARTH MECHANISM

Filed Jan. 15, 1947 5 Sheets-Sheet 1



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RECIPROCATING HEARTH MECHANISM

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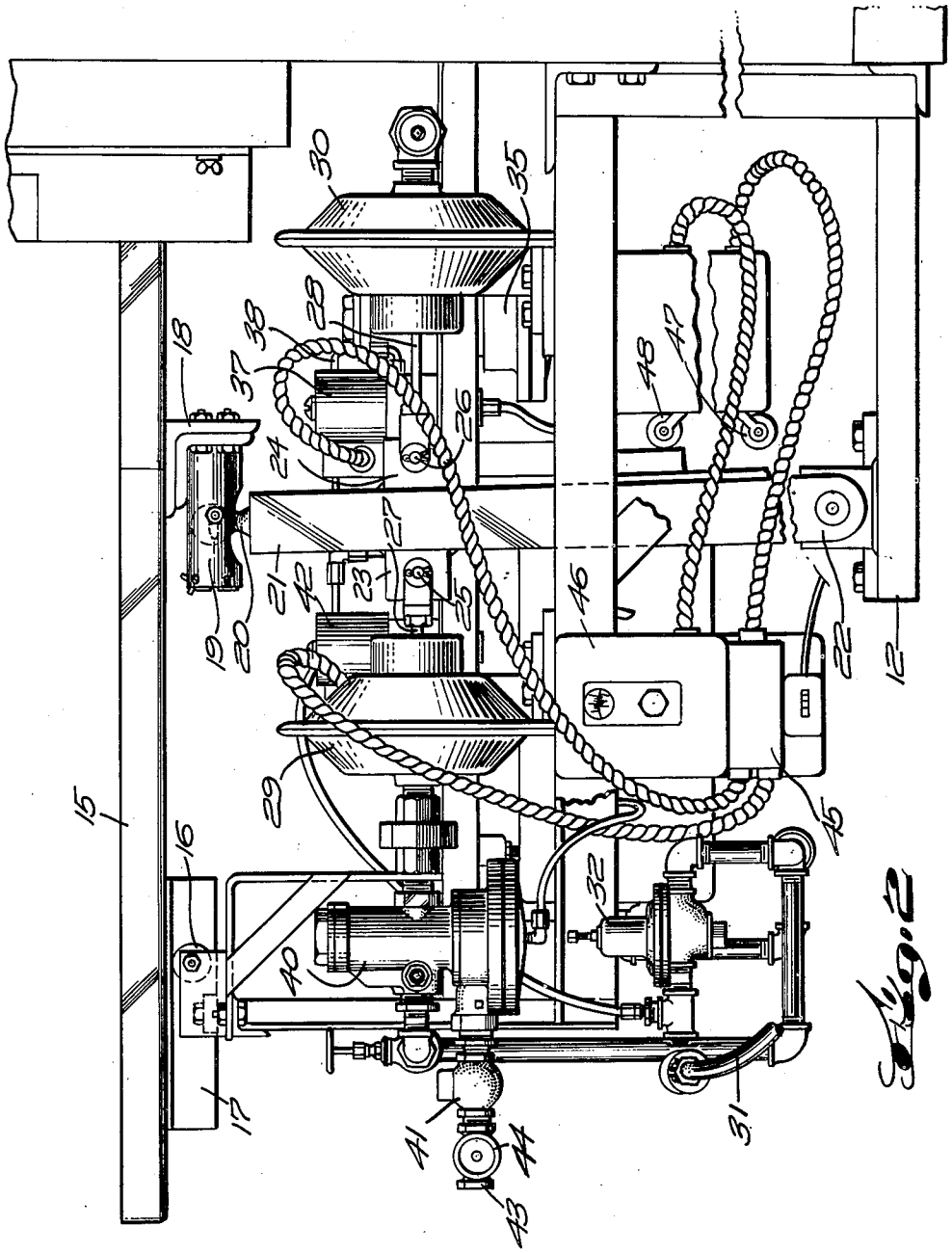


Fig. 2

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RECIPROCATING HEARTH MECHANISM

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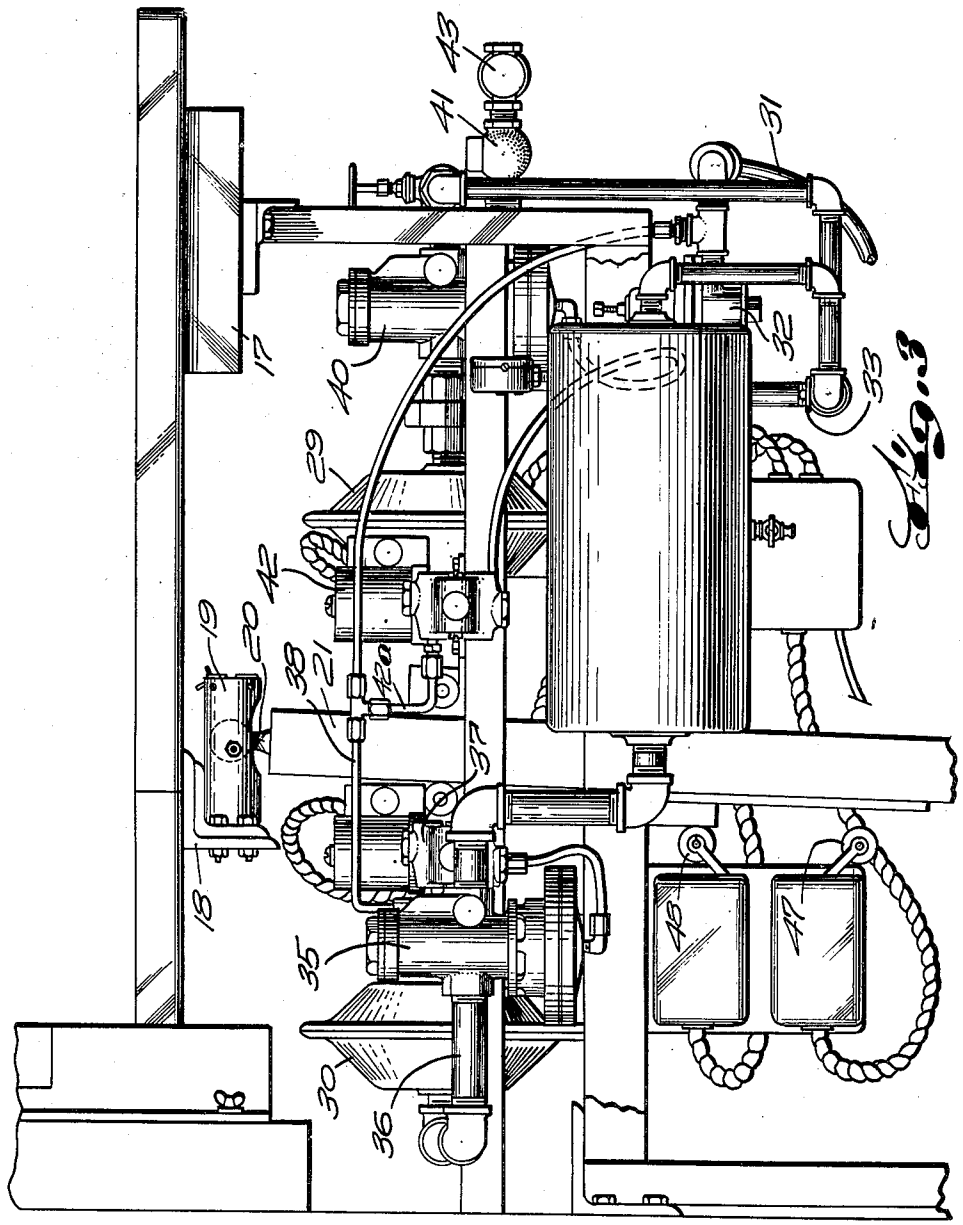


Fig. 3

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RECIPROCATING HEARTH MECHANISM

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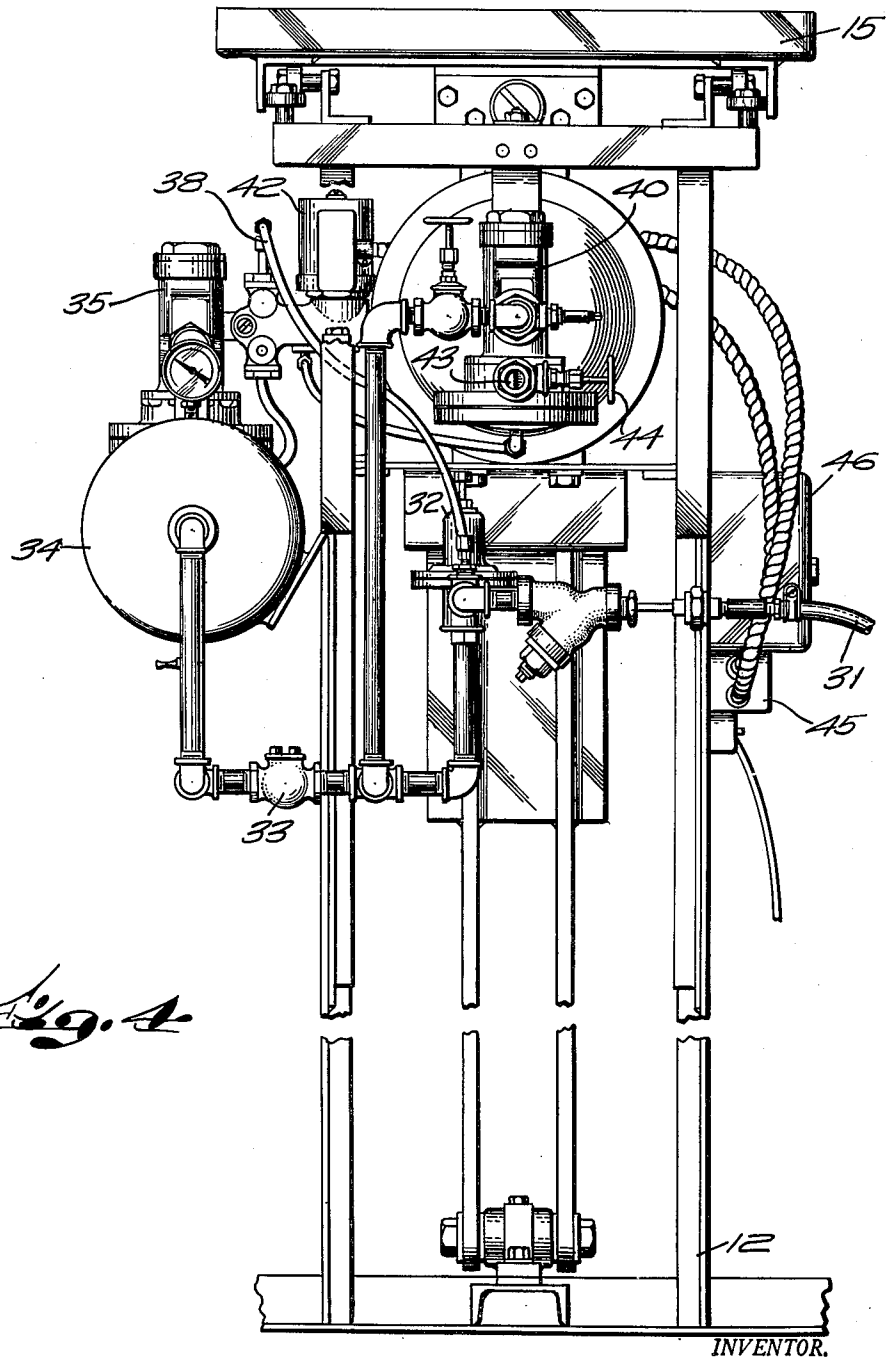


Fig. 1

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June 17, 1952 W. R. GILBERT 2,600,401

RECIPROCATING HEARTH MECHANISM

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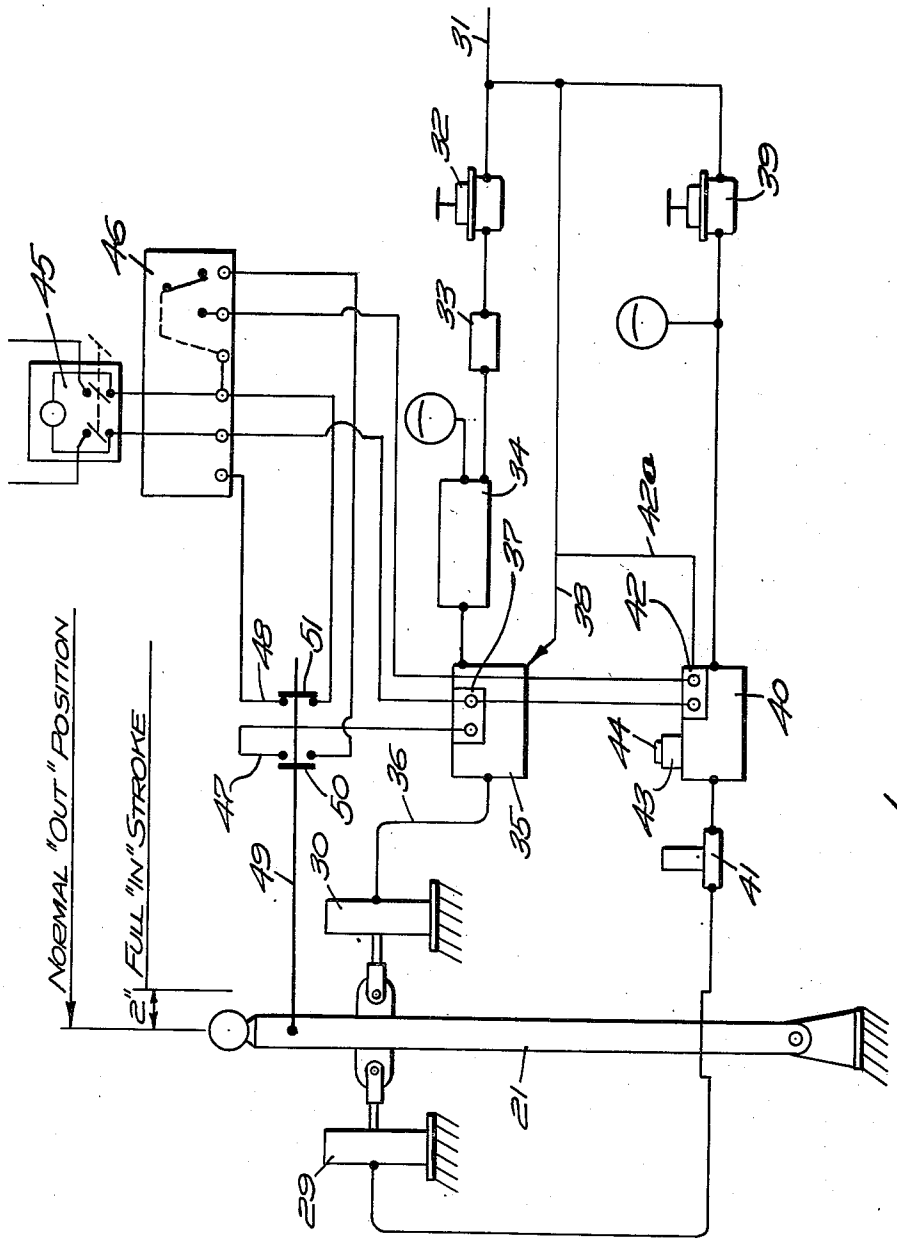


Fig. 5

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Patented June 17, 1952 2,600,401

UNITED STATES PATENT OFFICE

2,600,401

RECIPROCATING HEARTH MECHANISM

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Application January 15, 1947, Serial No. 722,202

8 Claims. (Cl. 198—220)

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The present invention relates to the heat treatment art, and has particular reference to a novel work conveyor arrangement for a heat treatment furnace.

The principal object of the invention is to provide a movable hearth which conveys work to be heat treated through the heat treatment furnace in a series of forward steps.

Another object of the invention is to progressively convey work to be heat treated through a heat treatment furnace in a series of controlled intermittent movements.

Still another object is to provide an intermittent propulsion system for work to be conveyed through a heat treatment furnace, utilizing hydraulic actuating motors.

With the above and other objects and advantageous features in view, the invention consists of a novel arrangement of parts more fully disclosed in the detailed description following, in conjunction with the accompanying drawings, and more specifically defined in the claims appended thereto.

In the drawings:

Fig. 1 is a perspective view of a conveyor type heat treatment furnace, disclosing a reciprocable work carrier hearth and its actuating mechanism;

Fig. 2 is a left side view of the actuating mechanism;

Fig. 3 is a right side view of the actuating mechanism;

Fig. 4 is a front elevation of the actuating mechanism; and

Fig. 5 is a diagrammatic view disclosing the relative arrangement of the actuating and control parts.

It has been found desirable to provide a regulatable intermittent actuation for the work carrying hearth of a heat treatment furnace for periodically advancing the work through the furnace. To this end, I position two hydraulic devices, such as air pressure diaphragm motors, which move the hearth forwardly at predetermined time intervals, and then quickly return the hearth rearwardly at high speed, whereby the work is periodically advanced by its forward momentum and inertia. I have found it advisable to apply pressure fluid to the forward actuation motor to obtain an accelerated forward stroke, and then to apply high pressure fluid to the return actuation motor to abruptly decelerate and return the hearth to its initial position; and I have found it preferable to set up a back pressure in the forward actuation motor to operate as a cushion or damper, while relieving excess

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pressure in this motor to prevent an excessive back pressure.

Referring to the drawings, the heat treatment furnace 10 may be of any desired type, electric heating being preferred, and has a heat treatment chamber 11 mounted on a supporting frame 12, the heat treatment chamber 11 having an entrance opening 13 through which the work to be heat treated is received; the heat treated work passes through an exit chute 14 from the rear and into an air cooling or fluid quenching compartment of standard type.

The lower portion of the heat treatment chamber has a movable hearth 15 which projects rearwardly through the entrance 13 and extends forwardly to the exit opening of the chute 14. It is preferred to provide the entrance opening with a curtain of protective gases, such as combusted gases, and thus exclude atmospheric air from the heat treatment chamber, in the manner shown in Hayes Patents Nos. 1,724,583 and 1,808,721; the exit opening may be sealed by having the work exit below the surface of the quenching medium, or the work may be passed into a suitable cooling compartment for slow cooling.

The movable hearth 15 is slidably mounted at each end on roller bearings 16, see Fig. 2, which are rotatably set in supports 17 or the like forming part of the frame 12; an angle iron base 18 is secured to the under side of the hearth and carries an end member 19 which is secured for swivel movement on the upper end 20 of an actuator bar 21. The actuator bar is pivotally mounted at its lower end 22 to the frame 12, and has two aligned blocks 23, 24 on its sides intermediate its ends, as shown in Fig. 2, pivot pins 25, 26 being rotatably mounted in the blocks and being respectively connected to the piston rods 27, 28 of two fluid actuated motors 29, 30, which are preferably of the diaphragm type and which form a coupled hydraulic reciprocating device, the motor 30 being a high pressure motor and the motor 29 a low pressure motor.

Actuating fluid, preferably high pressure air, is conveyed through conduit 31 to the motors 29, 30, to periodically reciprocate the actuator bar 21 and the hearth 15. The actuating fluid for the high pressure motor 30 passes through a reducing valve 32 and a check valve 33 to a storage or accumulator tank 34, and then through a three-way valve 35 of the diaphragm type, and a high pressure connection 36 to the high pressure motor 30. The valve 35 is preferably controlled by a solenoid pilot valve 37 of stand-

ard type which has a high pressure connection 38. Exhaust is through the valve 35 to atmosphere, preferably through a muffler, not shown.

The actuating fluid for the low pressure motor 29 passes from the conduit 31 through the reducing valve 32, which may be a separate reducing valve if desired, as designated by the reference numeral 39 in Fig. 5, a three-way diaphragm valve 40, and a regulatable safety relief valve 41 to the low pressure motor 29; the valve 40 is controlled by a solenoid pilot valve 42 through a connection 42*a*, and has an exhaust outlet connection 43 with a regulatable opening 44, to obtain a desired back pressure in the low pressure motor. The exhaust from the low pressure valve is also preferably through a muffler to atmosphere.

Referring to Fig. 5, the diaphragm valves 35 and 40 are controlled from a main switch 45, which closes an electric operating circuit through a timer 46 of standard type which operates the solenoid valves 37, 42 in conjunction with the limit switches 47, 48. These switches are opened and closed by means of a rod 49 secured to and movable with the actuating bar 21, the rod having contact disks 50, 51, and the movable parts of the switch being spaced to provide a lag between the closing of one switch and the opening of the other.

When the main switch 45 is closed, the timer 46 functions to cause operation of the solenoid valve 42 and thus open the valve 40 to admit low pressure fluid, for example up to thirty pounds, to the low pressure motor 29. This causes the diaphragm therein to move the actuating bar 21 at an accelerating low or medium speed, thus moving the work carrying hearth and the work thereon forwardly into the heat treatment chamber.

The forward movement of the actuating bar moves the rod 49 forwardly and first opens the limit switch 48 and then closes the limit switch 47, whereby the timer shifts the solenoid valve 42 to open the valve 40 to exhaust and shifts the solenoid valve 37 to open the valve 35 to intake.

When the limit switch 48 is open and the valve 40 is opened to exhaust, the lower pressure air begins to exhaust from the low pressure motor, but the momentum of the hearth and the remaining fluid pressure in the motor still carries the hearth forwardly for a short distance. The later closing of the limit switch 47 now operates the high pressure solenoid valve 37 to actuate the valve 35 and open it to intake before the hearth has stopped moving forwardly, and the admission of high pressure fluid to the high pressure motor causes a quick deceleration and a quick rearward movement of the actuating bar and the hearth, whereby the hearth is jerked back but the work stays in its forwardly moved position due to its momentum and inertia, to be again moved forwardly on the next forward movement of the hearth.

Since the sudden rearward movement of the actuating bar tends to produce a compression in the low pressure motor, the relief valve 41 vents any excess pressure while allowing enough air to remain and to function as a dashpot which cushions the end of the high pressure return, the size of the exhaust outlet opening 44 being regulated to provide a desired amount of cushioning.

The return movement of the actuating bar 21 first opens the limit switch 47 which deenergizes solenoid valve 37 and then closes the limit switch 48 which initiates a new cycle, thus causing high pressure exhaust and then low pressure intake after a predetermined interval, in accordance with the setting of the timer.

Summarizing the operation, the advance of work upon the hearth is brought about as follows: The hearth is normally at rest between cycles in its extreme rear or out-stroke position. Each cycle consists of a rapidly accelerating forward in-stroke, with acceleration less than that which would cause the work to slip backwards on the hearth; and a very sharp change of direction at the end of the forward in-stroke, such that the work cannot follow the change and slips forward; the completion of the rear out-stroke follows, with deceleration such that the hearth comes to rest with no tendency for the work to slip backwards. The complete cycle is factory adjusted to move average work 2 to 3 inches per cycle, and the frequency of recurrence of the cycles is controlled by the dial setting of the cycle timer, and may be varied from 2 to 60 seconds of rest between cycles. This will provide an operating work travel of from 2 to 60 inches per minute for average work; extremely light work will move at slower speeds, and work that has a tendency to roll requires special handling for the tail end of the load. A suitable capacity for normal operation is in the order of 15 lbs. per linear ft. for furnace hearths up to 10 ft. long.

When the control power is turned on, or when the timer times out rest period, the circuit is closed to the forward stroke solenoid air valve. This admits air to the forward stroke actuator, which moves the hearth toward the furnace. The air pressure to this actuator is controlled by the individual regulating valve, which has been factory pre-set to a secondary pressure that will give the correct forward stroke acceleration. Air continues to enter the forward stroke actuator through a fixed portion of the forward stroke travel, at which point the first limit switch opens to reset the timer, which in turn opens the circuit to the forward stroke solenoid valve. This solenoid valve transfers the forward stroke actuator from regulated pressure to pre-adjusted exhaust, but there is sufficient expanding air in the forward stroke actuator to complete the forward stroke. At a further point of forward stroke travel, the second limit switch closes, energizing the solenoid valve that transfers the rear stroke actuator from exhaust to regulated pressure. The air pressure to this actuator is also controlled by the regulating valve which has been factory pre-set to the correct pressure to give the desired rapid change of direction of the hearth. The hearth forward stroke is now rapidly decelerated and a rapidly accelerating rear stroke is immediately started. As the rear stroke progresses, the rear stroke limit switch opens, de-energizing the rear stroke solenoid valve and transferring the rear stroke actuator from regulated pressure to full exhaust. Before this actuator can exhaust completely, the expanding air gives the hearth sufficient momentum to complete the rear stroke. As the rear stroke progresses, the forward stroke limit switch closes, starting the timer for the timed period of hearth-at-rest. The deceleration of the hearth to rest at the completion of the rear stroke is controlled by allowing a certain portion of the air in the forward stroke actuator exhaust line to blow off through the pre-set safety valve, and the balance to escape through the factory set orifice to cushion the hearth to a smooth stop at the end of the rear stroke. The hearth remains in the rear stroke position until the timer times out and another cycle is started.

The improved intermittent actuation thus provides a step by step forward movement of work to be heat treated through the heat treatment chamber, the timing of the forward movement being controlled by the timer to provide the most desirable total duration for the heat treatment.

Although I have described a specific constructional embodiment of the invention, it is obvious that changes in the size, shape, arrangement and operation of the parts may be made to suit the requirements for different intermittent work conveying movements, without departing from the spirit and the scope of the invention as defined in the appended claims.

I claim:

1. In a heat treatment furnace, a reciprocable hearth, an actuator device operatively connected to said hearth, coupled high and low pressure hydraulic motors connected to said actuator device for reciprocating said hearth to obtain an accelerating forward movement and a quick decelerating and return movement, means for admitting pressure fluid to said motors in alternative timed relation, means for exhausting the low pressure motor fluid and admitting high pressure fluid to the high pressure motor just prior to the end of forward movement of the hearth, said low pressure motor fluid being exhausted through a regulatable outlet, and said low pressure motor having a relief valve to prevent excess pressures therein during the return movement.

2. In combination, a reciprocable hearth for the heat treatment chamber of a heat treatment furnace, an actuator for reciprocating said hearth, a low pressure motor and a high pressure motor connected to said actuator, a diaphragm valve for controlling inflow and outflow of hydraulic fluid to said low pressure motor, a solenoid pilot valve for said valve, a diaphragm valve for controlling inflow and outflow of hydraulic fluid to said high pressure motor, a solenoid pilot valve for said second valve, and electric timer means for periodically actuating said solenoid pilot valves to admit low pressure fluid to the low pressure motor for moving the actuator and hearth forward, to exhaust the low pressure fluid from the low pressure motor, and admit high pressure fluid to the high pressure motor for moving the actuator and hearth on a return stroke, and to exhaust the high pressure fluid from the high pressure motor and admit low pressure fluid to the low pressure motor to repeat the cycle of reciprocation of the hearth.

3. In combination, a reciprocable hearth for the heat treatment chamber of a heat treatment furnace, an actuator for reciprocating said hearth, a low pressure motor and a high pressure motor connected to said actuator, a valve for controlling inflow and outflow of hydraulic fluid to said low pressure motor, a valve for controlling inflow and outflow of hydraulic fluid to said high pressure motor, solenoid pilot valves for controlling said valves, and means for periodically actuating said solenoid pilot valves to admit low pressure fluid to the low pressure motor for moving the actuator and hearth forwardly at an accelerated speed, to exhaust the low pressure fluid from the low pressure motor, and admit high pressure fluid to the high pressure motor for decelerating the actuator and hearth and moving the actuator and hearth rearwardly, and to exhaust the high pressure fluid from the high pressure motor and admit low pressure fluid to the low pressure motor to repeat the cycle of reciprocation of the hearth.

4. In combination, a reciprocable hearth for the heat treatment chamber of a heat treatment furnace, an actuator for reciprocating said hearth, a low pressure motor and a high pressure motor connected to said actuator, a valve for controlling inflow and outflow of hydraulic fluid to said low pressure motor, a valve for controlling inflow and outflow of hydraulic fluid to said high pressure motor, and means for periodically actuating said valves to admit low pressure fluid to the low pressure motor for moving the actuator and hearth forwardly at an accelerating speed, to exhaust the low pressure fluid from the low pressure motor, and admit high pressure fluid to the high pressure motor for decelerating the actuator and the hearth and moving the actuator and hearth on a return stroke, and to exhaust the high pressure fluid from the high pressure motor and admit low pressure fluid to the low pressure motor to repeat the cycle of reciprocation of the hearth, said valve actuation being adjusted to initiate the return movement just before completion of the forward movement, said low pressure motor having a relief valve to prevent excessive pressure rise therein.

5. In combination, a reciprocable hearth for the heat treatment chamber of a heat treatment furnace, an actuator for reciprocating said hearth, a low pressure motor and a high pressure motor connected to said actuator, valves for controlling inflow and outflow of hydraulic fluid to said low and high pressure motors, solenoid pilot valves for said valves, and electric timer means for periodically actuating said solenoid pilot valves to admit low pressure fluid to the low pressure motor for moving the actuator and hearth forwardly at an accelerating speed, to exhaust the low pressure fluid from the low pressure motor, and admit high pressure fluid to the high pressure motor for decelerating the actuator and hearth and moving the actuator and hearth rearwardly, and to exhaust the high pressure fluid from the high pressure motor and admit low pressure fluid to the low pressure motor to repeat the cycle of reciprocation of the hearth, said low pressure motor having a relief valve to prevent excessive pressure rise therein.

6. In combination, a reciprocable hearth for the heat treatment chamber of a heat treatment furnace, an actuator for reciprocating said hearth, a low pressure motor and a high pressure motor connected to said actuator, a solenoid actuated valve for controlling inflow and outflow of hydraulic fluid to said low pressure motor, a solenoid actuated valve for controlling inflow and outflow of hydraulic fluid to said high pressure motor, and electric timer means for periodically operating said valves to admit low pressure fluid to the low pressure motor for moving the actuator and hearth forwardly at an accelerating speed, to exhaust the low pressure fluid from the low pressure motor, and admit high pressure fluid to the high pressure motor for decelerating the actuator and hearth and moving the actuator and hearth rearwardly, and to exhaust the high pressure fluid from the high pressure motor and admit low pressure fluid to the low pressure motor to repeat the cycle of reciprocation of the hearth, said low pressure valve having a controlled exhaust outlet connection.

7. In combination, a reciprocable hearth for the heat treatment chamber of a heat treatment furnace, an actuator for reciprocating said hearth, a low pressure motor and a high pressure motor

connected to said actuator, a valve for controlling inflow and outflow of hydraulic fluid to said low pressure motor, a valve for controlling inflow and outflow of hydraulic fluid to said high pressure motor, and means for periodically actuating said valves to admit low pressure fluid to the low pressure motor for moving the actuator and hearth forwardly at an accelerating speed, to exhaust the low pressure fluid from the low pressure motor, and admit high pressure fluid to the high pressure motor for decelerating the actuator and hearth and moving the actuator and hearth rearwardly, and to exhaust the high pressure fluid from the high pressure motor and admit low pressure fluid to the low pressure motor to repeat the cycle of reciprocation of the hearth, said valve actuation being adjusted to initiate the return movement just before completion of the forward movement, said low pressure motor having a relief valve to prevent excessive pressure rise therein, and said low pressure valve having a controlled exhaust outlet connection.

8. In combination, a reciprocable hearth for the heat treatment chamber of a heat treatment furnace, an actuator for reciprocating said hearth, a low pressure motor and a high pressure motor connected to said actuator, a solenoid actuated valve for controlling inflow and outflow of hydraulic fluid to said low pressure motor, a solenoid actuated valve for controlling inflow and outflow of hydraulic fluid to said high pressure motor, and electric timer means for periodically operating said valves to admit low pressure fluid to the low pressure motor for moving the actuator and hearth forwardly at an accelerating speed, to exhaust the low pressure fluid from the low pressure motor, and admit high pressure fluid to the high pressure motor for decelerating the actuator and hearth and moving the actuator and hearth rearwardly, and to exhaust the high pressure fluid from the high pressure motor and admit low pressure fluid to the low pressure motor to repeat the cycle of reciprocation of the hearth, said low pressure motor having a relief valve to prevent excessive pressure rise therein, and said low pressure valve having a controlled exhaust outlet connection.

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