

March 27, 1962

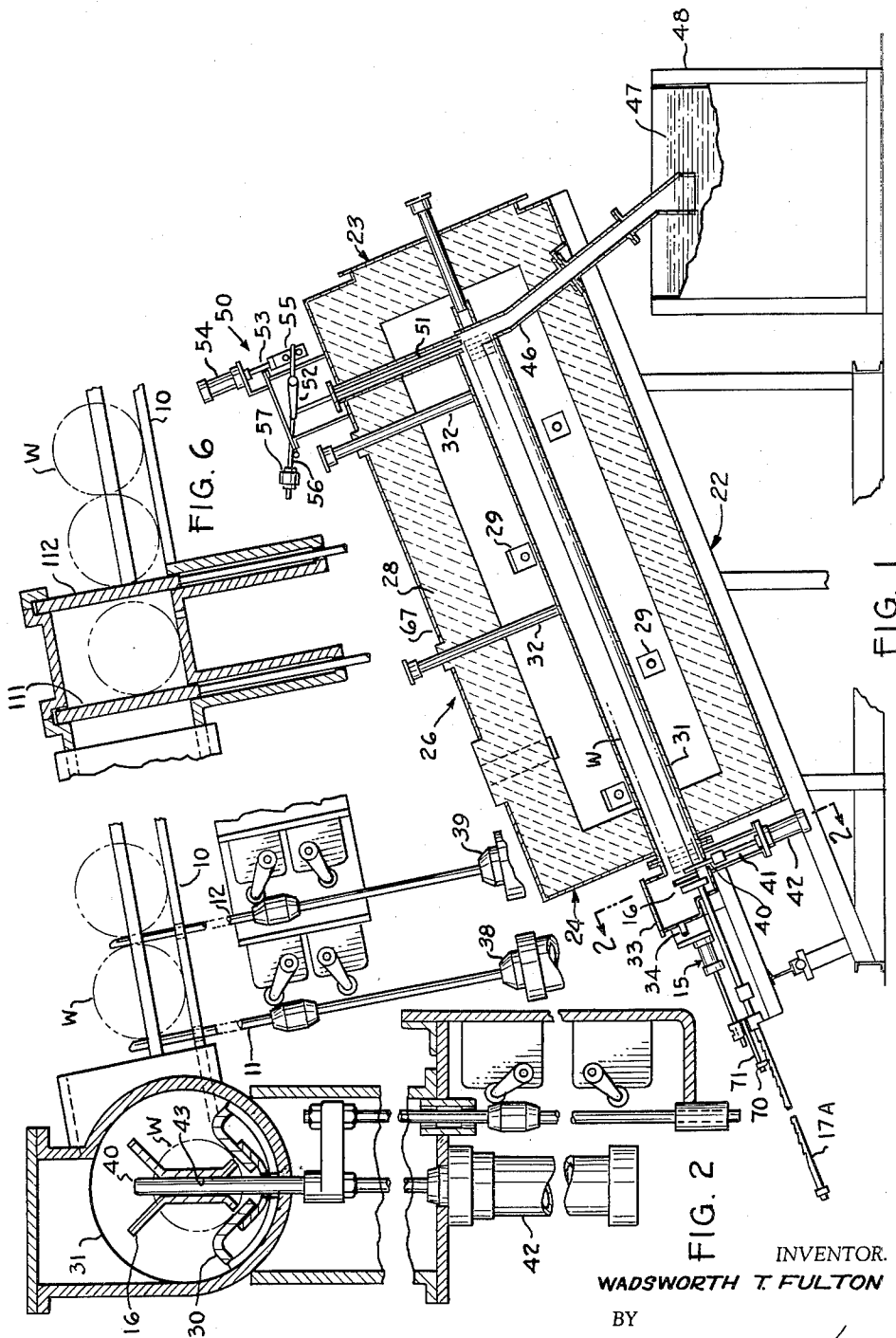
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3,027,149

INCLINED HEAT TREATING FURNACE

Filed April 24, 1958

4 Sheets-Sheet 1



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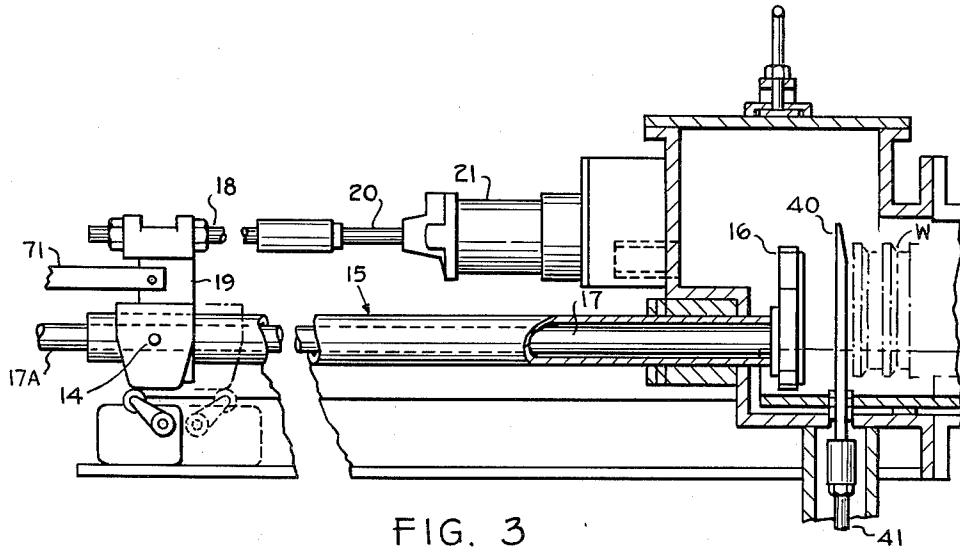


FIG. 3

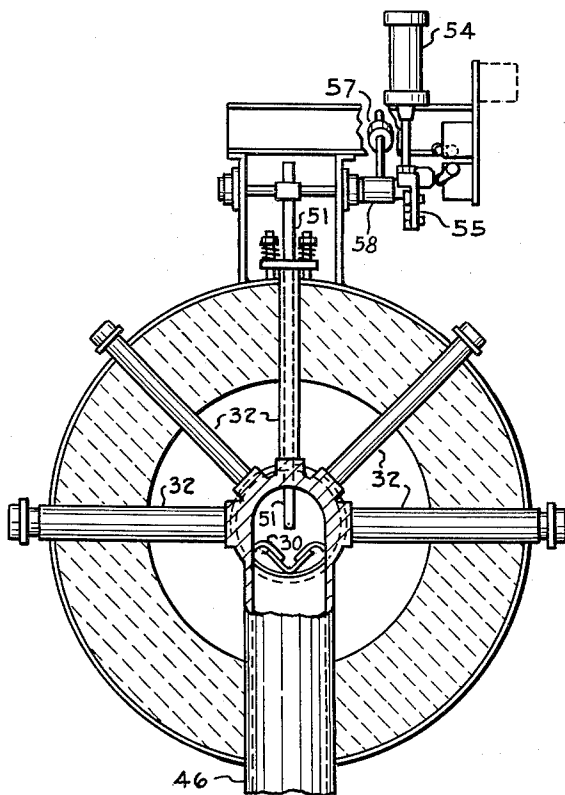


FIG. 4

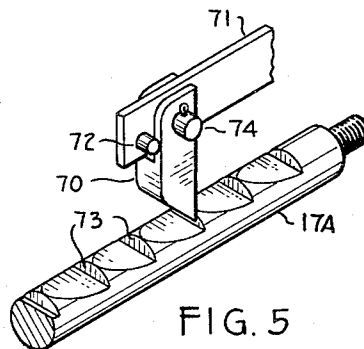


FIG. 5

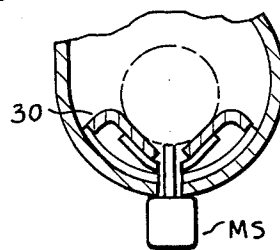


FIG. 10

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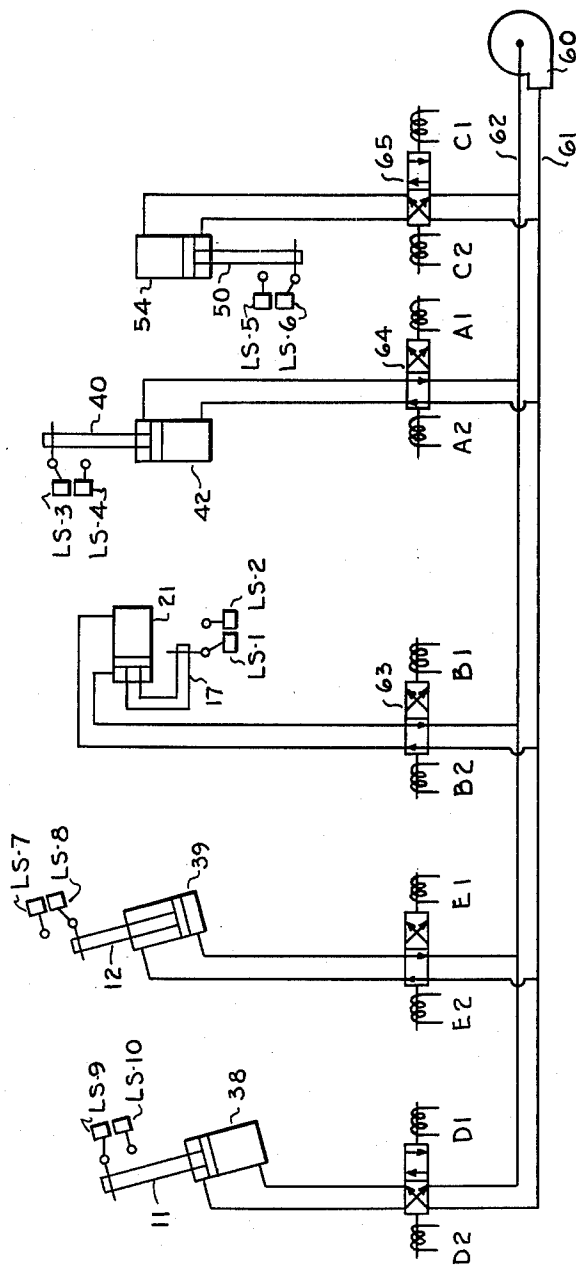


FIG. 7

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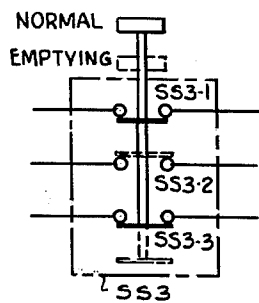
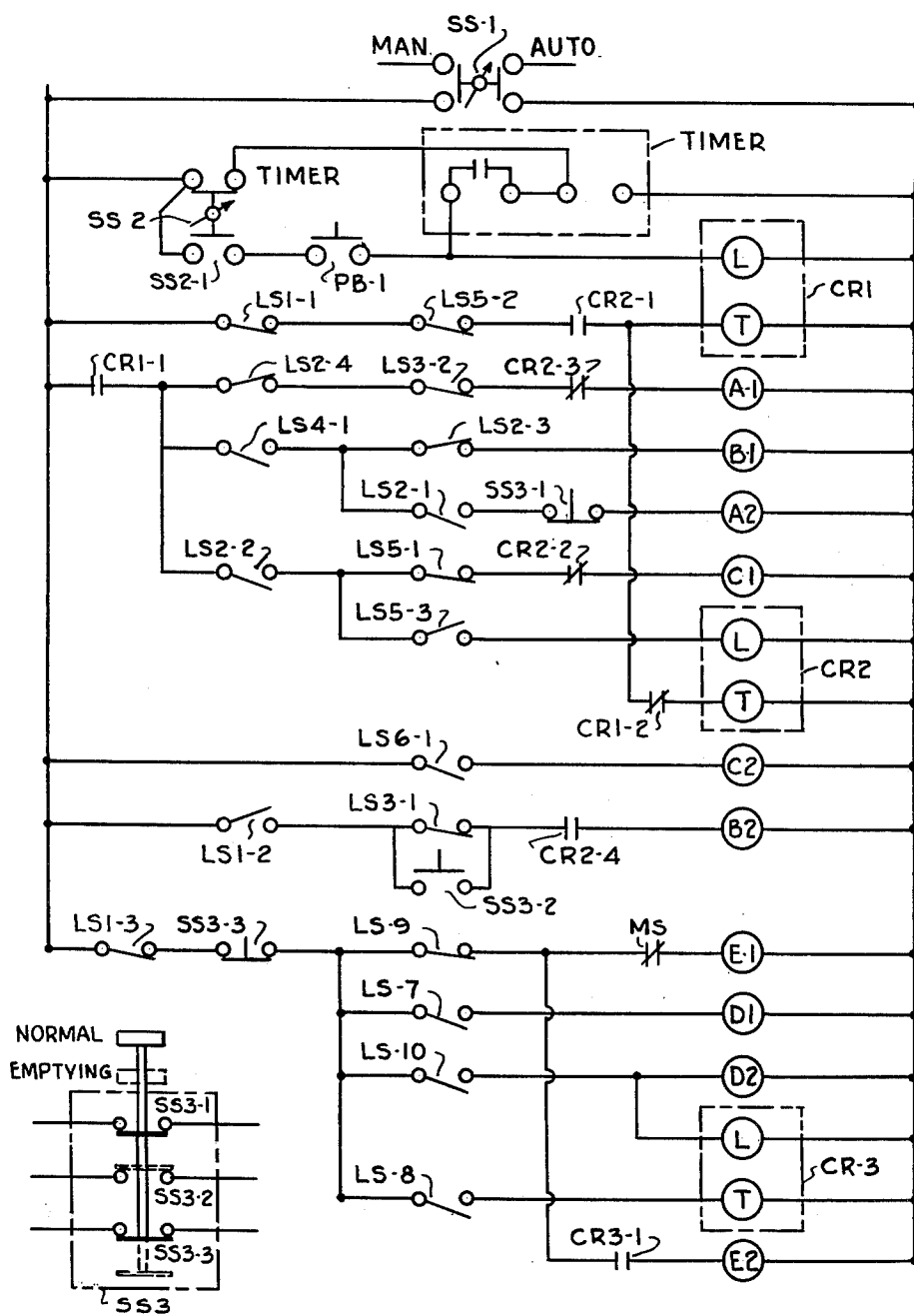
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INCLINED HEAT TREATING FURNACE

Filed April 24, 1958

4 Sheets-Sheet 4



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INCLINED HEAT TREATING FURNACE

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Filed Apr. 24, 1958, Ser. No. 730,608

1 Claim. (Cl. 263—6)

This invention relates generally to heat treating apparatus and particularly, although not limited thereto, to apparatus for automatically heat treating bearing races, and other metal articles having relatively small edge surfaces and having a tendency to topple when placed on edge and pushed.

In the heat treating of articles having relatively small edge surfaces, it is common to lay the articles on a broad side and push the work slowly through the furnace. Such arrangement requires an unduly long furnace which consumes premium manufacturing space. If such articles of work are placed on edge in a horizontal furnace, the work topples and falls upon an attempt to push it through the furnace. While vertical furnaces, in which work is pushed upwardly by elevating mechanism, do not present this problem of toppling, other disadvantages concomitant with such furnaces are at least twofold: the entire work load must be borne by the elevating mechanism; and complicated means for discharging individual articles are required.

It is accordingly an object of this invention to provide an improvement in apparatus for heat treating a row of articles, placed on edge, as they are pushed broad side in step-by-step fashion through a furnace in a manner whereby the entire load of a row of work articles is not continuously borne by the pushing mechanism and the individual articles are discharged by gravity, the aforesaid improvement relating to means to empty the apparatus of articles.

The present invention is directed to an improvement in heat treating apparatus, the heat treating apparatus comprising a feeding magazine section, pusher mechanism, work row holding mechanism, a furnace section with inclined work support means, and a discharge section. The work is placed in the magazine section from whence it is automatically fed, in timed sequence to the pusher mechanism, in a direction such that the broad side of the work is transverse to the longitudinal axis of the furnace. The pusher mechanism pushes the individual work pieces past the work row holding mechanism, when in a withdrawn position, up the inclined work support means in predetermined increments to form a row of work. As the pusher mechanism is withdrawn, in timed relation the work holding mechanism engages the last pushed work piece to prevent the row from sliding backwardly. As the pusher mechanism is further withdrawn, another work piece is automatically fed from the magazine in front of the pusher mechanism to be subsequently pushed to the furnace section and form part of the row. This operation is continuously repeated to increase the length of the row until the work support is completely filled. Upon subsequent advancement of the row, as a new work piece is introduced to the row, the first work piece is discharged by gravity down suitable guide means, preferably in the form of an enclosed chute, to the quenching medium or any other subsequent operation.

The length of the furnace and the rate of pushing are interrelated to expose the work for a predetermined time to heat in order to attain the desired work temperature.

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The heat supply to the furnace may be furnished by any suitable means. When the heat source is radiant, as by electrical means, only guide rails need be provided to support the work as it is transferred through the furnace. However, when direct fired gas burners are employed as the source of heat, the work may be enclosed in a muffle within the furnace to protect the work from undesirable atmosphere contaminants. The muffle may encompass the work and support rails, or may serve directly as the support means.

In some operations, the individual work pieces have a tendency to adhere to each other. In such cases, positive means for dislodging one piece from the other may optionally be provided at the discharge end of the furnace.

The specific improvement toward which this invention is directed comprises means for emptying the furnace during work stoppage or interruptions so that work already in the furnace will not be unduly exposed to over heating and consequent damage. The novel arrangement of the invention provides means for utilizing the reciprocating pusher mechanism to impart step-by-step advancing motion to the pusher head without intermediate retraction. To perform the emptying operation, the normally reciprocating rod to which the pusher head is attached is disconnected from the piston rod of the actuator, and an extension rod attached to the normally reciprocating rod. The pusher head may then be advanced manually, or, by applying an adaptor the pusher head may be advanced automatically.

Having summarized the operation of the apparatus of the invention, the various sections and means for carrying out the operation will now be described.

In the accompanying drawing forming a part of this specification:

FIGURE 1 is a cross-sectional elevational view of a pusher type furnace embodying the present invention;

FIGURE 2 is a transverse sectional view taken along line 2—2 of FIGURE 1 illustrating one form of escapement means and pusher head;

FIGURE 3 is an enlarged longitudinal view of the pusher and work holding mechanism;

FIGURE 4 is a transverse view at the discharge end of the furnace illustrating the mode of supporting the muffle and the dislodging means;

FIGURE 5 is a fragmentary perspective view of the novel adaptor means for emptying the furnace;

FIGURE 6 is a longitudinal sectional view illustrating an alternate escapement means which also functions as sealing means;

FIGURE 7 is a schematic representation of the fluid control apparatus for the furnace apparatus;

FIGURE 8 is a representation of the electrical control circuit for the furnace apparatus;

FIGURE 9 is schematic representation of the push-button selector switch SS3 of FIGURE 8 with the normal position indicated in solid lines and the emptying position indicated in discontinuous lines;

FIGURE 10 is a view showing the position of a switch which prevents undesirable feeding of work.

The work W is placed on edge in a suitable inclined magazine 10 wherein it advances by gravity to reciprocating stop 12. As the stop 12 is lowered the foremost work piece advances to reciprocating stop 11. The stop 11 is then lowered and concurrently the stop 12 is raised whereby the foremost work piece is released to a position for pushing and the remainder of the work is held for

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subsequent intermittent advancement as said prior foremost work piece. The rate of reciprocation of the stops 11 and 12 is controlled in timed relation with the pusher mechanism, generally designated by the numeral 15. The controls for achieving this timed relation will later be described.

The pusher mechanism 15 comprises a pusher head 16 mounted on the end of reciprocating rod 17. Rod 17 is operatively interconnected to piston rod extension 18 by bracket 19. Extension 18 is in turn suitably connected to piston rod 20 of fluid motor or actuator 21.

The furnace, generally indicated by the numeral 26, comprises a steel shell 67 lined with refractory 28. The heating source, in this case for purposes of illustration is shown as being direct fired burners 29. A V-channel 30 is provided to support the row of work as it progresses through the furnace. In the case where the furnace is direct fired, a muffle 31 circumposes the work to protect against possible contamination. The longitudinal axes of the support 30 and the furnace 26 are parallel to each other. Furnace 26 is supported by structure 22 which inclines the furnace at an angle to the horizontal, with discharge end 23 being higher than charge end 24. The angle of inclination is sufficient to overcome any tendency of the work pieces to topple on support 30 as they are pushed broad side through said furnace from the charge towards the discharge end of the furnace.

The muffle 31 may be supported by pipe hangers 32, as in FIGURE 4, or any other suitable means. The advantage of using pipe hangers 32 as support means is that one or more of them may also be used as sighting holes for viewing the work within the furnace.

An atmosphere gas introductory chamber 33 may be provided at the charge end of the muffle 31 to which atmosphere gas is introduced by conduit 34 from any suitable source. The gas subsequently flows upwardly into the muffle 31 to form a protective atmosphere for the work as it is being heat treated.

As the work is advanced into the muffle 31 to form a row, appropriate means must be provided to retain the row in the advanced position in order to permit the introduction of additional work pieces to the pusher mechanism. Accordingly a reciprocating stop member or hold finger 40 is provided. Finger 40 is suitably connected to piston rod 41 of fluid motor or actuator 42 which is operated in timed sequence with the pusher mechanism 15 to permit the work piece immediately before the pusher head 16, to form part of the row.

The pusher head 16 may be bifurcated as shown in FIGURE 2 or slotted and be of sufficient width that the finger 40 may be advanced within the opening 43 and retain the work row before the pusher head 16 is withdrawn, thus limiting the backslide of the work row.

Upon reaching the discharge end of the furnace, the individual work pieces are discharged by gravity down an enclosed chute 46 which extends below the quenching medium 47 in quench tank 48 thus forming a seal to prevent infiltration of air to the muffle 31.

In those operations where the individual work pieces tend to adhere to each other, breaker means, generally designated by the numeral 50, may be provided. The breaking means disclosed comprises a breaker finger 51 suitably suspended from a pivotable arm 52 over the furnace 26. The arm 52 is pivoted by piston rod 53 of fluid actuator 54 through linkage 55 to raise the finger 51. A counter weight 57 is provided on arm 56 to rotate shaft 58 upon which arm 52 is also mounted to drop the finger 51 into breaking position in timed sequence with the pusher mechanism 15.

The fluid circuit, which may be hydraulic or pneumatic, is illustrated in FIGURE 7, as being hydraulic, where a pump 60 is interposed between supply and return lines 61 and 62, respectively. The fluid motors 21, 42, and 54 actuate respectively the pusher 15, the stop member 40, and the breaker finger 51 while fluid motors 38 and

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39 may be used to actuate fingers 11 and 12. The control valve 63 for the pusher 15 has solenoid valves B1 and B2 for moving the valve 63 to its forward and reverse pusher positions. The fluid motor 42 for stop member 40 is controlled by valve 64 which has solenoid valves A1 and A2 for moving the valve 64 to the up and down finger positions. The fluid motor 54 of breaker means 50 is controlled by valve 65 with solenoid valves C1 and C2 for moving the valve 65 to the in and out positions. The motions of the fluid motors are integrated by an electrical control system, including limit switches LS-1 and LS-2 contacted by pusher 15, limit switches LS-3 and LS-4 contacted by stop member 40 and limit switches LS-5 and LS-6 contacted by breaker means 50.

The electrical control system, illustrated schematically in FIGURE 8, utilizes control relays CR1 and CR2 which have latch and trip coils L and T and a two-position selector switch SS1, marked manual and automatic. At the start of the cycle, the various mechanisms are in the following positions:

Stop member 40-in (holding work)
Pusher 15-out
Breaker finger 51-out
Selector switch SS1-automatic
Selector switch SS2-timer
Push button selector switch SS3-normal

The cycle is initiated by setting the timer for the desired time; the setting of the timer includes the running time as well as the idle time between cycles. At the expiration of the time set on the timer, contacts SS2-1 in the timer closes and control relay CR1 latches and closes contact CR1-1 while control relay CR2 opens.

When contact CR1-1 closes to energize solenoid valve A1, stop member 40 starts to move out and releases limit switch LS3. When limit switch LS3 is released, contacts LS3-1 and LS3-2 are opened. At the end of the withdrawing motion of stop member 40 limit switch LS4 is contacted and contact LS4-1 closed.

Upon opening of contact LS3-2 and closing of contact LS4-1, solenoid valves A1 and B1 are respectively de-energized and energized. The energizing of valve B1 causes the pusher 15 to move in and release limit switch LS1, whereupon contacts LS1-1 opens, and contact LS1-2 closes. At the end of the inward pusher limit switch LS2 is contacted to close contacts LS2-1 and LS2-2, open contact LS2-3 de-energizing solenoid valve B1 and open contact LS2-4.

As contact LS2-1 is closed solenoid valve A2 is energized and stop member 40 moves in to release limit switch LS4 and open contact LS4-1 de-energizing solenoid valve A2. At the end of the inward motion of stop member 40 limit switch LS3 is contacted to close contacts LS3-1 and LS3-2.

Upon closing of contact LS2-2, solenoid valve C1 is energized to permit breaker finger 51 to move in, releasing limit switch LS5, closing contact LS5-3 and opening contacts LS5-2 and LS5-1 to de-energize solenoid valve C1. At the end of the inward motion of breaker finger 51, limit switch LS6 is contacted to close contact LS6-1.

Closing of contact LS5-3 causes control relay CR2 to latch and close contacts CR2-1 and CR2-4 and open contacts CR2-2 and CR2-3.

With contacts LS1-2, LS3-1 and CR2-4 closed, solenoid valve B2 is energized to move pusher 15 out releasing limit switch LS2, thus opening contacts LS2-1 and LS2-2 and closing contacts LS2-3 and LS2-4. With the opening of contact LS2-2, the coil of control relay CR2 is de-energized. At the end of the outward motion of pusher 15 limit switch LS1 is contacted to close contact LS1-1 and open contact LS1-2 whereupon solenoid valve B2 is de-energized.

The closing of contact LS6-1 energizes solenoid valve C2 to start the breaker finger moving out and releasing limit switch LS6 thus opening contact LS6-1 and de-en-

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energizing solenoid valve C2. At the end of the breaker finger outward motion limit switch LS5 is contacted, thus closing contacts LS5-1 and LS5-2 and opening contact LS5-3.

With contacts LS1-1 and LS5-2 closed control relay CR1 trips to open contact CR1-1 and close contact CR1-2, thereby tripping control relay CR2. When control relay CR2 trips, contacts CR2-2 and CR2-3 are closed while contacts CR2-1 and CR2-4 are opened. Upon opening of contact CR2-1 the trip coils CR1 and CR2 are de-energized.

The above is a description of one complete cycle. The cycle is repeated each time the cycle timer makes contact.

The above described controls synchronize the operation of the pusher, stop member and breaker finger. Where automatic feeding operation is desired the following described controls may be added to the control system to synchronize the feeding with the pushing of the work.

Because it is necessary to accomplish all of the feeding operations when the pusher is in the retracted position, the feeding operation will not commence until limit switch LS1 is contacted.

The magazine hold finger 11 is normally advanced to retain the column of work while the magazine hold finger 12 is normally withdrawn from the work. Thus when limit switch LS1 is contacted and contacts LS1-3 closed, solenoid valve E1 is energized to start finger 12 upward and retain all but the lowermost race. As finger 12 starts upwardly limit switch LS8 is released. At the end of the stroke limit switch LS7 is contacted to close its contacts and energize solenoid valve D1 to withdraw finger 11 and release the lowermost race to the pusher mechanism. As finger 11 is fully withdrawn LS10 is contacted, solenoid valve D2 is energized to send finger 11 immediately back; when limit switch LS10 is contacted control relay CR3 is latched. At the end of the upward stroke of finger 11, with contacts CR3-1 of control relay CR3 closed, and as limit switch LS9 closes, solenoid valve E2 is energized to withdraw finger 12 and release the work to allow the work to advance to finger 11. As the finger 12 is fully withdrawn, limit switch LS8 is contacted and control relay CR3 tripped to set the controls in their normal positions. At this time the pusher is advanced and when retracted again and limit switch LS1 is contacted the above feeding cycle is repeated.

To insure that the feeding cycle will not start to repeat while the pusher mechanism is retracted and a work piece is in position in front of the pusher head, normally closed switch MS may be placed beneath the feeding position as shown in FIGURE 10. When a piece is in position the switch MS will be opened to prevent the energizing of solenoid valve E1 and all further contingent operations.

Occasionally, it is necessary to empty the furnace because of work stoppages or interruptions. The pusher mechanism 15 may be disconnected by removing pin 14 and then an extension rod 17A secured to rod 17. The work pieces remaining in the furnace may then be pushed out manually. While an experienced operator may satisfactorily push such pieces manually, in some cases it is preferable to extract them automatically.

Novel means for continuing automatic emptying operation after the extension rod 17A is attached is shown in FIGURE 5. A pivotable adaptor member 70 is shown as being attached to stationary arm 71 by pin 74. The extension rod 17A may be provided with a series of serrations 73 which member 70 is adapted to engage and advance the extension rod 17A on a forward stroke. Adaptor 70 is retained in engagement with a serration 73 by means of stop 72. On the return stroke, the member 70 pivots about pin 74, rides over a serration into position for the next advancing position thus the extension rod 17A, and concomitantly the pusher rod 17 and pusher head 16, are carried to an advanced position on a forward stroke but are not carried by the adaptor 70

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on a retracting stroke. After the last remaining work piece is discharged, the pivotable adaptor 70 is disengaged and the pusher head 16 retracted to its normally retracted position.

In order to insure that the various mechanisms will not interfere with each other during the emptying procedure described above, selector switch SS-3 is incorporated in the electrical circuit to "lock out" the mechanisms which cause interference.

During the normal cycle contacts SS3-1 are closed to permit finger 40 to reciprocate; contacts SS3-2 are normally open; and contacts SS3-3 are closed to permit the feeding mechanism to function. If at any time it is desired to empty the furnace, with the extension rod attached, the operator may position the selector switch SS3 to the "emptying" cycle as indicated in FIGURE 9 by discontinuous lines and contacts SS3-1 will be opened to lock out finger 40; contacts SS3-2 will be closed to form a by-pass circuit around contacts LS3-1 and reverse the motion of piston rod 20 upon completion of its forward motion for advancing rod 17 through the furnace; and contacts SS3-3 will be opened to prevent any work from being fed into the pushing mechanism 15.

An alternate form of escapement means from the feed magazine 10 is shown in FIGURE 6. Gates 111 and 112 are provided and completely transverse the cross-sections of the enclosed portion of the feed magazine 10 when they are in an advanced position. Thus the gates 111 and 112 in addition to controlling the feeding of work to the pusher 15 in the same manner as stops 11 and 12 serve as sealing means to minimize the flow of air into the heating chamber or the flow of atmosphere gases outwardly.

The foregoing is an extensive disclosure of the principles involved in the present invention which will enable persons skilled in the art to take advantage of this invention in similar or equivalent forms.

What is claimed is:

Heat treating apparatus for heating a series of superimposed relatively thin articles comprising, in combination: a heating chamber for passage of the relatively thin articles broadwise and on edge therethrough, said chamber having a charge end and a discharge end and a discharge opening adjacent said discharge end and positioned to discharge the articles therethrough by gravity; means for supporting said chamber at an angle of inclination with the discharge end higher than the charge end, said angle of inclination being sufficient to overcome the tendency of the relatively thin articles to fall on their broad side as they are being advanced through said chamber; reciprocating pusher mechanism associated with the charge end of said chamber for advancing the series of articles broadwise and on edge through said chamber in a step by step manner from the charge end towards the discharge end for removal through the discharge opening; retractable holding means associated with the charge end of said chamber for holding the series of articles in said chamber to permit the reciprocating pusher mechanism to be retracted; control means operatively connecting said reciprocating pusher means and said holding means to control their cycle of operation in the following sequence: the pusher mechanism is advanced to advance the articles in the chamber; the holding means is advanced to hold the series of articles in the chamber; the pusher mechanism is retracted and held in position a sufficient time to permit at least one additional article to be positioned between the pusher mechanism and the holding means; the holding means is retracted; and the pusher mechanism is again advanced to advance the articles in the chamber, the frequency of the cycle being determined by the control means whereby each of said series of articles is within the chamber a predetermined time before discharge through said opening, and means for selectively interrupting the cycle of operation of the control means to lock the holding means in retracted po-

sition and permit the pusher mechanism to advance step
by step to empty the articles from the chamber.

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