Feb. 28, 1939. H. J. STEIN 2,149,245

HEAT TREATING FURNACE

Filed Dec. 9, 1936 2 Sheets-Sheet 1

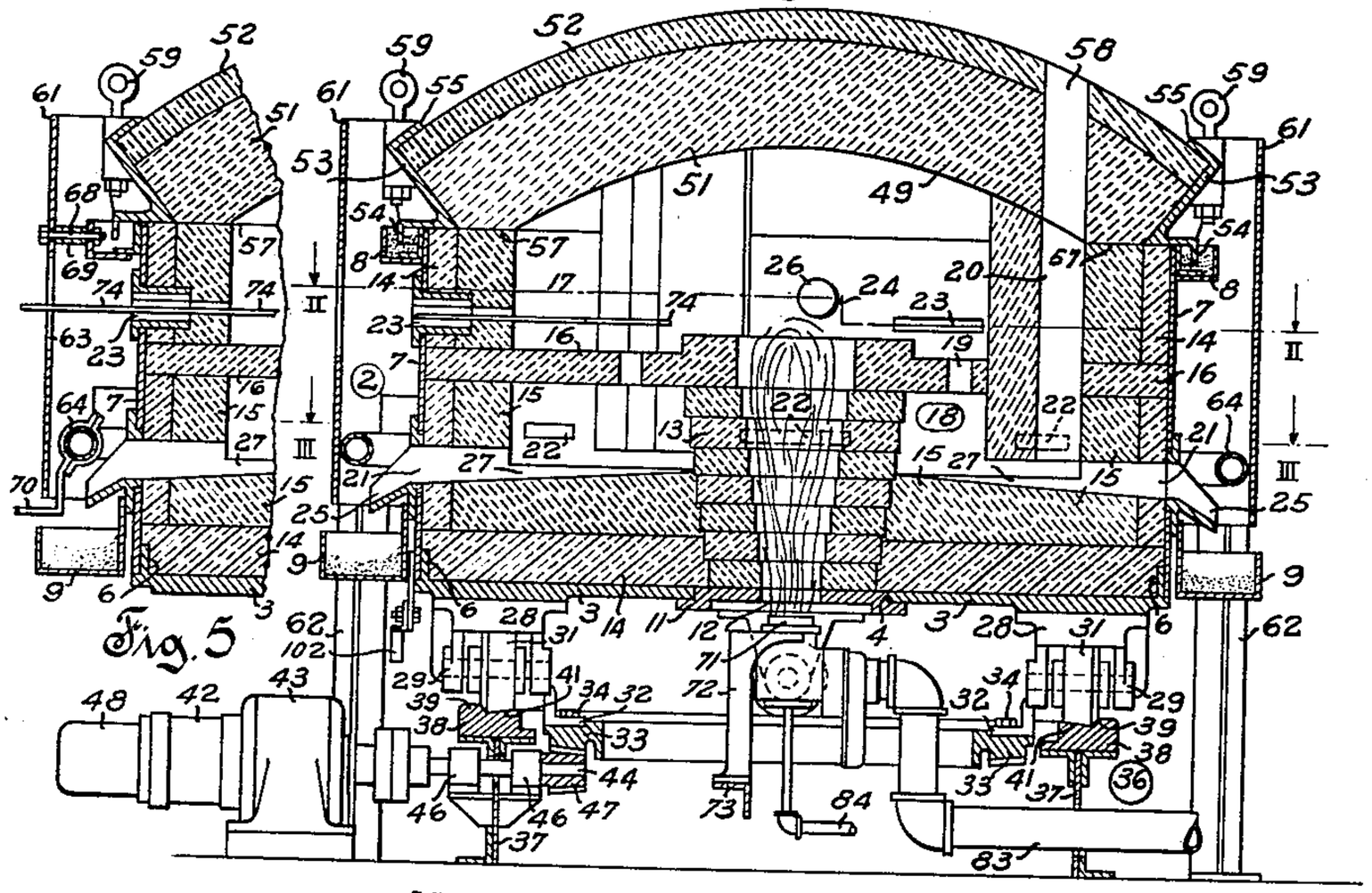

Fig. 5

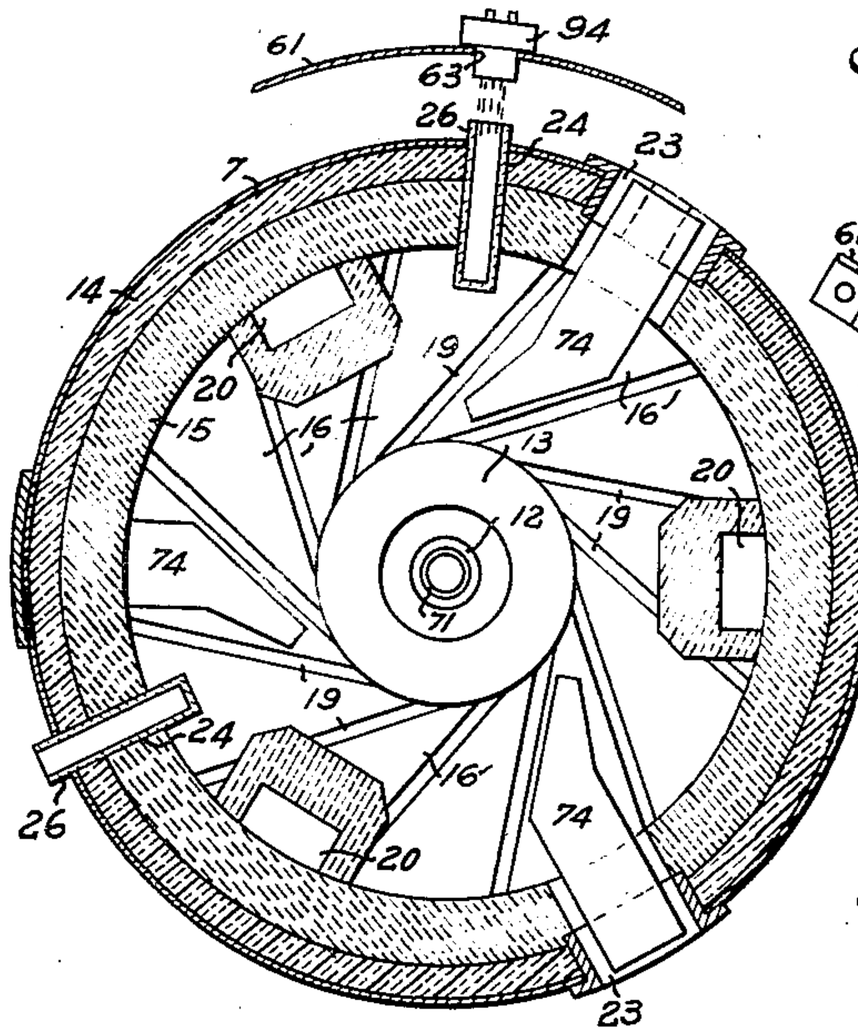

Fig. 2

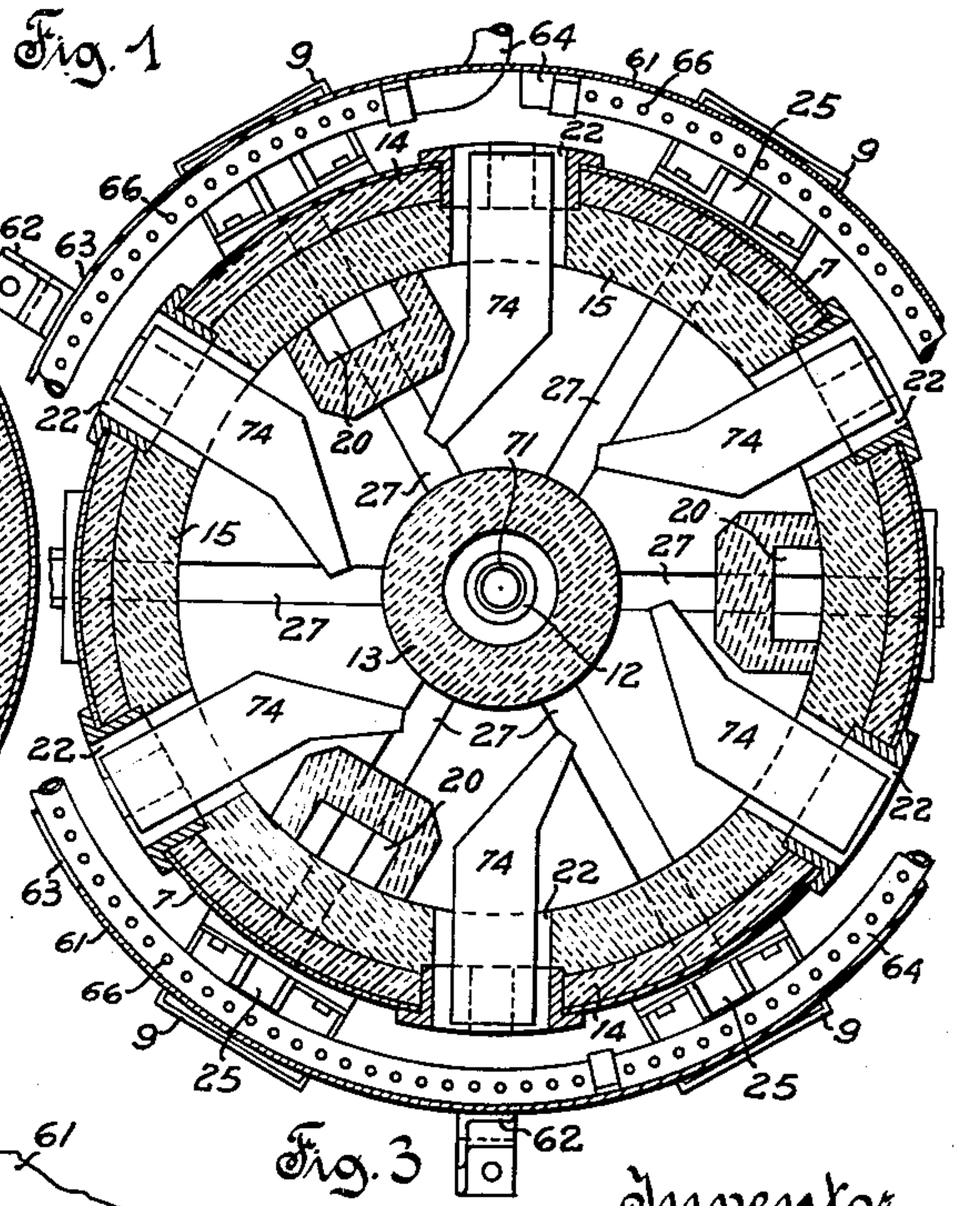

Fig. 1

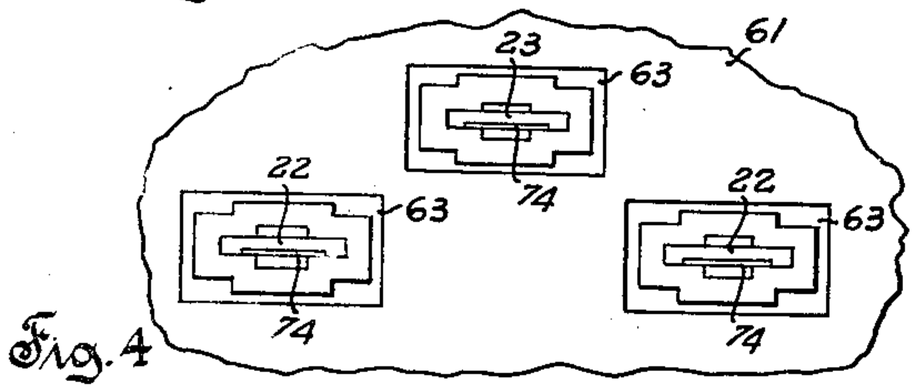

Fig. 4

Fig. 3

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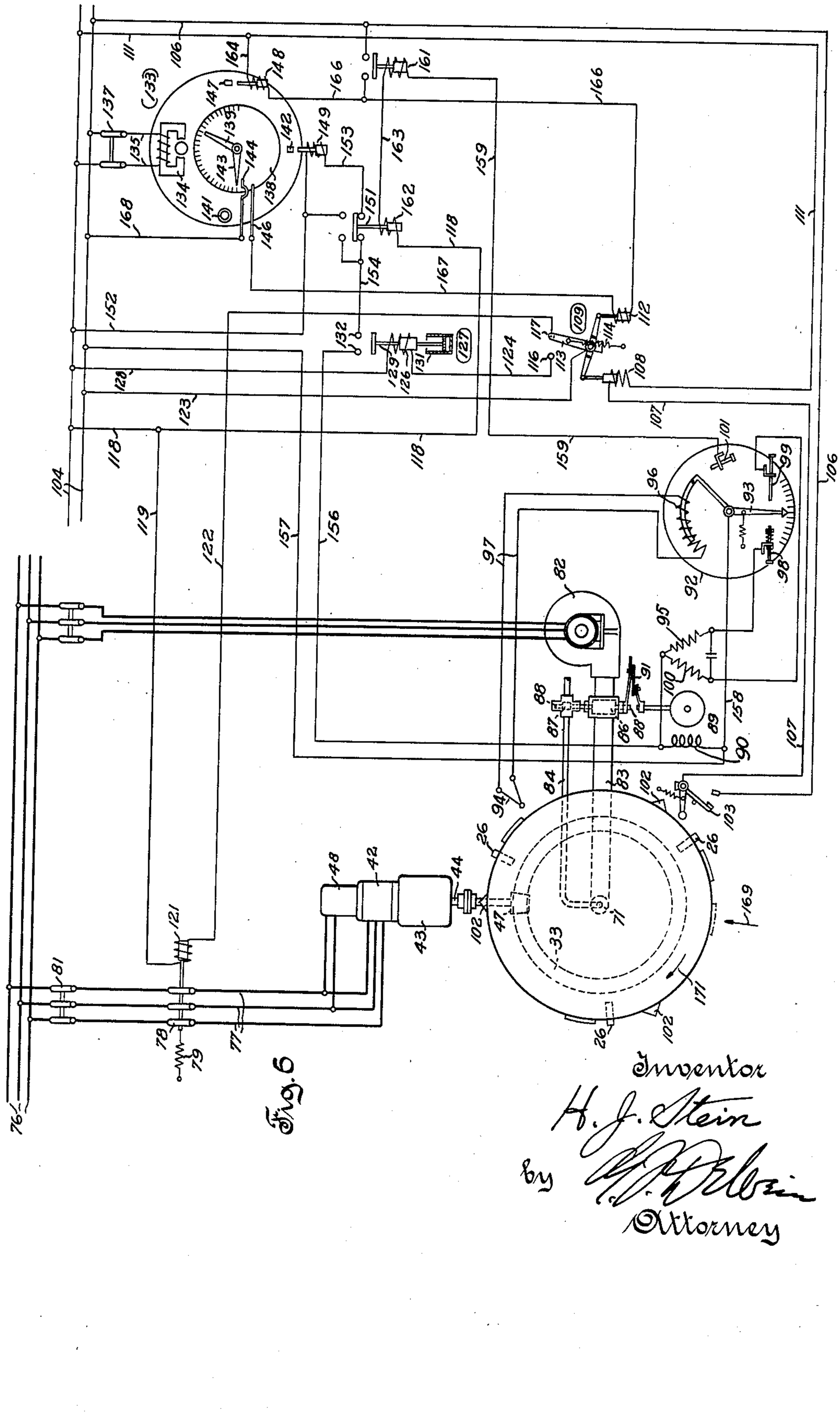

Fig. 6

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UNITED STATES PATENT OFFICE

2,149,245

HEAT TREATING FURNACE

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Application December 9, 1936, Serial No. 114,980

20 Claims. (Cl. 263—35)

This invention relates in general to the construction, operation and control of heat treating, forging and welding furnaces and more particularly to rotary furnaces designed to economically carry out heat treating, forging and welding operations on a production basis.

An object of this invention is to provide a centrally fired furnace having one or more heating zones, which is constructed to maintain a high uniform pressure throughout the heating zones at all times, thereby preventing cross drafts and an unequal distribution of the heat.

Another object is to provide a furnace having a central firing tube, a parabolic reflecting surface overlying said tube, an annular heating zone and a source of radiant energy in said tube substantially at the focal point of said surface whereby the radiant energy will be uniformly reflected throughout the heating zone.

Another object is to construct a furnace in which central firing, a concave or parabolic reflecting or deflecting surface and one or more heating zones are so correlated that the conditions of temperature, pressure and atmosphere are uniform throughout each heating zone.

Another object is to construct and operate a rotary heat treating furnace in which central firing, a concave or parabolic reflecting and deflecting surface and one or more heating zones are so correlated that each piece of stock is always subjected to the same conditions of temperature, pressure and atmosphere for exactly the same period of time to thereby produce work of uniform quality.

Another object is to provide means for carrying out the aforementioned mode of operation and control.

Another object is to provide a control system including a temperature indicating device which is rendered operative as a control means only when it is capable of rendering accurate temperature indications.

Another object is to provide a centrally fired furnace which is compact, cheap to manufacture, and easily repaired and which rotates as a unit, thereby eliminating relative rotation between parts and the necessity for providing the usual ineffective and troublesome seals.

The invention, accordingly, consists of the mode of operation and features of construction, combinations of elements and arrangement of parts as more particularly pointed out in the appended claims and in the detailed description, reference being had to the accompanying drawings, in which:

Fig. 1 is a central, vertical section through a rotary furnace embodying the invention;

Fig. 2 is a sectional plan view of the furnace taken on the line II—II of Fig. 1 showing the arrangement of the upper charging openings, the gas discharge flues, the pyrometer tubes and the slotted partition means;

Fig. 3 is a sectional view of a furnace taken along the line III—III of Fig. 1, showing the arrangement of the lower firing openings, the firing tube and the channels for discharging slag;

Fig. 4 is a fragmentary side elevation of the annular shield showing the relative arrangement of the charging openings which are arranged to coincide with those in the furnace;

Fig. 5 is a vertical sectional view showing a modified arrangement in which the protecting shield moves bodily with the furnace; and

Fig. 6 is a schematic showing of the furnace embodying the control system.

Referring to Figs. 1–3, it is seen that the furnace, per se, comprises a top or a roofed portion 1 and a lower or body portion 2. The body portion includes a circular metal base plate 3 having a central opening 4 and an upstanding annular flange 6 adjacent its outer periphery. An annular metal side wall casing 7 has its inner surface adjacent its lower edge surrounding and in telescopic relation to the upstanding flange 6 with its lower edge resting on the base plate 3 to be supported thereby; the upper portion of the casing 7 having formed or mounted thereon, in any desired manner, an annular upwardly opening sealing channel 8. Boxlike slag pockets 9 extend outwardly from the lower edge of the casing 7; the pockets being equally spaced circumferentially thereof and attached to or formed integral with the slag spouts 25 in any desired manner. Obviously the slag pockets may be secured to the furnace casing 7 instead of to the slag spouts 25 if it is so desired.

An annular metal collar 11 cooperates with the central opening in the base plate 3 to define a burner opening 12 and a centrally positioned, upwardly flaring firing tube 13, formed of any suitable heat resisting material, extends upwardly into the furnace a material distance in coaxial relationship with said opening. The inner surface of the metal side wall 7 and the base plate 3 are covered with a layer of any suitable insulating material 14 which is in turn covered by a relatively thick layer of ceramic or other high heat resistant material 15. A plurality of horizontally extending and circumferentially spaced members 16 bridge the space between the upper

portion of the firing tube and the inner surface of the side wall and divide the space between the firing tube and side wall into an upper high heat zone 17 and a lower, low heat zone 18, with the spaces between said members providing passages 19 through which the flue gases pass from the upper zone downwardly into the lower zone. A plurality of circumferentially spaced vertically extending flues 20 are formed on the inner surface of the side wall with their lower ends in communication with the low heat zone at a point adjacent the base and side wall for conducting the flue gases from the low heat zone to the atmosphere. The furnace side wall is provided with four vertically spaced series of openings, 21, 22, 23 and 24, the openings in each series being equally spaced circumferentially of the furnace. The lower openings 21 are in vertical alinement with the slag pockets 9 and are inclined upwardly and inwardly with their inner ends forming continuations of upwardly inclined and inwardly extending channels 27 formed in the refractory base 15, which constitutes a hearth, for collecting and conducting the slag outwardly through said openings. Suitable spouts or nozzles 25 are mounted to cooperate with said openings and discharge the slag issuing therefrom into the underlying slag pockets 9. The next higher series of openings 22 underlie alternate members 16 and constitute charging openings for the low heat zone; the stock which is inserted through such openings lying directly beneath a member 16 to be shielded thereby from any slag or like material which might be discharged from the high heat zone downwardly through the passages 19 into the low heat zone. The next higher series of openings 23 overlie every fourth member 16 and constitute charging openings for the high heat zone. The upper series of openings 24 are positioned adjacent the charging openings for the high heat zone and, extending through each opening 24 and into the furnace, is a radiating type pyrometer tube 26 which may be constructed of any suitable material such as silicon carbide.

Depending from the base plate 3 are at least three equally spaced bifurcated brackets 28 each carrying a shaft 29 on which is mounted a roller 31 with either the roller being slidably and rotatably mounted on the shaft or the shaft being slidably and rotatably mounted in suitable bearings formed in the bracket with the roller fixed thereon so that the furnace and brackets may move laterally relative to the rollers. The inner leg of each bracket 28 extends downwardly to a point beneath the roller and terminates in a horizontally and inwardly extending flange 32 for supporting the ring gear 33 which is secured thereto in any suitable manner as by cap screws 34. The base structure 36 includes an annular member 37 having its upper surface providing a track 38 for the rollers 31; the track comprising an outer and upwardly extending vertical retaining portion 39 and an inner upwardly inclined roller supporting surface 41. The rollers 31 have their supporting surface beveled to engage the inclined surface 41 of the track 38 and are retained against outward movement by the retaining portion 39 and against inward movement by the aforesaid inclined surface. The furnace is rotated by means of an electric driving motor 42 which, through a reduction gearing mechanism 43, slowly rotates a shaft 44 which is supported in bearings 46 carried by the annular base member 37. The inner end of the shaft 44 carries a pinion 47 which meshes with the ring gear 33. Operatively associated with the motor 42 is a magnetic breaking mechanism 48 of known construction.

The roof or top portion 1 has an inner parabolic surface 49 overlying the centrally positioned firing tube 13 and the annular high heat zone 17 with its focal point lying on the axis of the said tube so that when the burner is operated to terminate its flame, which constitutes a source of radiant energy, substantially at such point, the emitted rays will be reflected from said surface downwardly and uniformly throughout the high heat zone. In addition, if the burner is operated so that the flame impinges on the concave surface 49, the gases will be deflected and uniformly distributed throughout the heating zone. In this connection it should be obvious that although the upwardly flaring firing tube 13 shields the flame from cross drafts and other conditions tending to produce unequal conditions of temperature, pressure and atmosphere, it also permits the flame to diverge prior to impinging on the concave surface 49 and as a result the velocity of the flame is materially reduced and, after impinging on said surface, appears to slowly roll or billow radially outward towards the side wall. However the uniform downdraft effect produced by the plurality of equally and circumferentially spaced flues causes the flame to descend uniformly throughout the heating zone. The top portion comprises a relatively thick inner layer of ceramic or other high heat resistant material 51, an outer layer of insulating material 52 and an annular metal retaining member 53 having an upwardly and inwardly extending retaining flange 55 and an outwardly extending horizontal portion that terminates in a downwardly depending annular sealing flange 54 which, when the top portion is in its proper position, extends into the annular sealing channel 8 formed on the side wall 7. It should be understood that the channel 8 is substantially filled with any suitable granular or liquid material which will provide an effective seal and is solely for the purpose of permitting relative movement between the roof and body portion of the furnace which may result from an unequal expansion of these parts. The lower peripheral portion of the roof is formed to provide a flat annular seating surface 57 which cooperates with a like surface presented by the top of the side wall proper. Three equally and circumferentially spaced vertically extending flue passages 58 are provided to form continuations of the vertical flue passages 20 in the body portion 2. The top or roof portion 1 is also provided with eye bolts 59 which are for the purpose of bodily lifting the roof from the body portion 2. In a like manner the body portion may also be provided with a similar arrangement (not shown) or the spouts 25 may be considered an equivalent arrangement whereby the body portion together with the top, if desired, may be lifted bodily from the supporting structure 36. This arrangement greatly facilitates repairs as it is obvious that the roof portion may be bodily removed and repaired or a new roof portion substituted therefor or, after removal of the roof portion, the body portion may then be removed and repaired or a new body substituted. In addition, it should be borne in mind that the particular manner of fabricating the furnace walls and roof structure, per se, forms no part of this invention and any suitable construction may be employed as, for example, the refractory or heat resistant mate-

rial and also the insulating material, may either be assembled in block form or suitable molds may be employed and the refractory and insulating material inserted while in a plastic state. The firing tube 13 and the partition members 16 may also be constructed in any preferred manner and, if desired, in accordance with the examples set forth above in connection with the wall and roof structure.

An annular shield 61 surrounds the side wall of the furnace in spaced relation thereto and is supported upon stationary leg structures 62. The shield is provided with four openings 63 (see Figs. 2 and 4); the upper opening receiving a pyrometer device comprising a thermocouple 94; the next lower opening being in vertical alinement with the upper series of changing openings 23; and the two lower openings being in vertical alinement with the lower series of charging openings 22 so that when the furnace is rotated relative to the shield the pyrometer tubes 26 will successively come into alinement with the thermocouple 94 and in a similar manner the upper and lower charging openings will likewise successively come into alinement with the corresponding openings in the shield, attention being directed to Fig. 4 which clearly shows that at the time the upper charging opening is in alinement with the corresponding opening in the shield, two lower charging openings, one on each side of the upper charging opening, are simultaneously alined with the two lower openings in the shield 61. An annular blast pipe 64 is positioned near the lower edge of the shields 61 and is supported thereby in any suitable manner (not shown) and has an annular series of upwardly directed openings 66 (see Fig. 3) for directing an annular sheet of air upwardly adjacent the inner surface of the shield so as to protect the operator from the heat issuing from the furnace through the charging openings. The lower edge of the shield is spaced above the slag pockets 9 and the lower edge of the spouts 25 so that an instrument may be inserted into the outer portion of the slag openings 21 for clearing or cleaning the same.

Fig. 5 shows a modified form of structure in which the shield is supported by the furnace for movement bodily therewith, it being understood that, in this arrangement, the total number of openings and their arrangement must conform with the total number and the arrangement of the charging openings in the furnace side wall. In this case the blast pipe 64 must be supported independently of the shield 61 by any suitable means such as stationary brackets 70 (only one of which is shown). The supporting means for the shield in this modification comprises a bolt 68 extending through the shield and the outer upstanding edge of the sealing channel 8 with a suitable spacing member 69 therebetween. Only one of the supporting means for the shield 61 is shown in Fig. 5, but it should be understood that a sufficient number of bolts and spacing members are employed at spaced intervals to securely mount the shield on the furnace in the manner indicated.

Operatively associated with the burner opening 12, which is coaxial with the firing tube 13, is a burner 71 supported on a bracket 72 which is in turn supported by a beam member 73 carried by the annular base member 37. The burner, when operating, will direct a flame axially of the firing tube 13 which defines an upward flaring flame confining passage which is generally circular in cross section as shown in Fig. 1 and the length of the flame can be adjusted so that its hottest portion is substantially at the focal point of the parabolic inner surface 49 for the purpose hereinbefore set forth.

The use of a concave or a parabolic reflecting surface overlying the central firing tube and annular heating zone insures a uniform distribution of the heated gases throughout said zone and, when a source of radiant energy, for example the burner flame as previously described, is positioned substantially at the focal point of said surface, the emitted rays will be reflected downwardly and uniformly throughout the heating zone. The annular baffle structure comprising the members 16 together with the equally and circumferentially spaced flues 20 operates to maintain a relatively high pressure throughout the heating zone or zones at all times thereby preventing cross drafts and an unequal distribution of heat. The construction of the furnace as a unit for bodily rotation about a vertical axis results in a compact unitary structure which entirely eliminates relative rotation between parts and the necessity for providing seals.

The illustrated furnace, which is especially designed for use in welding plow shares on a production basis, is charged and operated in the following manner: assuming that the burner has been placed in operation in the usual and well known manner and that the furnace temperature has reached its normal value, a plow share 74 is inserted through the lower right hand opening in the shield 61 and into the furnace through the charging opening in the lower series 22 which is alined therewith and rotation of the furnace is started by closing the circuit of the driving motor 42. As alternate charging openings in the series 22 come into alinement with the aforementioned opening in the shield, which occurs at each 120° of rotation or ⅓ revolution, rotation of the furnace is stopped for a short interval (preferably automatically as hereinafter disclosed) and a plow share is inserted as hereinbefore set forth. At the end of one complete revolution the lower heat zone will then contain three plow shares inserted through charging openings spaced 120° apart. During the next complete revolution of the furnace three additional plow shares will be inserted in a like manner in the openings which become alined with the lower left hand opening in the shield (see Fig. 4) which is spaced 60° from the previously mentioned right hand opening. At the end of two complete revolutions the lower heat zone will be completely charged (containing six plow shares) and the plow share initially inserted will be in alinement with the lower right hand opening. During the interval the furnace is at rest the last mentioned plow share will be withdrawn from the low heat zone and inserted into the high heat zone through the upper opening in the shield (see Fig. 4) which during the interval the furnace is at rest is always in alinement with one of the charging openings in the high heat zone. This process is continued until the high heat zone is completely charged i. e., contains three plow shares and thereafter during the interval when the furnace is at rest a plow share is withdrawn from the high heat zone, the appropriate plow share in the low heat zone is removed and inserted into the high heat zone and a new plow share is inserted into the low heat zone. Thus it is seen that each plow share remains in the furnace during three complete revolutions, two in the low heat zone and one in the high heat zone, thereby subjecting each plow

share to the same conditions of pressure, temperature and atmosphere for the same period of time. This procedure results in an equal and uniform treatment of each and every plow share which passes through the furnace.

The invention is obviously not limited solely for the heat treatment of plow shares as it can readily be employed for heat treating other articles and in this connection, it may be well to point out that the number and spacing of the charging openings, the speed and rotation of the furnace and the stopping intervals may be varied as desired in order to satisfy the requirements of the particular heat treating process used. In addition, it should be understood that a particular number of heat treating zones is not essential in order to carry out the spirit of the invention and that it can be readily applied to furnaces having any desired number of such zones but not less than one. The members **16** which divide the interior of the furnace into low and high heat zones as previously described may be varied in number and shape as desired or the partitioning means may be formed as an integral structure having openings or passages extending therethrough for the purposes described.

Fig. 6 is a schematic illustration of the previously described furnace embodying a preferred control arrangement for effecting a desired mode of operation in connection with the welding of small stock, such as plow shares, on a production basis. The various control elements employed in the above referred to arrangement to effect the desired operation are old per se and are shown as cooperating diagrammatically in order that the general mode and sequence of operation can be readily and thoroughly understood.

The furnace is mounted for rotation about a vertical axis on the base structure **36** and is rotated in a clockwise direction by means of the ring gear **33** which meshes with the pinion **47** fixed on the shaft **44**. The motor **42** is connected to the shaft **44** by means of the reduction gearing mechanism **43** and operatively associated with the motor **42** is a magnetically operated braking mechanism **48**. The motor **42** and the braking mechanism **48** being connected to a common source of power, line **76**, by means of the conductors **77**. A solenoid operated switch **78**, which is biased toward open position by means of a spring **79**, and a normally closed, manually operated switch **81** control energization of the motor **42** and braking mechanism **48**; the latter being operative when deenergized to almost immediately stop rotation of the motor and furnace.

The burner unit illustrated includes a motor driven blower **82** for supplying air under pressure through the pipe **83** and a fuel supply pipe **84**. Suitable valves **86** and **87** respectively control the flow of fuel and air through the pipes **84** and **83** and to the burner and, as shown, are mounted on a common stem **88** for simultaneous actuation by means of a suitable reversing motor **89** which is operatively connected to said stem by a crank and link mechanism **91**.

A temperature indicator **92**, of the Leeds and Northrup type, has a solenoid actuated indicating arm or pointer **93** which, as viewed in Fig. 6, moves from the position shown in a clockwise direction upon a decrease in temperature and in a counterclockwise direction upon an increase in temperature.

The furnace is provided with pyrometer tubes **26** of any suitable material which extend through the side wall of and into the furnace at a point adjacent to each of the charging openings in the upper or high heat zone. A sensitive thermocouple **94** (of known construction) is fixedly mounted on a stationary structure, preferably the annular shield **61**, so as to be opposite one of the tubes during the interval the furnace is at rest. The thermocouple **94** and the solenoid **96** which actuates the pointer **93**, are connected in a closed circuit comprising the conductors **97**. The temperature indicator **92** also includes adjustable stops or contacts **98**, **99** and **101** for the pointer **93**; the pointer and stops being electrically insulated from their supporting structure and constituting switches for controlling operation of the system as hereinafter described.

The furnace is also provided with projections **102**, one near each charging opening in the high heat zone which operate, when the furnace is rotated to successively contact a normally open switch **103** to momentarily close the same and thereby energize a circuit comprising one side of the line **104**, wire **106**, switch **103**, wire **107**, solenoid **108** of switch **109** and wire **111** back to the other side of the line. Switch **109** is of the opposed solenoid, snap acting type and comprises solenoids **108** and **112**, switch blade **113**, a biasing spring **114** and the contacts **116** and **117**. Energization of the solenoid **112** moves the switch blade **113** to engage the contact **117** thereby closing a circuit including one side of the line **104**, wires **118** and **119**, the motor switch solenoid **121**, wire **122**, contact **117**, switch blade **113**, and wire **123**, back to the other side of the line. Energization of the solenoid **108** moves the switch blade **113** to engage the contact **116** thereby closing a circuit comprising one side of the line **104**, wire **123**, wire **124**, solenoid **126** of a duration timer or retarded relay **127** and wire **128** back to the other side of the line **104**. The duration timer or retarded relay comprises a solenoid actuated switch **129** having a dashpot arrangement **131** which prevents the switch **129** from bridging the contacts **132** for a predetermined time interval (fifteen seconds in this particular arrangement) after energization of its actuating solenoid **126**.

A Stromberg electric clock **133** has its driving motor **134** continuously energized through conductors **135** connected to the line **104** through a manually operated switch **137**. The dial **138** of the clock is calibrated in any desired increments of time, preferably seconds, and the setting hand **139** may be moved by means of a knob **141** to any predetermined position depending upon the particular timing interval desired. Pressing the starting button **142** connects the hand **143**, which is biased to the position shown, with a driving mechanism actuated by the motor **134** whereupon it commences to move slowly in a clockwise direction and continues such movement until it is superimposed with the setting hand **139** at which time the connection with the driving mechanism is released and the hand immediately returns to its initial position and, due to its inertia, strikes the resilient blade **144** causing it to momentarily engage a similar blade **146**. The hand **143** would then continue to move and repeat the previously described cycle of operation unless some means were provided for stopping its operation which, in the present instance, comprises a button **147**, operable when pressed, to disengage the hand **143** from its driving mechanism whereupon it immediately returns to its initial position and no further movement will take place unless the starting button is again pressed.

The so-called "stopping" of the clock with the hand 143 in its initial position is automatically accomplished by means of a solenoid 148 which, when energized, presses the button 147 to stop the clock in the manner previously described; the aforementioned resilient blades 144 and 146 constituting a switch which momentarily closes a circuit including the solenoid 148. Thus it is seen when the hand 143 reaches the setting hand 139 it immediately returns to its initial position, and closes the switch comprising the resilient blades 144 and 146 thereby energizing the solenoids 112 and 148. The starting button 142 is operatively associated with the solenoid 149 which, when energized, presses the starting button to start the clock as previously described. The solenoid 149 is in circuit with the duration timer switch 129, the reversing motor 89 and the solenoid switch 151 as follows:

One side of line 104, wire 152, solenoid 149, wire 153, switch 151, wire 154, switch 129, wire 156, the reversing motor 89 and wire 157 back to the other side of the line 104.

The contact 98 of the temperature indicator 92 is resilient and, if the temperature becomes excessively low, pointer 93 will move this contact to the left until the pointer engages stop 101 which closes a circuit from one side of the line 104 through wires 157 and 158, pointer 93, contact 101, wire 159, solenoid 161, wire 163, solenoid 162 and wire 118 back to the other side of line 104. Solenoid 161 closes its switch and a circuit through wires 164 and 166 which energizes solenoid 148 to stop the timing clock 133. Solenoid 162 actuates switch 151 to open the circuit including the starting solenoid 149 and closes a shunt circuit about the latter which prevents its reenergization and rotation of the furnace until the temperature again reaches the normal value. The spaced contacts 98 and 99 of the temperature indicator 92, which are adjustable, are preferably spaced so as not to permit a temperature deviation of more than a few degrees in either direction. A greater deviation will cause the pointer 93 to engage one or the other of the contacts 98 and 99 to energize the reversing motor 89 and effect a corresponding regulation of the fuel and air to maintain the temperature within the desired limits.

The normal operation of the furnace will now be described it being assumed that the furnace is completely charged with stock as shown in Figs. 2 and 3, i. e. with six pieces in the low heat zone and three in the high heat zone and that the point of charge is indicated by the arrow 169 in Fig. 6. With the various control elements in the positions shown in Fig. 6, the driving motor 42 and the electromagnetic brake 48 are energized and the furnace is rotating in a clockwise direction as indicated by the arrow 171.

When the projection 102 engages and closes the switch 103, a circuit will be energized comprising one side of the line 104, wire 111, solenoid 108 of switch 109, wire 107, switch 103 and wire 106 back to the other side of the line 104. Energization of solenoid 108 will move the switch blade 113 from engagement with contact 117 and into engagement with the contact 116. Breaking the connection with contact 117 will open the circuit comprising one side of line 104, wires 118 and 119, solenoid 121 and wires 122 and 123 back to the other side of the line, thereby immediately deenergizing the driving motor and the braking mechanism whereupon the furnace will stop with the charging opening at the point indicated by the arrow 169 with the thermocouple 94 in alinement with one of the pyrometer tubes 26. Connecting the blade 113 and contact 116 will close a circuit comprising one side of the line 104, wire 128, solenoid 126 of the duration timer 127, and wires 124 and 123 back to the other side of the line 104. After approximately fifteen seconds, the switch 129 will bridge the contacts 132 completing a circuit including one side of the line 104, wire 157, the armature winding of the reversing motor 89, wire 156, wire 154, switch 151, the clock starting solenoid 149, the wire 152 back to the other side of line 104. The delay of fifteen seconds provided by the duration timer is necessary in order to obtain an accurate temperature indication and prevent improper regulation of the burner as it is obvious that during the time interval required for the furnace to rotate 120°, the space between the projections 102, the thermocouple 94 will have cooled down considerably and upon realinement with a pyrometer tube would not instantaneously render a correct indication of the furnace temperature, and, as a result, the pointer 93 would engage contact 98 thereby energizing the motor field winding 95 and since the armature winding 90 is also energized, the motor 89 will rotate so that the fuel and air valves would be opened more each time the previously described cycle of operation was repeated. If the temperature of the furnace becomes either too low or too high while the switch 129 engages contacts 132, the indicator pointer 93 will engage with one or the other of contacts 98 and 99 and energize one or the other of the field windings 95 and 100 to thereby rotate the control motor 89 in a direction to effect the necesary burner regulation. However, if the temperature is sufficiently low to cause the pointer 93 to also engage contact 101 such engagement will close a shunt circuit about the armature and field windings 90 and 95, respectively, of the motor 89 which is effective to maintain the motor inoperable. This shunt circuit comprises one side of line 104, wires 157, 158, pointer 93, contact 101, wire 159, solenoid 161, wire 163, solenoid 162 and wire 118 back to the other side of line 104.

Energization of the starting solenoid 149 will start the clock hand 143 moving towards the setting hand 139 and when it returns to its initial position as previously described, it will close the resilient contacts 144 and 146, thereby energizing a circuit comprising one side of the line 104, wire 111, wire 164, stopping solenoid 148, wire 166, solenoid 112 of switch 109, wire 167 and wire 168 back to the other side of the line 104. Energization of solenoid 148 stops the clock with the hand 143 in its initial position while energization of solenoid 112 engages the switch blade 113 with contact 117, thereby energizing the driving motor 42 and the braking mechanism 48 and deenergizing the duration timer 127. Energization of the driving motor starts the furnace rotating through another cycle of operation as previously described and deenergization of the duration timer 127 opens the circuit of the burner control motor 89 and the starting solenoid 149 of the time clock 133.

The time interval consisting of the aforementioned fifteen seconds and the time required for the clock hand 143 to move from its initial position to the setting hand 139 and back to its initial position, provides the time necessary to remove a piece of stock from the high heat zone,

transfer another piece from the low heat zone into the high heat zone and to place a new piece in the low heat zone. In other words, with the particular number of charging openings employed, a piece of stock remains in the furnace during three complete revolutions. However, it should be understood that the number of pieces of stock in the furnace at any one time may be varied as may also the stopping interval and the rate of and the number of revolutions made by the furnace to complete any desired or preferred cycle of operation. Moreover, the previously described mode of operation is obviously applicable to furnaces having any desired number of charging openings and only a single heat zone. The furnace is prevented from rotating during intervals when the temperature is excessively low by means of the circuit closed by the pointer 93 and the contact or stop 101 of the temperature indicator as previously described and, it may be well to again point out, that when the aforementioned circuit is closed, the burner regulating motor is inoperative since the motor windings are shunted by the wire 158 and the rate of firing remains the same until after the furnace reaches the normal operating temperature which will occur due to the fact that no new or cold material is being inserted for heat treatment and therefore the heating requirements have been materially reduced. In other words, the firing rate necessary to maintain the heating zone or zones at any desired temperature will depend, excepting the usual heat losses, upon the rate of heat utilization and since the firing rate is only varied between narrow limits, it necessarily follows that if the temperature falls below the lower limit, continued operation of the burner without utilizing the generated heat will quickly raise the temperature to within the desired limits. However, it should be understood that if the lowering of the temperature is due to faulty burner operation which continues and might be caused by failure of either the fuel supply or the blower motor, then it will be necessary to remedy such defect before the furnace will continue to operate in the normal manner as hereinbefore described.

It should be understood that the power lines 76 and 104, although shown as being entirely independent, can obviously be interconnected either directly or by means of a stepdown transformer if the control system proper is to be operated at a relatively low potential. Moreover, while the automatic switches or relays are shown as being closed when their actuating solenoid is energized, it is obvious that if it is desired, the opposite mode of operation may be employed and that any other suitable means may be used to effect actuation of the switches or relays in the manner described.

In view of the foregoing, it is readily seen that the controlling factors in any heat treating operation, time and temperature are accurately controlled at all times to thereby produce work of uniform quality.

The previously described mode of operation insures an identical treatment of all stock thereby producing products of uniform quality and eliminates practically all of the waste that normally results from poor judgment or guesswork on the part of the operator or attendant.

Although but a few embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. A generally circular heat treating furnace comprising a base having a centrally disposed, upwardly extending firing tube, a side wall surrounding said tube, a roof overlying said base and tube, means extending from said firing tube to the side wall and dividing the interior of the furnace into upper and lower communicating heating zones, and a plurality of circumferentially spaced discharge flues communicating with said lower heating zone at a point near said base and the inner periphery of the side wall.

2. A generally circular heat treating furnace comprising a base having a centrally disposed, upwardly extending firing tube, a side wall surrounding said tube, a roof overlying said base and tube, means extending from said firing tube to the side wall and dividing the interior of the furnace into upper and lower communicating heating zones, said side wall having vertically spaced series of openings providing access to the upper and lower heating zones for inserting and withdrawing stock, and a plurality of circumferentially spaced, discharge flues communicating with the lower portion of said lower heating zone.

3. A generally circular heat treating furnace comprising a base having a centrally disposed, upwardly extending firing tube, a side wall surrounding said tube, a roof overlying said base and tube, means extending from said firing tube to the side wall and dividing the interior of the furnace into upper and lower communicating heating zones, said side wall having vertically spaced series of openings providing access to the upper and lower heating zones for inserting and withdrawing stock, a plurality of circumferentially spaced discharge flues communicating with the lower portion of said lower heating zone and an annular shield surrounding said side wall and having vertically spaced openings alined with the vertically spaced series of openings in the side wall.

4. A generally circular heat treating furnace comprising a base having a centrally disposed, upwardly extending firing tube, a side wall surrounding said tube, a roof overlying said base and tube, means extending from said firing tube to the side wall and dividing the interior of the furnace into upper and lower communicating heating zones, said side wall having vertically spaced series of openings, a pyrometer tube extending into the furnace through each opening in the upper series with the next two lower series constituting charging openings providing access to the upper and lower heating zones, a plurality of circumferentially spaced discharge flues communicating with the lower portion of said lower heating zone, means supporting said furnace for bodily rotation about a vertical axis, a stationary shield surrounding said side wall and having vertically spaced openings alined with the series of charging openings and a pyrometer alined with said pyrometer tubes so that, when the furnace is rotated, a pyrometer tube and a charging opening in each series will simultaneously come into alinement with the pyrometer and the openings in said shield.

5. In a combination comprising a generally circular, centrally fired heat treating furnace having a plurality of circumferentially spaced charg-

ing openings and pyrometer tubes, means for rotating said furnace, and a stationary shield surrounding said furnace having a segmental portion containing openings and a pyrometer so arranged that when the furnace is rotated the charging openings and pyrometer tubes come into alinement respectively with the openings and the pyrometer, means operative to stop rotation of the furnace with a pyrometer tube and the adjacent charging openings in alinement respectively with the pyrometer and openings in said shield, and means operable after a predetermined time interval to start rotation of the furnace.

6. In a combination comprising a generally circular, centrally fired heat treating furnace having a plurality of circumferentially spaced charging openings and pyrometer tubes, means for rotating said furnace and a stationary shield surrounding said furnace having a segmental portion containing openings and a pyrometer so arranged that when the furnace is rotated the charging openings and pyrometer tubes come into alinement respectively with the openings and the pyrometer, means operative to stop rotation of the furnace with a pyrometer tube and the adjacent charging openings in alinement respectively with the pyrometer and openings in said shield, means operable after a predetermined time interval to start rotation of the furnace, and temperature responsive means rendered operative during the stopping interval to prevent rotation of the furnace when the temperature is below a predetermined value.

7. In a combination comprising a generally circular, centrally fired heat treating furnace having a plurality of circumferentially spaced charging openings and pyrometer tubes, means for rotating said furnace and a stationary shield surrounding said furnace having a segmental portion containing openings and a pyrometer so arranged that when the furnace is rotated the charging openings and pyrometer tubes come into alinement respectively with the openings and the pyrometer, means operative to stop rotation of the furnace with a pyrometer tube and the adjacent charging openings in alinement respectively with the pyrometer and openings in said shield, means operable after a predetermined time interval to start rotation of the furnace, temperature responsive means rendered operative during the stopping interval to prevent rotation of the furnace when the temperature is below a predetermined value, and means rendering said temperature responsive means inoperative for a predetermined time interval after stopping rotation of the furnace.

8. In a combination comprising a generally circular, centrally fired heat treating furnace having a motor regulated burner, a plurality of circumferentially spaced charging openings and pyrometer tubes, means for rotating said furnace and a stationary shield surrounding said furnace having a segmental portion containing openings and a pyrometer so arranged that when the furnace is rotated the charging openings and pyrometer tubes come into alinment respectively with the openings and the pyrometer, means operative to stop rotation of the furnace with a pyrometer tube and the adjacent charging openings in alinement respectively with the pyrometer and openings in said shield, means operable after a predetermined time interval to start rotation of the furnace, and temperature responsive means rendered operative during the stopping interval to control operation of the burner regulating motor and prevent rotation of the furnace when the temperature is below a predetermined value.

9. In a combination comprising a generally circular, centrally fired heat treating furnace having a motor regulated burner, a plurality of circumferentially spaced charging openings and pyrometer tubes, means for rotating said furnace and a stationary shield surrounding said furnace having a segmental portion containing openings and a pyrometer so arranged that when the furnace is rotated the charging openings and pyrometer tubes come into alinement respectively with the openings and the pyrometer, means operative to stop rotation of the furnace with a pyrometer tube and the adjacent charging openings in alinement respectively with the pyrometer and openings in said shield, means operable after a predetermined time interval to start rotation of the furnace, and temperature responsive means rendered operative during the stopping interval to control operation of the burner regulating motor and prevent rotation of the furnace when the temperature is below a predetermined value, and means rendering said temperature responsive means inoperative for a predetermined time interval after stopping rotation of the furnace.

10. In combination with a motor driven rotary furnace having circumferentially spaced charging openings, means for obtaining temperature indications and switch actuating projections, a motor regulated burner and a magnetic braking mechanism for stopping the furnace, a control system comprising in circuit temperature responsive means controlling operation of said burner motor, an automatic switch controlling operation of said driving motor and braking mechanism, timing means controlling actuation of said automatic switch to energize the driving motor and release the brake, a retarded relay delaying operation of said timing and temperature responsive means and a switch actuated by said projections causing operation of said relay and automatic switch to deenergize the driving motor and apply the brake to stop rotation of the furnace with said temperature responsive means operatively associated with the means for obtaining temperature indications.

11. In combination with a motor driven rotary furnace having circumferentially spaced charging openings, means for obtaining temperature indications and switch actuating projections, a motor regulated burner and a magnetic braking mechanism for stopping the furnace, a control system comprising in circuit temperature responsive means controlling operation of said burner motor, an automatic switch controlling operation of said driving motor and braking mechanism, timing means controlling actuation of said automatic switch to energize the driving motor and release the brake, a retarded relay delaying operation of said timing and temperature responsive means, a switch actuated by said projections causing operation of said relay and automatic switch to deenergize the driving motor and apply the brake to stop rotation of the furnace with said temperature responsive means operatively associated with the means for obtaining temperature indications, and means controlled by said temperature responsive means for rendering said timing means inoperative to start rotation of the furnace when the temperature is below a predetermined value.

12. A control system for rotary furnaces com-

prising in circuit a driving motor for rotating the furnace, a burner regulating motor, timing means operable when actuated to start said driving motor after a predetermined time interval, temperature responsive means operable to control operation of said burner regulating motor and, when the temperature is below a predetermined value, to prevent actuation of said timing means to start rotation of the furnace, a retarded relay delaying operation of said timing and temperature responsive means and a switch responsive to furnace movement operable when actuated to cause operation of said relay and to stop said driving motor.

13. In a combination comprising a furnace control system having temperature responsive means including a temperature indicating device and a furnace having a plurality of spaced means for obtaining temperature indications each of which is operatively associated with said device at spaced time intervals, means operable to render said system inoperative for a predetermined interval each time said association is established in order to insure a correct temperature indication and proper regulation of the furnace.

14. A heat treating furnace comprising a base having an upwardly extending firing tube, a side wall spaced from and surrounding said tube, a roof overlying said tube and base, means dividing the interior of the furnace into upper and lower communicating heating zones which surround said tube, and a plurality of spaced discharge flues communicating at circumferentially spaced points with the lower portion of said lower heating zone.

15. In a combination comprising a furnace control system having temperature responsive means including a temperature indicating device and a furnace having means for obtaining temperature indications which is operatively associated with said device at spaced intervals, means operable to render said system inoperative for a predetermined interval each time said association is established in order to insure a correct temperature indication and proper regulation of the furnace.

16. A heat treating furnace comprising a hearth, a means extending upward from the hearth and defining an upward flaring flame confining passage which is generally circular in cross section, a side wall surrounding said means and forming with said means an annular heating zone surrounding said flame passage, a concave reflecting and deflecting surface overlying said passage and hearth, and discharge flue means communicating with said zone below the top of the flame passage and adjacent the hearth and cooperating to cause the products of combustion issuing from said passage to descend uniformly throughout the heating zone prior to their discharge therefrom.

17. A heat treating furnace comprising a hearth having a centrally disposed means extending upward from the hearth and defining a flame confining passage which is generally circular in cross section and in which the cross sectional area progressively increases towards the discharge end, a side wall surrounding said means and forming with said means an annular heating zone surrounding said flame passage, a stock charging opening formed in said side wall at a point adjacent the hearth and below the top of the flame passage, a concave reflecting and deflecting surface overlying said passage and hearth, and discharge flue means communicating with said zone below the top of the flame passage and adjacent the hearth and cooperating to cause the products of combustion issuing from said passage to descend uniformly throughout the heating zone prior to their discharge therefrom.

18. A heat treating furnace comprising a hearth having a centrally disposed means extending upward from the hearth and defining an upward flaring flame confining passage which is generally circular in cross section, a side wall surrounding said means and forming with said means an annular heating zone surrounding said flame passage, one or more stock charging openings formed in said side wall at a point adjacent the hearth and below the top of the flame passage, a concave reflecting and deflecting surface overlying said passage and hearth, and discharge flue means communicating with the outer peripheral portion of said heating zone below said charging openings and cooperating to cause the products of combustion issuing from said passage to descend uniformly throughout the heating zone and past said charging openings and to cause cold air entering through the charging openings to immediately pass downward adjacent the side wall and into the flue means.

19. A heat treating furnace comprising a hearth, a means extending upward from the hearth and defining a flame confining passage, a side wall forming with said means an annular heating zone surrounding the flame passage and having one or more stock charging openings located adjacent the hearth and below the top of the flame passage, a roof overlying said passage and hearth, and discharge flue means communicating with the outer peripheral portion of said heating zone below said charging openings and cooperating to cause the products of combustion issuing from said passage to descend uniformly throughout the heating zone and past the charging openings and to cause cold air entering through the charging openings to immediately pass downward adjacent the side wall and into the flue means.

20. In combination with a heat treating furnace comprising means including a hearth defining a heating zone having one or more charging openings located adjacent the hearth and a burner means communicating with said zone at a point above said charging openings, means for preventing cold air entering the furnace through the charging openings from flowing over the hearth and cooling the stock disposed thereon comprising discharge flue means communicating with said heating zone at points near to and below the charging openings and operable to cause the products of combustion to descend past the charging openings and to cause cold air entering through said charging openings to immediately pass downward and into the discharge flue means.

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