Sept. 2, 1941. J. H. GERMANY 2,254,891

HEAT-TREATING FURNACE

Filed July 31, 1940 2 Sheets-Sheet 1

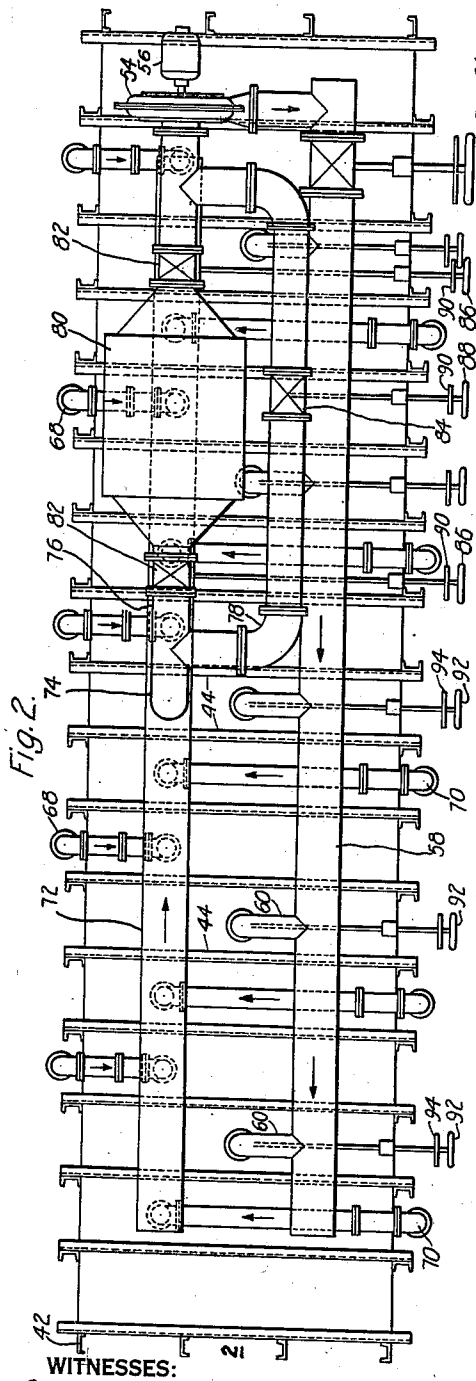

Fig. 2.

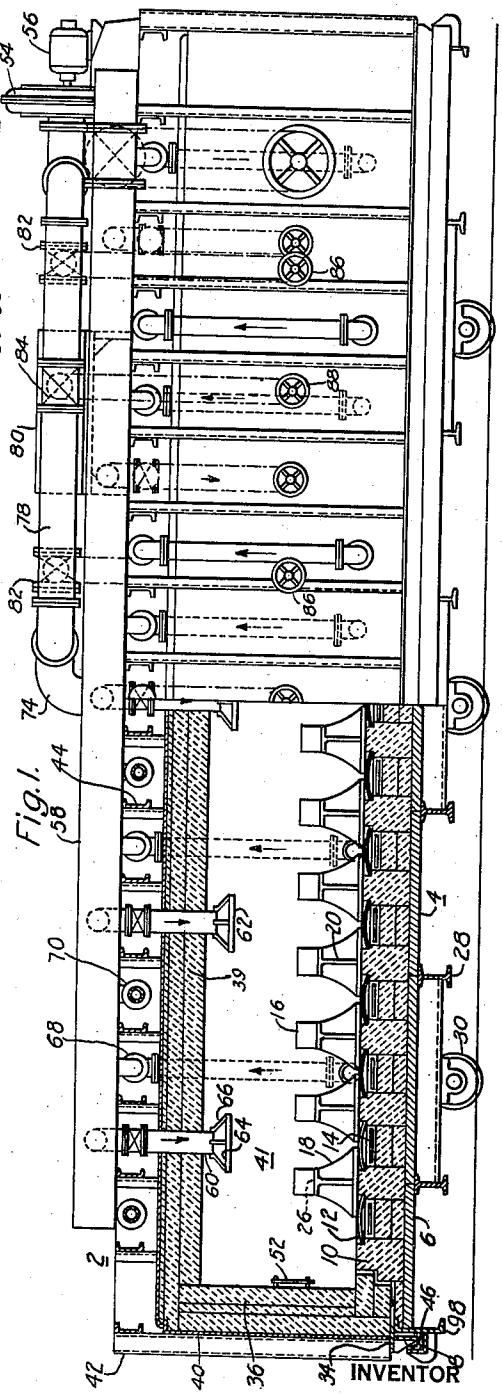

Fig. 1.

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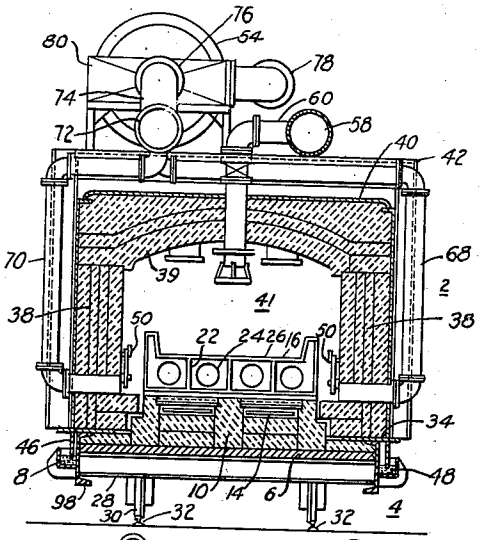

Fig. 3.

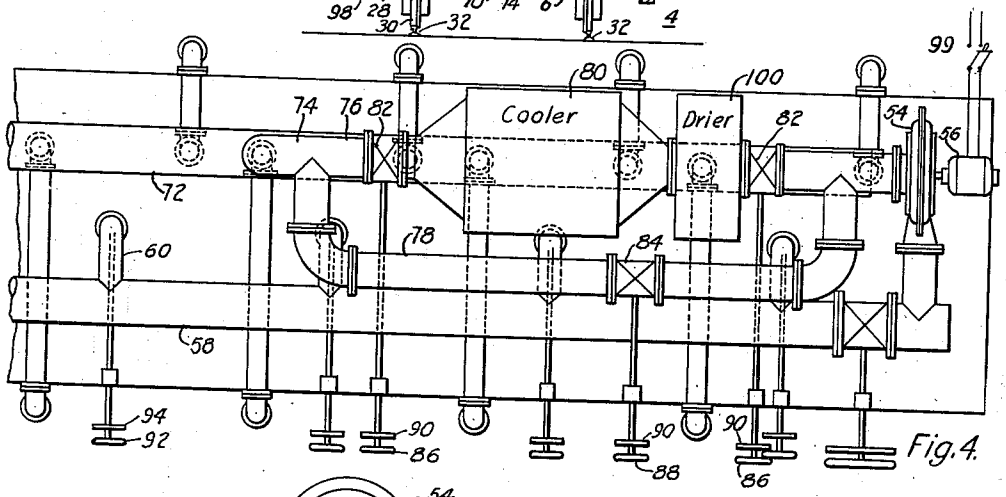

Fig. 4.

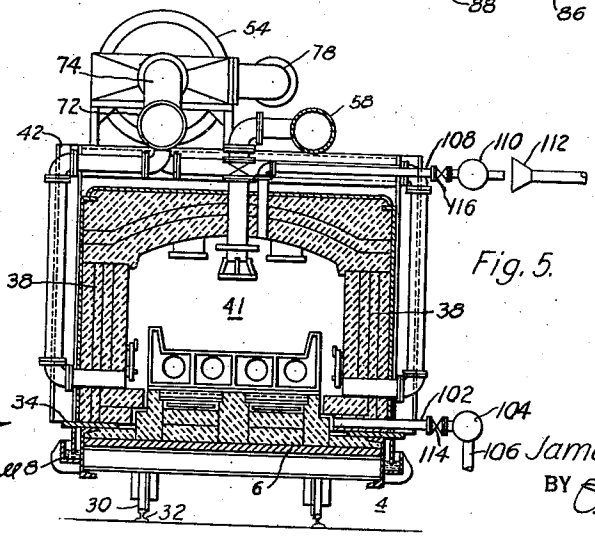

Fig. 5.

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UNITED STATES PATENT OFFICE

2,254,891

HEAT-TREATING FURNACE

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Application July 31, 1940, Serial No. 348,725

8 Claims. (Cl. 266—5)

My invention generally relates to electric furnaces for heat-treating metals, but more particularly relates to furnaces of the bell-type having a heating bell which can be lowered over a charging-supporting base having a charge thereon, the heating bell being adapted to be raised after the heat-treatment to enable the charge to be further processed for such purposes as may be desired.

In the heat-treating field, the many different heat-treating processes require a large number of different types of furnaces, each, as a rule, designed to carry out most efficiently the particular heat-treating process involved; and the furnace in which one particular charge can be heat-treated may not be useful for a different heat-treatment of the same or a similar charge. As an example of such a condition, a furnace for annealing a high carbon alloy or tool steel may not be particularly useful for tempering or drawing the same or a similar charge at a relatively low temperature because the former process usually requires heating the charge to temperatures at which heat is transferred predominantly by radiation, while the latter may require heating the charge to temperatures at which heat is transferred most efficiently and effectively by convection. Accordingly, in the prior art it has been customary to provide separate furnaces for each of the aforesaid processes. It is at once manifest that if a single furnace can be provided for operation through a large range of temperatures including those at which heat is transferred primarily by radiation and those at which heat is transferred primarily by convection, a large saving in the initial investment for furnaces can be effected. It is accordingly a primary object of my invention to provide a single furnace of more general utility than prior furnaces of the same general type.

It is a more specific object of my invention to provide a furnace in which a plurality of controlled heat-treating processes can be carried out for the heat-treatment of steel or the like, which processes include, for example, annealing, normalizing and tempering.

It is a general object of my invention to include in a heat-treating furnace, provisions for recirculating a gas, or air, or an atmosphere of controlled composition through the heat-treating chamber of the furnace in such manner that the gas flows in paths substantially transverse to the length of the heat-treating chamber. Preferably the gas is recirculated by a blower outside of the furnace proper and by distributing the gas inlets and gas outlets along the length of the furnace, and by controlling the gas-flow through each or some of them, the furnace can be generally utilized to effect a controlled heating, as, for example, in tempering, or to effect a controlled cooling, as, for example, in annealing, the heating and cooling being controllable so as to uniformly heat-treat the charge.

The recirculation of the gas can be used during low-temperature heating processes as a convection heat-transferring means for more speedily and more uniformly heat-treating the charge. In order to use the same conduit system for heat-treating processes in which controlled cooling is required, the gas circulation conduits may be provided with selectable branch-passages, one of which includes a cooler and, if desired, a drier, so that by suitable manipulation of valves the recirculating gases may be caused to pass through the cooler for certain cooling steps of annealing processes, or the cooler may be by-passed during heating steps of a heat-treating process.

It is an additional object of my invention to provide a bell furnace of the type having a separable base and bell, the bell being provided with a gas circulating system entirely supported by it so that duct-connecting and duct-disconnecting are not required during the raising or lowering of the bell, the gas circulating conduit system being raised or lowered with the bell as a unit.

The objects, advantages and applications of my invention are numerous and generally embrace those indicated as well as others not specifically mentioned, which will be apparent from the following description which is to be taken in conjunction with the accompanying drawings, in which:

Figure 1 is an elevational view, partly in vertical section, of the essential features of a furnace embodying my invention;

Fig. 2 is a top plan view of the furnace with parts omitted for clarity;

Fig. 3 is a transverse vertical sectional view of the furnace;

Fig. 4 is a fragmentary top plan view of a modified form of furnace embodying my invention with parts omitted for clarity of illustration; and

Fig. 5 is a sectional view similar to Fig. 3 of a furnace embodying my invention, the furnace having provisions for transmitting a controlled atmosphere to, and bleeding it from, the heat-treating chamber of the furnace.

Referring more particularly to the drawings, the furnace shown is of the bell type comprising a raisable and lowerable bell indicated in its en-

tirety by the reference character 2, the bell in operating position resting on a car base indicated in its entirety by the reference character 4; the bell being provided with suitable eye-bolts or the like by means of which it may be lifted to enable the car base to be rolled in position below it or removed after the heat-treating process for the reception of another car base or the same car base after reloading with a second charge.

The car base 4 comprises a metallic base plate 6 around the periphery of which is gas tightly secured a sealing trough 8. The base plate supports refractory and insulating tile 10 constructed and arranged to contain troughs 12 in which may be disposed base heating elements 14. The refractory tile also supports a plurality of heat-resistant alloy hearth sections 16 each being provided with side legs 18 and an upright 20 between the legs, the upright having suitable reinforcing ribs 22 between enlarged holes 24 in the upright. Each hearth section has a horizontal hearth plate 26 between the legs and on top of the upright, and as may be observed from Figs. 1 and 3, the arrangement of the hearth sections is such that the hearth can support bars of various lengths. The car base includes spaced trucks 28, each having wheels 30 adapted to ride on rails 32 for movement into and out of position beneath the raisable bell 2.

The refractory tile of the car base is stepped along its edges for the reception of the walls of the bell 20 which is provided with a heavy supporting peripheral base-frame 34. The bell 2 further comprises end walls 36, side walls 38 and a top wall 39, the walls being constructed of insulating and refractory tile in a customary manner and defining a heat-treating or heat-treatment chamber 41 in conjunction with the car base. The walls are encased in an outer metallic casing or shell 40, and suitable structural steel channels 42, secured to the supporting base-frame 34, extend upwardly above the top of the bell walls. A sufficient number of these channels are provided along the outside of the bell to provide, in conjunction with transverse top channels 44, a strong and rigid bell structure, the top channels 44 also serving to support the gas circulating system to be later described. Depending from the base-frame 34 is a sealing flange 46 cooperating with the trough 8 to provide a gas-seal between the car base and the bell when the trough is filled with a suitable sealing means such as oil 48.

The furnace is heated by means of the bottom heating units 14 and additional heating units 50 mounted along the length of the inside of the side walls and 52 on the end walls. In Figs. 1, 3 and 5, heating elements have been omitted for clarity of the illustration. The heating units are preferably divided into separate controllable zones along the length of the furnace selectively energizable to controllable degrees.

Gas is circulated in substantially transverse orbits in the heat-treating chamber 41 by forced drafts created by a blower 54 driven by a motor 56. The blower discharges into a distribution manifold 58 which extends longitudinally across the top of the bell. A plurality of discharge ducts 60 branch from this manifold at spaced distances along its length and extend downwardly through the top wall 39 to provide a discharge of gas at the top of the heat-treating chamber 41. Attached to the gas discharge opening of each of these ducts is a flow-distributing device 62 comprising a bottom spreader plate 64 spaced from the end of the associated duct 60 and secured thereto by a plurality of small supporting members 66. The gas is discharged at the top of the chamber 41 at a plurality of points along its longitudinal center by the spaced discharge ducts 60, and is withdrawn from along the bottom of the chamber by means of a plurality of outlet ducts 68 and 70, the outlet ducts 68 being associated with one of the side walls 38 and the outlet ducts 70 being associated with the other side wall.

The alternate outlet ducts 68 and 70 are staggered with respect to each other and with respect to the discharge ducts 60, and it is obvious that the gas discharged by the discharge ducts will be spread by the spreaders 64 and will flow downward to the outlet ducts 68 and 70, the holes 24 in the hearth sections facilitating the distribution and flow of the gas about the charge. The outlet ducts 68 and 70 extend through the side walls and upwardly along the walls to connect to a suitable exhausting system leading to the intake of the blower 54. This exhausting system comprises an exhaust collector pipe 72 substantially paralleling the intake distribution manifold 58 and receiving the gas flowing through the outlet ducts 68 and 70.

The ends of this pipe 72 are closed but substantially centrally thereof a pair of paralleled branch duct-passages is provided which ultimately come together and lead to the intake of the blower 54. One of these branch passages includes an air-conditioning means, while the other by-passes this air-conditioning means so that the gas flowing in the exhaust collector pipe 72 may be directly led to the blower without air-conditioning treatment or may be led to the blower after traversing the air-conditioning branch wherein the gas may be treated in any desired manner. To this end a duct 74 leads from the exhaust collector pipe 72, the duct 74 being connected to two branch duct-passages 76 and 78, the duct-passage 76 including a heat-exchange unit in the form of a cooler 80. The two duct-passages rejoin near the blower intake.

Valves 82 are provided at the gas intake and gas outlet of the cooler 80 for controlling the gas-flow through the branch duct-passage 76, and a similar valve 84 controls the gas-flow through the branch duct-passage 78; the valves being suitably controlled through suitable mechanical connections including handwheels 86 and 88 on the sides of the bell, the adjustment of the valves being indicated by an indicating means including stationary indicating scales 90 behind the handwheels and suitable indicating pointers on the handwheels.

The discharge ducts 60 are each provided with gas-flow control means in the nature of hand-operated valves controlled by handwheels 92 provided with pointers cooperating with scales on stationary back plates 94 for indicating the adjustment of the gas-flow through the associated discharge duct.

A furnace such as described has general utility for heat-treatment of metals or the like, and in operation a charge is loaded on the car base by any suitable means, the charge-supporting hearth being particularly adapted in this case to support long bars, rods or similarly shaped articles. With the bell in the raised position, the car base is run under the bell, which is then lowered so that the supporting base-frame 34 rests on the channels 98 around the periphery of the base plate 6 and forming part of the seal-

ing-trough 8. The sealing flange 46 is disposed within the trough 8 and as soon as the bell is in position, oil may be pumped into the trough to seal the heat-treating chamber. The furnace is then ready for heat-treatment and can be utilized for any one of the number of different heat-treatment purposes. For example, in the event a charge having a length substantially equal to the length of the heat-treating chamber 41 is to be annealed, a process usually involving heating to ranges about 1700–1900° F. and subsequent controlled cooling, the heating elements are suitably energized, and zone-controlled to bring the temperature up to the proper point.

For cooling a heated charge, or subsequent cooling of a preheated charge, the valves 82 and 84 may be manipulated so that recirculation of the atmosphere may be utilized to cool the charge, it being understood that energization of the blower motor is suitably controlled in the discussion of these processes, a switch 99 being shown in Fig. 4 in the energizing leads of the motor, as representative of motor-controlling means.

By controlling the operation of the blower motor, or the relative open and closed positions of the valves 82 and 84, or the flow of the refrigerant or cold water through the cooler 80, or any combination of these, the degree of cooling can be very effectively controlled.

Whenever recirculation of gas is utilized for cooling or tempering, the location of the distributing ducts 60 and outlet ducts 68 and 70 cause a thorough envelopment of the charge by the recirculating gas.

In the event that charges of less length than the chamber 41 are to be heat-treated, they may be disposed symmetrically with respect to the center of the car base and by controlling the handwheels 92 and the zone controls for the heating units, the temperature distribution in the chamber can be controlled as desired, the temperatures being indicated by any suitable thermal-responsive means in the customary manner. Such thermal responsive means may also be utilized, if desired, to automatically control the heating elements or the position of the valves in the various ducts as is known to one skilled in the art.

A furnace such as described can be utilized for annealing with controlled cooling, or for normalizing or for tempering various products. In case the furnace is used for tempering, which involves temperatures generally in the range of approximately 900° to 250° F., the cooling duct-passage 76 is closed, and duct-passage 78 opened so that the atmosphere in the chamber 41 is continuously recirculated for effecting a rapid and uniform transfer of heat to the charge by convection.

It is desirable for the general utility of my furnace to lag or heat-insulate the distributing manifold 58, the distributing duct 60, the outlet ducts 68 and 70, the exhaust pipe 72, and the duct-passage 78 to make the furnace more efficient during tempering operations. This might entail a slightly larger cooler than would be the case if these pipes were not heat insulated as is the present practice, but the slightly larger cooler represents an insignificantly increased fraction of the cost of the extra furnace for tempering, which my invention makes unnecessary.

In Figs. 4 and 5, I show modified forms of furnaces in which the air-conditioning means includes, in addition to the cooler 80, a drier 100 in the branch duct-passage 76 for the purpose of drying a controlled atmosphere fed to the furnace by a plurality of pipes 102 distributed along the bell and leading from along a manifold 104 fed with protective atmosphere by a flexible connection 106 connected to suitable atmosphere-producing equipment. A bleeder arrangement comprising a few pipes 108 extends from the top of the chamber 41 to a manifold 110 from which extends a pipe terminating in a burner tip or in proximity to a vacuum exhaust system 112. A valve 114 controls the supply of the controlled atmosphere to the furnace and a valve 116 controls the amount of atmosphere bled from the furnace since in usual practice it is desirable to continually feed a small amount of atmosphere to the heat-treating chamber 41 in order to maintain the atmosphere pure and clean. However, it must be understood that the amount of controlled atmosphere fed to the furnace is very small compared to the rate at which the atmosphere is circulated by the blower 54. Thus, for one particular design during a controlled cooling operation, the blower recirculated the gas at the rate of approximately 1000 cubic feet per minute, whereas the controlled atmosphere supplied was at the rate of approximately 10 cubic feet per minute. It should be understood, of course, that in preparing the furnace for heat-treatment with a controlled atmosphere in the heating chamber, it is first necessary to purge the furnace and conduit systems.

The drier 100 in the furnace modification shown in Fig. 4 is especially useful with certain furnaces employing non-decarburizing gases as protective or controlled atmospheres since it is desirable in such cases to remove water vapor from the atmosphere in order to maintain a low dew point.

In accordance with the objects of my invention, I have described a furnace of general utility in which charges of various lengths can be uniformly heat-treated in accordance with a selected number of different heat-treatment processes, and while I have shown preferred forms of furnaces embodying my invention, it is obvious that many changes may be made and equivalents substituted.

I claim as my invention:

1. A heat-treating bell furnace adapted for various heat-treating processes involving heating or cooling a charge, or both, the charge being substantially surrounded by a recirculating gas; comprising a base including a charge-supporting hearth; a removable insulated heating bell for said base cooperating therewith to provide a heat-treating chamber; heating means for heating said heat-treating chamber, said heating means having surfaces for emitting heat and being of the type which does not introduce combustion gases into said chamber for heating, said heating means being supported by said bell; a blower secured to the outside of said bell; conduit means secured to the outside of said bell for providing gas-flow paths to and from said blower for recirculating gas from and to said heat-treating chamber with said gas passing in direct contact with said surfaces of said heating means, said conduit means including gas-conditioning means comprising a cooler, said conduit means including by-pass ducts for said cooler and valve means for causing the gas to flow through said cooler or said by-pass ducts, said conduit means being supported by said bell, and having gas-inlet and gas-outlet openings in said bell at said

heat-treating chamber, whereby said bell with said conduit means may be raised from and lowered on said base as a unit.

2. A heat-treating bell furnace adapted for heat-treating a charge while substantially enveloped by a recirculating gas, comprising an elongated base including an elongated substantially rectangular charge-supporting hearth, an elongated substantially rectangular heating bell cooperating with said base to provide a heat-treating chamber, said base and said bell being separable, heating means for heating said heat-treating chamber, gas-conduit means including a blower, for providing gas-flow paths to and from said blower for recirculating gas from and to said heat-treating chamber, said gas-conduit means including a branch passage having therein a gas-conditioning means comprising a cooler, valve means for controlling the flow of gas through said branch passage, said gas-conduit means including a plurality of ducts having a series of gas-inlet openings and a series of gas-outlet openings at said heat-treating chamber, the openings of one of said series of openings being spaced along the length of said bell at the top thereof, and the openings of the other of said series being spaced along the length of said bell near the bottom of the sides thereof, the last said series of openings being staggered with respect to the said one series of openings, and means to control the flow of gas through said ducts.

3. A heat-treating furnace device comprising, in combination, an elongated structure comprising walls defining a heat-treating chamber having an elongated charge-supporting means therein, gas-conduit means for recirculating gas in gas-flow paths including portions in said heat-treating chamber, said gas-flow path portions being generally transverse to the length of said heat-treating chamber, said gas-conduit means including a gas-propelling means, and gas-distributing ducts providing a series of spaced gas-inlet openings and an associated series of spaced gas-outlet openings at said heat-treating chamber, the openings of one of said series of openings being spaced along the length of said chamber near the top thereof, and the openings of the other of said series of openings being spaced along the length of opposite walls of said chamber near the bottom thereof, for causing the gas-paths from said gas-inlet openings to include portions flowing directly from each gas-inlet opening to proximate gas-outlet openings.

4. A heat-treating furnace adapted for various heat-treating processes involving heating or cooling a charge, or both, comprising an outer heat-resistant structure including walls defining a heat-treating chamber having a charge-supporting hearth; heating means in said heat-treating chamber, said heating means having surfaces for emitting heat and being of the type which introduces no combustion gases into said heat-treating chamber for heating, said heating means being supported by said walls; a blower outside said structure; conduit means for providing gas-flow paths to and from said blower for recirculating gas to and from said chamber with the gas passing in contact with said surfaces of said heating means, said conduit means including gas-conditioning means comprising a cooler, said conduit means including by-pass ducts for said cooler and valve means for causing the gas to flow through said gas-conditioning means or said by-pass ducts, said conduit means having a plurality of spaced gas-inlet and a plurality of spaced gas-outlet openings distributed in said walls along the length thereof, and means for distributing the flow of the gas through said openings.

5. A heat-treating furnace adapted for various heat-treating processes involving heating or cooling a charge, or both, comprising a heat-resistant structure including walls defining an elongated heat-treating chamber, a hearth in said heat-treating chamber upon which a charge is adapted to be supported, said hearth having substantially transverse passages for the flow of gas, heating means in said heat-treating chamber having surfaces for emitting heat, said heating means being of the type which introduces no combustion gases into said heating chamber for heating, gas-conduit means for recirculating a gas in gas-flow paths including said heat-treating chamber and said passages, the gas passing in contact with said surfaces, said gas-conduit means comprising gas-propelling means outside said structure and gas-ducts providing a series of spaced gas-inlet openings and a series of spaced gas-outlet openings for said heat-treating chamber, one of said series being staggered with respect to the other of said series.

6. A heat-treating furnace adapted for various heat-treating processes involving heating or cooling a charge, or both, comprising a heat-resistant structure including walls defining an elongated heat-treating chamber, a hearth in said heat-treating chamber upon which a charge is adapted to be supported, said hearth having substantially transverse passages for the flow of gas, heating means in said heat-treating chamber having surfaces for emitting heat, said heating means being of the type which introduces no combustion gases into said heating chamber for heating, gas-conduit means for recirculating a gas in gas-flow paths including said heat-treating chamber and said passages, the gas passing in contact with said surfaces, said gas-conduit means comprising gas-propelling means outside said structure and gas-ducts providing a series of spaced gas-inlet openings and a series of spaced gas-outlet openings for said heat-treating chamber, one of said series of openings being near the top of said structure and the other of said series being near the bottom of said structure.

7. A heat-treating furnace adapted for various heat-treating processes involving heating or cooling a charge, or both, comprising a heat-resistant structure including walls defining an elongated heat-treating chamber, a hearth in said heat-treating chamber upon which a charge is adapted to be supported, said hearth having substantially transverse intercommunicating passages for the flow of gas, heating means in said heat-treating chamber having surfaces for emitting heat, said heating means being of the type which introduces no combustion gases into said heating chamber for heating, gas-conduit means for recirculating a gas in gas-flow paths including said heat-treating chamber and said passages, the gas passing in contact with said surfaces, said gas-conduit means comprising gas-propelling means outside said structure and gas-ducts providing a series of spaced gas-inlet openings and a series of spaced gas-outlet openings for said heat-treating chamber, one of said series of openings being near the top of said structure and the other of said series being near the bottom of said structure, with one series in staggered relation to the other series.

8. A heat-treating furnace adapted for various heat-treating processes involving heating or cooling a charge, or both, comprising a heat-resistant structure including walls defining an elongated heat-treating chamber, a hearth in said heat-treating chamber upon which a charge is adapted to be supported, said hearth having substantially transverse passages for the flow of gas, heating means in said heat-treating chamber having surfaces for emitting heat, said heating means being of the type which introduces no combustion gases into said heating chamber for heating, gas-conduit means for recirculating a gas in gas-flow paths including said heat-treating chamber and said passages, the gas passing in contact with said surfaces, said gas-conduit means comprising gas-propelling means outside said structure and gas-ducts providing a series of spaced gas-inlet openings and a series of spaced gas-outlet openings for said heat-treating chamber, one of said series of openings being near the top of said structure and the other of said series being near the bottom of said structure, said gas-conduit means further comprising a gas-conditioning means, by-pass ducts for by-passing said gas-conditioning means, and valve means for controlling the flow of gas through said gas-conditioning means and said by-pass ducts.

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