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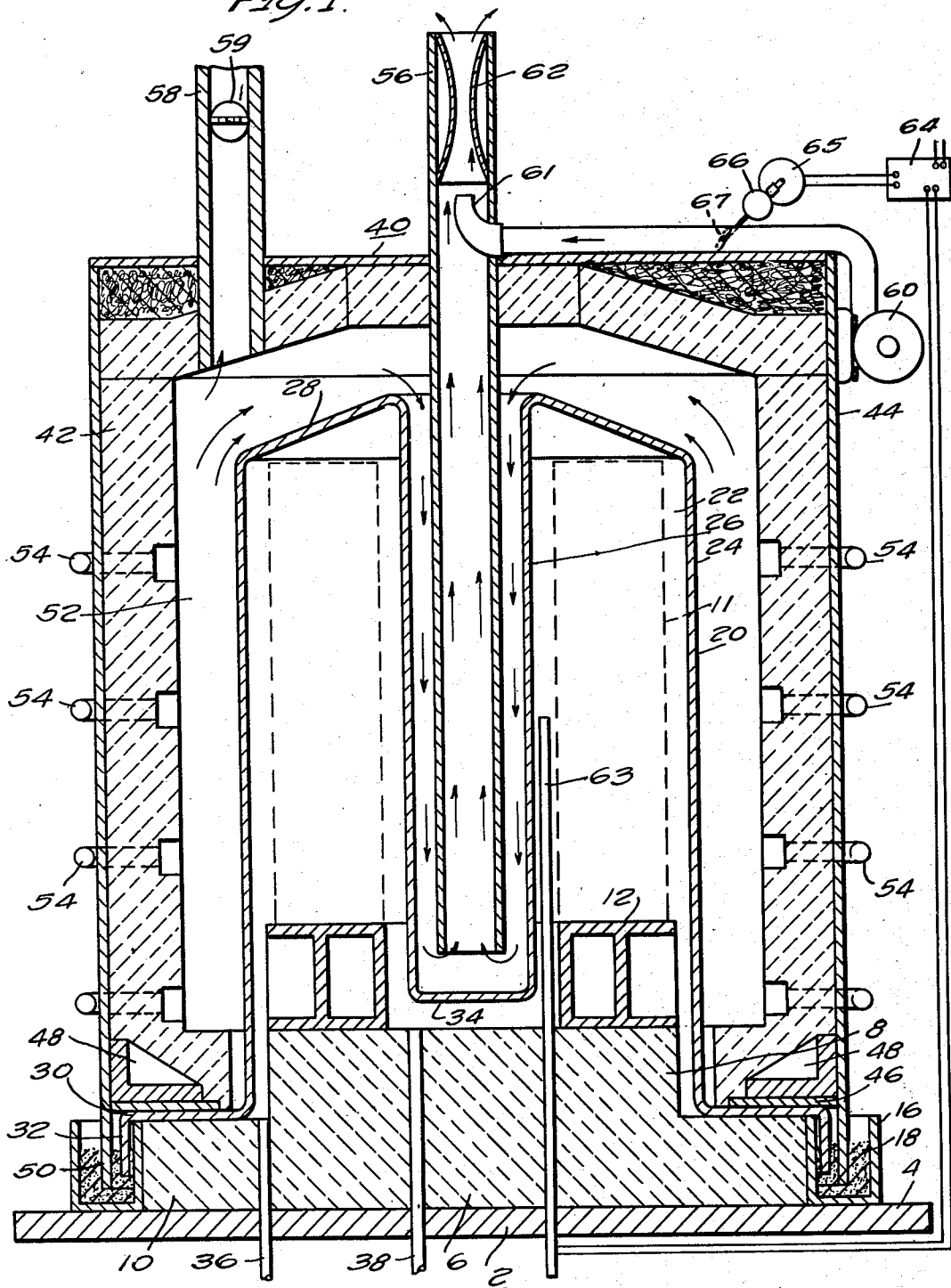
2,303,901

DIRECT GAS-FIRED BELL FURNACE

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2 Sheets-Sheet 1

Fig. 1.



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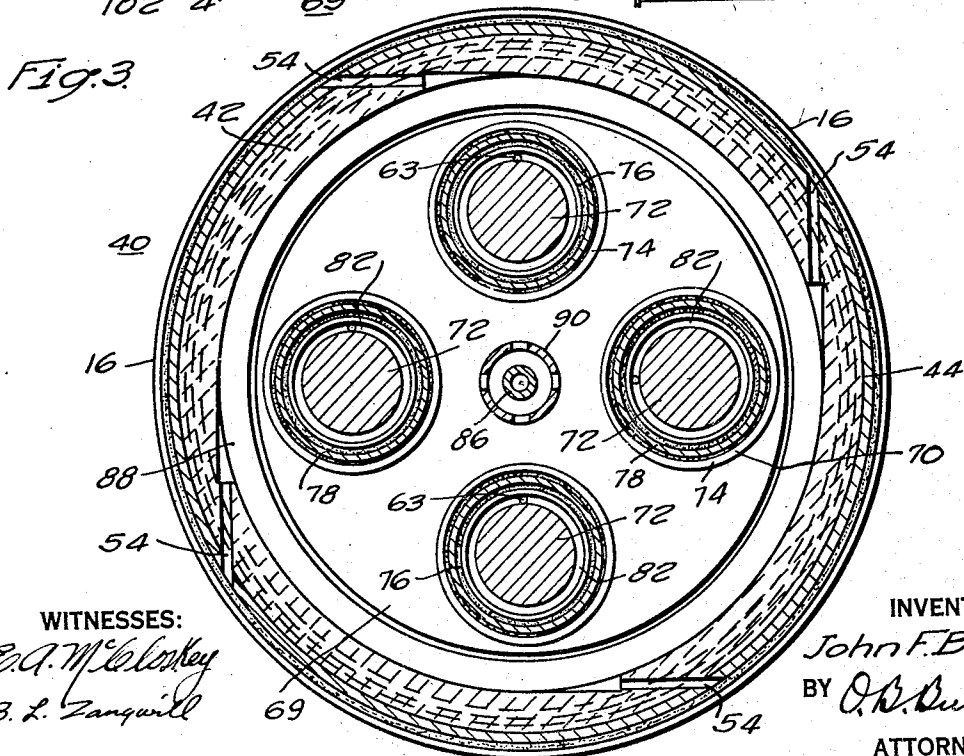
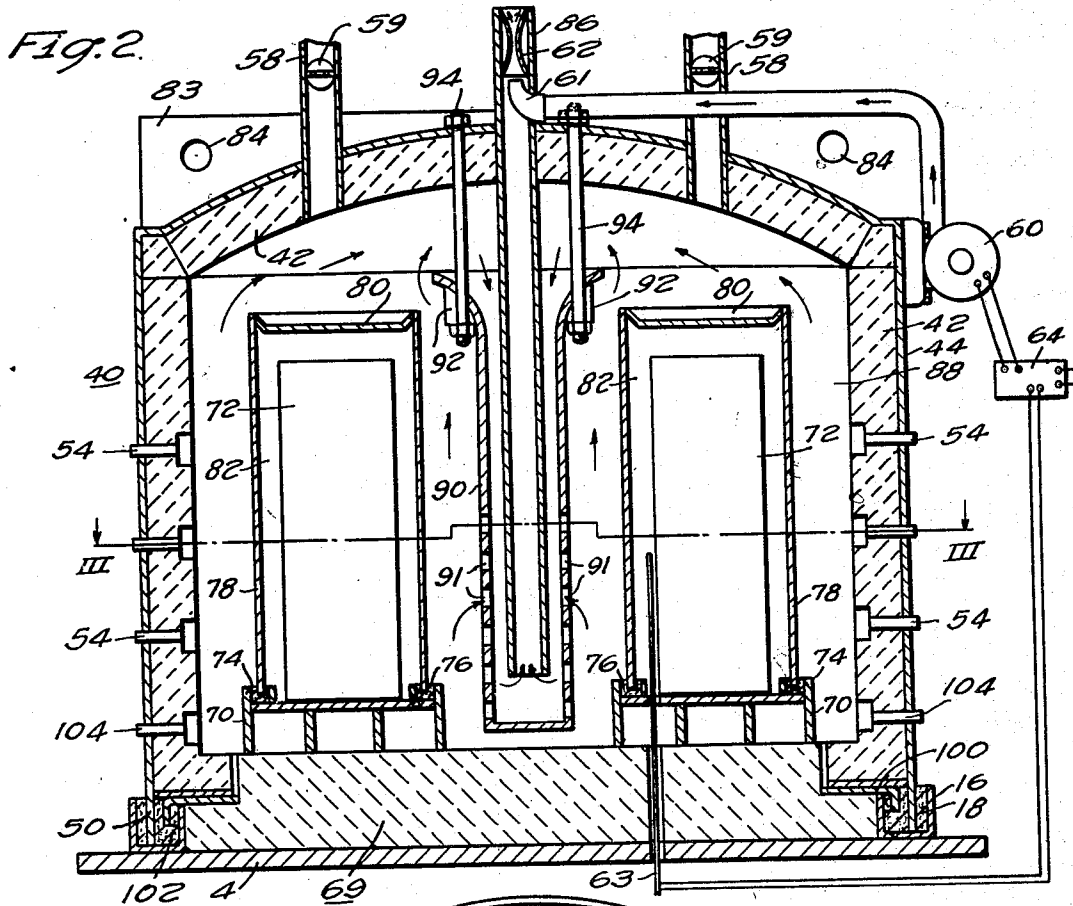
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DIRECT GAS-FIRED BELL FURNACE

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2 Sheets-Sheet 2



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2,303,901

DIRECT GAS-FIRED BELL FURNACE

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Application January 15, 1941, Serial No. 374,491

8 Claims. (Cl. 266—5)

This invention relates to direct gas-fired industrial heat-treating furnaces of the type having a charge heat-treatment chamber formed by a charge-supporting means or hearth and a metallic inner hood, the hood being encompassed by a heating bell. In a furnace of this kind, the heat-treatment chamber is permeated by a controlled or protective atmosphere for enveloping the charge being heat-treated.

It is an object of my invention to provide a furnace of the type described which is economical in operation, which will uniformly heat-treat the charge, in which the temperatures within the heat-treatment chamber are uniformly distributed, and in which the hood is completely enveloped by the heating fluid discharged in the heating space between the hood and the bell.

It is among the objects of my invention to provide a direct gas-fired furnace of the type described in which the burning or burnt gases in the heating space between the hood and the bell are made to completely encompass the hood for uniform and more efficient heating, whereby the available heat in the burning or burnt gases is utilized to the utmost extent for heating the charge.

It is an object of my invention to provide a direct gas-fired bell furnace having an annular charge-treating space defined by an annular encompassing hood in which the charge is heated by heat supplied by the combustion gases at both the inside and outside portions of the exterior of the hood.

It is also an object of my invention to provide a means for controlling the flow of gases to the inner central space of the annular hood so that the heat supplied to the inner exterior of the hood can be controlled, preferably in such manner that more heat is supplied at the beginning of a heat-treatment, the heat being gradually decreased as the charge approaches its desired maximum temperature.

Other objects, features and innovations of my invention, in addition to those more specifically mentioned above, will be apparent from the following description thereof which is to be taken in conjunction with the accompanying, somewhat schematic, drawings in which similar reference numerals refer to similar parts. In these drawings:

Figure 1 is a vertical sectional view of one form of industrial heat-treating furnace embodying the teachings of my invention, which furnace has a single hood within the heating bell;

Fig. 2 is a vertical sectional view of a modified

form of furnace embodying the teachings of my invention, which furnace has a bell capable of encompassing a plurality of hoods; and

Fig. 3 is a horizontal sectional view of the furnace of Fig. 2, taken substantially on the line III—III of Fig. 2.

Referring more particularly to the embodiment shown in Fig. 1, the furnace comprises a base indicated in its entirety by the reference numeral 2, the base comprising a metallic base plate 4, supported or reinforced in any suitable manner. The base plate 4 supports a non-metallic refractory bed 6 which is stepped to provide a central, charge-supporting portion 8 which is raised above the outer peripheral portion 10. The portion 8 comprises a hearth for a charge 11, the charge resting upon a heat-resistant metallic framework 12 on top of the hearth.

The particular furnace of the embodiment of Fig. 1 is designed for heat-treating charges of annular form such as coils of wire and coils of steel strip. Accordingly, the furnace is generally circular in shape, with a circular base, and the framework 12 is annular, having a maximum diameter substantially equal to the diameter of the portion 8. The base also includes a peripheral gas-sealing means in the form of a metallic channel 16 adapted to contain a suitable sealing medium 18 which may be any usual finely divided sand or preferably a liquid.

A thin metallic inner hood 20 cooperates with the charge-supporting means to provide a somewhat annular heat-treatment chamber 22 in which the charge 11 is disposed. The hood comprises a substantially vertical outer cylindrical member 24 and a substantially vertical inner cylindrical member 26, with a top bridging portion or member 28 closing the top edges of the vertical members 24 and 26 of the hood. The outer cylindrical member 24 terminates at the bottom in a peripheral skirt 30 which, in the particular embodiment, is horizontally disposed and rests on top of the outer section 10 of the refractory bed 6. Depending from the skirt is a peripheral sealing flange 32 disposed in the sealing medium 18. The inner hood member 26 is closed at the bottom by a closing member 34. The hood is substantially gas-tight and in conjunction with the base plate 4 and the gas sealing expedients comprising the channel 16, the sealing medium 18 and the sealing flange 32 substantially gas-tightly encloses the heat-treatment chamber 22, so that the charge may be enveloped by any suitable or desired atmosphere which is conducted to the heat-treatment chamber through

an inlet pipe 36. The atmosphere in the heat-treatment chamber may be maintained clean and pure by continually supplying fresh gas to the chamber, and venting gas through an outlet pipe 38.

The hood and the heat-treatment chamber which it defines are heated by means of an insulated cylindrical outer heating bell indicated in its entirety by the reference numeral 40, the bell comprising suitable non-metallic insulating and heat resistant walls 42 provided with an outer metallic substantially gas-impervious shell or jacket 44 in the usual manner. The bell is removably placeable on the base by eye-bolts or equivalent means, not shown, provided on the top of the bell to enable the bell to be raised or lowered. The bell is provided with a lower metal annular strengthening and refractory-supporting plate 46 reinforced by any suitable gussets 48, or the equivalent, the strengthening plate resting on the skirt 30 so that the bell is supported by the base 2. The shell 44 is provided with a depending peripheral sealing flange 50 disposed in the sealing medium 18 to assure a gas-tight heating space 52 between the bell and the hood. A plurality of vertically spaced horizontal rows of tangentially firing gas burners 54 are provided in the bell 40 for heating the charge.

In order to assure a thorough envelopment of the hood by heating gases and, therefore a uniform and efficient heating of the charge, the center of the top of the bell is provided with an opening in which is disposed a heat-resistant metallic pipe 56 secured to the top of the bell and having a lower portion depending therefrom, and extending to a point somewhat above the closing member 34. This pipe 56 may be all or part of a flue means for exhausting the heating gases discharged by the burners 54. If desired, any desired number of additional flues such as 58 may be distributed over the upper portion of the bell close to the side walls, these flues having damper means 59 for controlling the amount of heating gases passing through them.

With the arrangement shown, it is evident that combusted gases will follow the paths indicated by the arrows in Fig. 1, a large part of the heating gases flowing over the top bridging member 28 down the outer sides of the inner cylindrical member 26 and then flowing out of the heating space through the flue pipe 56. The amount of discharge gases flowing through the pipe 56 may be controlled by adjusting the position of the dampers 59, or by a draft-establishing means in the form of a blower driven by a variable speed motor 60, injecting an air blast upwardly in the pipe 56 through a conduit or air supply line terminating in a nozzle 61, the nozzle being part of an injector of the Venturi type formed with a tubular element 62 in the pipe 56 having flaring ends in a known manner.

A temperature responsive means 63 disposed about midway inside the hood near the inner cylinder 26 actuates any suitable control mechanism 64, including a reversible motor 65 and a speed-reducing gearing 66, for controlling the position of a damper or valve 67 in the air supply line to the nozzle 61. If desired, the temperature responsive control means may act directly on the motor 60 of the blower, controlling its speed, this modification being shown in Fig. 2.

The amount of exhaust gases flowing through the flue pipe 56 may be controlled by means of the motor-operated damper or valve 67 in the air supply line to the nozzle 61, a varying air

blast from the nozzle sucking more or less of the furnace gases through the exhaust flue pipe 56, thereby varying the heat applied to the inner circumference of the hood. The temperature responsive means actuates the operating mechanism for setting the position of the damper or valve 67 in accordance with the temperature at the inner periphery of the charge. This control of the damper or valve 67 may be synchronized with the operation of a pyrometer, which may also be the mechanism 64, for controlling the fuel input to the gas burners for heating, or maintaining the temperature of, the charge 11.

By having the gas burners discharge substantially tangentially in the annular heating space, a swirling movement is initially imparted to the heating gases, which persists to some extent in the portion of the gases passing over the top of the hood and sweeping downwardly inside the central depression of the hood to the inlet of the flue pipe 56.

By means of the furnace described, a very effective and uniform heating can be obtained, since the flow of the combusted gases can be quite readily controlled and distributed because the relative amounts of discharging gases passing through the central discharge flue and the outer flues 58 are automatically changed by operation of damper 67 in Fig. 1, or by a change in the speed of the motor 60 in Fig. 2. By closing the dampers 59 substantially all of the heating gases may be made to flow through the flue pipe 56, and conversely, if desired, by opening these dampers and shutting off the air supply to the nozzle 61, substantially all of the heating gases may be made to flow through the flues 58. Intermediate conditions are obtained by control of the injected draft flowing through the nozzle 61, this operation being automatically controlled in the instant embodiments. However, it is obvious that the dampers 59 and 67 may be hand-controlled, or both automatically controlled. Additionally, the provision of a complete seal at the bottom of the heating space 52 prevents chimney effects, thereby eliminating the possibility of unpredictable volumes of air being sucked into the heating space and disturbing controlled combustion, a feature more particularly described in the application of J. H. Germany, Serial No. 298,461, filed October 7, 1939, and assigned to the Westinghouse Electric & Manufacturing Company.

Figs. 2 and 3 show the application of my invention to a furnace of the type having a single heating bell capable of encompassing a plurality of cylindrical hoods. In this embodiment, the charge-supporting base refractory 69 has an enlarged hearth comprising a plurality of heat-resistant metallic skeleton frameworks 70 generally circular in form and having a solid charge support. The frameworks 70 support charges 72 which might be a plurality of coils of wire as before or coils of sheet metal. Each of the skeleton frameworks 70 is provided with a peripheral sealing channel 74 containing a finely divided non-metallic refractory sand 76 for gas-sealing the lowermost edges of a metallic inner hood 78 which is formed of a cylindrical member closed by a top member 80 to provide a substantially gas-tight heat-treatment chamber 82.

The skeleton frameworks 70 are disposed within the heating bell 40 and spaced from the walls of the bell and from its central axis. In the particular embodiment four such frameworks are symmetrically arranged about the center of the furnace.

The top of the bell is provided with a plate 83

having eyes 84 for the reception of a crane hook or the like for moving the bell. Distributed around the top of the bell, close to its vertical walls, are a plurality of flues similar to the flues 58 of the embodiment of Fig. 1, having similar dampers 59; and supported by the bell centrally thereof is a flue pipe 86 which projects downwardly into a heating space 88 within the bell. Spaced about the flue pipe 86 is a gas-diverting baffle 90 provided with a plurality of holes 91 around its lower portion. This baffle is in the form of a pipe with an outwardly flared upper end provided with lugs 92 for engaging the heads of bolts 94 by means of which it is supported from the top of the bell. The heating bell rests on an annular plate 100 on the base, having a periphetal sealing flange 102 disposed in the sealing medium 18.

The heating bell of the embodiment of Fig. 2 also comprises a series of horizontally spaced gas burners arranged in vertically spaced rows. However, the lowermost row of burners 104 are arranged to discharge gases somewhat directly toward the center of the furnace whereas the other rows of burners 54 fire tangentially, as shown in Fig. 3. It is evident that draft establishing means may be provided for the flue pipe 86 which is similar to that shown in the embodiment of Fig. 1.

By means of the central flue the heating gases in the heating space 88 can be made to entirely envelope the inner hoods 78. By providing the burners 104 discharging between the hoods and through the skeleton frameworks the envelopment of the hoods by heating gases is made even more effective. Burnt gases are discharged through the flues 58 and the flue-pipe 86. The baffle 90 prevents undue turbulence of the heating gases within the center of the furnace, and, moreover, compels a good portion of the gases to flow toward the top of the heating bell where they enter into the flared inlet of the baffle, as indicated by the arrows, and progress between the baffle and the flue pipe 86 until they reach the bottom of the latter from whence gases are discharged. The apertures around the bottom of the baffle 90 also admit some of the heating gases directly to the flue pipe.

The bottom termination of the flue pipes 56 and 86 can be adjusted to suit the particular design of a furnace, but in general in furnaces following the specific structures described, the bottoms of these pipes are fairly close to the bottom of the heating spaces.

While I have shown my invention in forms for illustrating the teachings thereof, it is clearly evident that many equivalents, modifications and applications will immediately occur to those skilled in the art.

I claim as my invention:

1. A furnace for the heat-treatment of charges in a protective atmosphere, said furnace comprising a charge-supporting base having a hearth, an inner metallic hood having a central depression, said hood cooperating with said hearth for providing an enclosed substantially annular heat-treatment chamber in which a charge may be heat-treated, said hood having a portion closing the bottom of said depression, a removable outer heating bell substantially encompassing and spaced from said hood, said bell and said hood cooperating to provide a heating space between said hood and bell, means for directly discharging heating gases into said heating space between said bell and said hood for heating said hood by substantially surrounding

said hood with said gases, and flue means for said gases comprising a flue portion in said depression having an intake in the lower part of said depression, whereby said gases substantially envelope the portion of said hood defining said heat-treating chamber.

2. A furnace for the heat-treatment of charges in a protective atmosphere, said furnace comprising a charge-supporting base having a hearth, an inner metallic hood having a central depression, said hood cooperating with said hearth for providing an enclosed substantially annular heat-treatment chamber in which a charge may be heat-treated, a removable outer heating bell substantially encompassing and spaced from said hood, said bell and hood cooperating to provide a heating space between said bell and hood, means comprising burners carried by said bell, for directly discharging heating gases into said heating space between said bell and said hood for heating said hood by substantially surrounding said hood with said gases, and flue means in said depression, comprising an intake in the lower part of said depression and a discharge through the top portion of said bell, whereby the gases substantially envelope the portion of said hood defining said heat-treating chamber.

3. A furnace for the heat-treatment of charges in a protective atmosphere, said furnace comprising a charge-supporting base having a hearth, an inner metallic hood having a central depression, said hood cooperating with said hearth for providing an enclosed substantially annular heat-treatment chamber in which a charge may be heat-treated, a removable outer heating-bell cooperating with said hood for providing a heating space between said hood and said bell, means for directly discharging heating gases into said heating space between said bell and said hood for heating said hood by substantially surrounding said hood with said gases, and flue means for said heating gases comprising a flue pipe depending from said bell, having a discharge opening aligned with a flue opening in the top of said bell, said pipe depending into said depression, whereby the gases substantially envelope the portion of said hood defining said heat-treating chamber.

4. A furnace for the heat-treatment of charges in a protective atmosphere, said furnace comprising a charge-supporting base having a hearth, an inner metallic hood having a central depression, said hood cooperating with said hearth to provide an enclosed substantially annular heat-treatment chamber in which a charge may be heat-treated, a removable outer heating bell substantially encompassing and spaced from said hood, said bell and said hood cooperating to provide a heating space, means for directly discharging heating gases into said heating space for heating said hood by substantially surrounding said hood with said gases, and flue means in said depression, comprising flue passage means having an intake in the lower part of said depression and a discharge through the top portion of said bell, said flue means further comprising additional spaced flue passage means, and means for controlling the flow of said heating gases through said flue passage means, whereby the gases substantially envelope the portion of said hood defining said heat-treating chamber.

5. A furnace for the heat-treatment of charges in a protective atmosphere, said furnace comprising a base having charge-supporting means,

inner metallic hood means cooperating with said base for substantially gas-tightly enclosing the material being heat treated, an outer heating bell substantially encompassing and spaced from said inner hood means to provide a heating space, means for directly discharging heating gases into said heating space for heating said hood means by substantially surrounding said hood means with said heating gases, said discharge of heating gases being in proximity to the sides of said heating bell, flue means for said gases comprising a flue pipe having an intake near said base and an outlet aligned with a flue outlet in the top of said heating bell, said pipe being disposed with said inner hood means between said pipe and the said sides of said bell, and gas-directing means comprising a second pipe about said first pipe, said second pipe having openings at each of its ends.

6. A furnace for the heat-treatment of charges in a protective atmosphere, said furnace comprising a charge-supporting base having a hearth, an inner metallic hood having a central depression, said hood cooperating with said hearth for providing an enclosed substantially annular heat-treatment chamber in which a charge may be heat treated, a removable outer heating bell substantially encompassing and spaced from said hood for providing a heating space, means for directly discharging heating gases into said heating space between said bell and said hood for heating said hood by substantially surrounding said hood with said heating gases, flue means comprising a flue pipe depending from said bell into said depression, having a discharge opening aligned with a flue opening in the central portion of the top of said bell, said flue means further comprising other flue passages in said bell, and temperature responsive means for controlling the relative amount of said gases passing through said flue pipe and flue passages.

7. A furnace for the heat-treatment of charges, said furnace comprising a base having charge-supporting means, inner metallic hood means cooperating with said base for substantially gas-tightly enclosing the charge to be

heat-treated, an outer insulated bell substantially encompassing and spaced from said inner hood means for providing a heating space, means for directly discharging heating gases into said heating space along and in proximity to the sides of said insulated bell, and gas-flow-controlling means for causing said heating gases to flow and be distributed about the sides and top of the hood means exposed to said heating space, said gas-flow-controlling means comprising gas-passage means including a pipe having an intake near said base, and an outlet aligned with an opening in the top of said heating bell, said pipe being located in said heating space with said inner hood means between said pipe and the sides of the bell, said gas-flow-controlling means further comprising additional spaced flue-passage means having an intake in the top portion of said heating bell.

8. A furnace for the heat-treatment of charges, said furnace comprising a base having charge-supporting means, inner metallic hood means cooperating with said base for substantially gas-tightly enclosing the charge to be heat-treated, an outer heating bell substantially encompassing and spaced from said inner hood means for providing a heating space, means for directly discharging heating gases into said heating space along and in proximity to the sides of said heating bell, and gas-flow-controlling means for causing said heating gases to flow and be distributed about the sides and top of the hood means exposed to said heating space, said gas-flow-controlling means comprising gas-passage means including a pipe having an intake near said base, and an outlet aligned with an opening in the top of said heating bell, said pipe being located in said heating space with said inner hood means between said pipe and the sides of the bell, said gas-flow-controlling means further comprising additional spaced flue-passage means having an intake in the top portion of said bell, and means for controlling the relative flow of gases through said gas-passage means.

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