Feb. 29, 1944. H. G. ELDER ET AL 2,343,004

METALLURGICAL FURNACE AND METHOD OF FIRING THE SAME

Filed Oct. 29, 1940 2 Sheets-Sheet 1

FIG. 1.

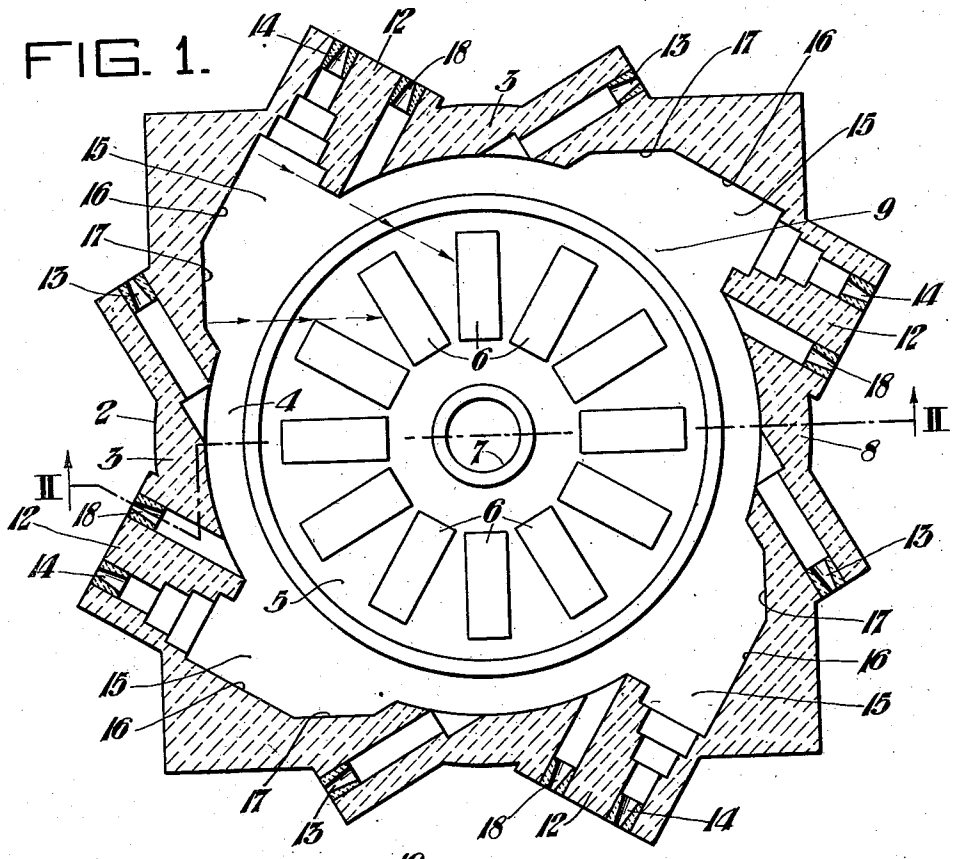
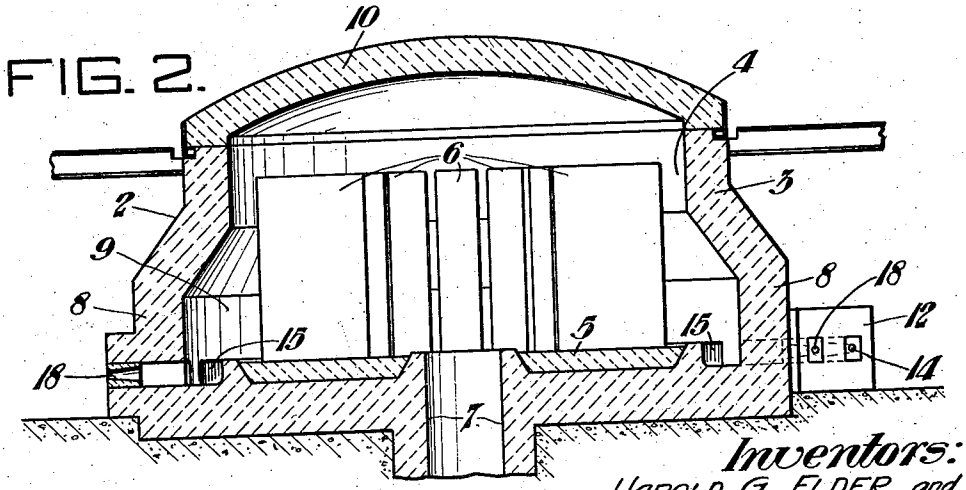


FIG. 2.



Inventors:
HAROLD G. ELDER and
JOHN F. MOWAT,
by: John E. Jackson
their Attorney.

Feb. 29, 1944. H. G. ELDER ET AL 2,343,004

METALLURGICAL FURNACE AND METHOD OF FIRING THE SAME

Filed Oct. 29, 1940 2 Sheets-Sheet 2

FIG. 3.

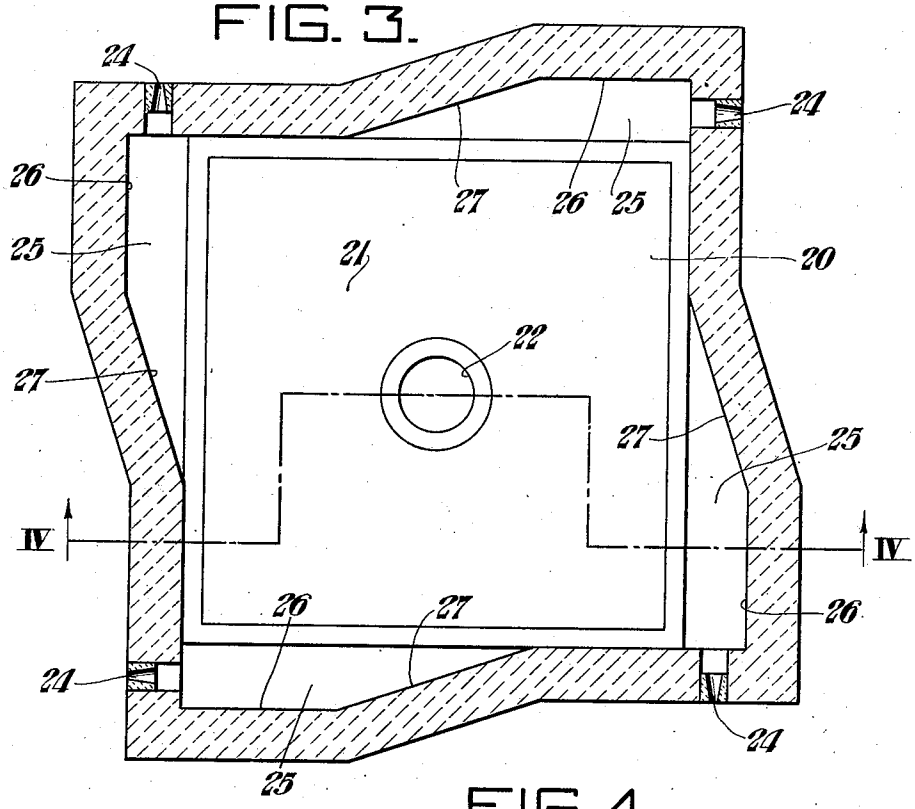
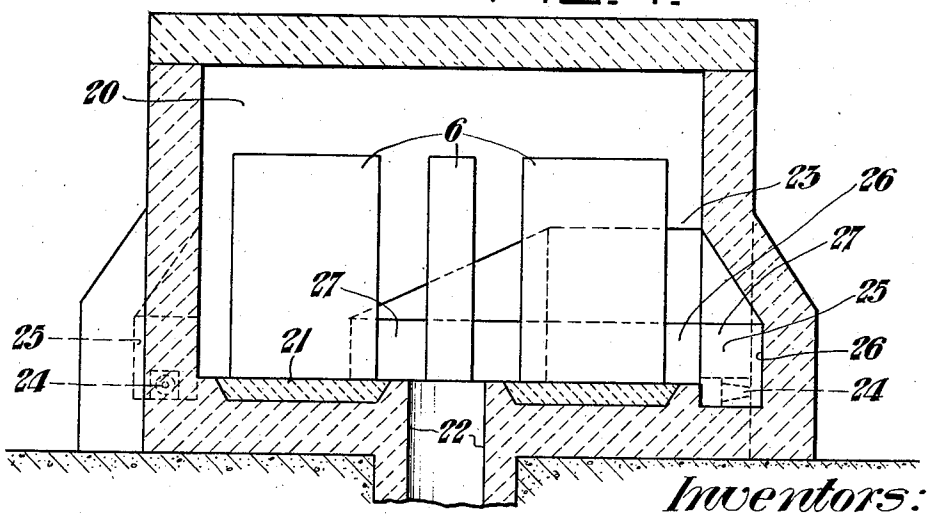


FIG. 4.



Inventors:
HAROLD G. ELDER and
JOHN F. MOWAT
by: John E. Jackson
their Attorney.

Patented Feb. 29, 1944 2,343,004

UNITED STATES PATENT OFFICE

2,343,004

METALLURGICAL FURNACE AND METHOD OF FIRING THE SAME

Harold G. Elder, Chicago, and John F. Mowat, La Grange, Ill.

Application October 29, 1940, Serial No. 363,336

6 Claims. (Cl. 263—43)

This invention relates to furnaces and, particularly, to an improved metallurgical furnace for heating ingots and the like and to an improved method of operating the same.

Various types of furnaces, more commonly called soaking pits, have been heretofore suggested and used for heating ingots and the like. Such furnaces are usually heated by means of burners arranged in the side walls thereof which usually burn a rich fuel gas for firing the same, such as coke oven gas, natural gas, or oil, with cold air supplied for combustion in a manner well known to those skilled in the art. While some of these furnaces have been satisfactory in their operation and use, others have been unsatisfactory, and in most furnaces the burners were so positioned therein that the flame produced thereby was in extremely close proximity to the ingots being heated therein. In such furnaces it was therefore necessary to limit the flame temperature by carefully controlling the fuel input to the burners so as to avoid overheating of the ingots and consequent melting or burning of the metal from which the ingots were made which was not only inconvenient and troublesome, but also inefficient and relatively expensive in their operation.

Accordingly, it is one of the objects of the present invention to provide an improved furnace for heating ingots and the like which is simple and inexpensive in its construction and operation and at the same time, a furnace which uses less fuel than any furnace heretofore suggested or used, thereby resulting in increased efficiency.

It is another object of the invention to provide an improved furnace for heating ingots and the like in which the time for heating the ingots or articles therein has been reduced to a minimum due to the extremely high rate of heat initially supplied to the furnace.

It is a further object of this invention to provide a furnace for heating ingots and the like of an improved construction and an improved and more economical method of firing and operating the same.

Various other objects and advantages of this invention will become more apparent in the course of the following specification, and will be particularly pointed out in the appended claims.

In the accompanying drawings there is shown, for the purpose of illustration and description, one embodiment and a modification thereof, which our invention may assume in practice.

In these drawings:

Figure 1 is a horizontal section through the improved metallurgical furnace or soaking pit of our invention;

Figure 2 is a vertical section taken on the line II—II of Figure 1;

Figure 3 is a horizontal section similar to Figure 1 showing a furnace or soaking pit of a slightly modified construction in accordance with our invention; and,

Figure 4 is a vertical section taken on the line IV—IV of Figure 3.

Referring more particularly to Figure 1 of the drawings, there is shown a conventional type circular furnace 2 or soaking pit for heating ingots and the like comprising a circular side wall 3, usually made of refractory brick, so as to furnish a cylindrical-shaped heating chamber 4 therein having a flat hearth 5 arranged centrally thereof upon which the ingots 6 or articles to be heated are placed in special relation to each other as shown in Figure 1. There is arranged in the center of the heating chamber 4 and extending through the hearth 5 a vertically arranged outlet port 7 for the downward removal of the waste gases from the heating chamber. The bottom portion of the side walls 3 of the furnace is extended outwardly therearound as at 8 so as to provide an annular main combustion chamber 9 between the outer ingots or articles and the inner side of the bottom side wall portions 8 within the heating chamber. There is provided a dome-shaped refractory top 10 which is removable for the purpose of charging the ingot or articles to be heated into the furnace and for removing the same therefrom.

According to the present invention, there is suitably arranged at spaced apart intervals around the furnace in the outwardly extending bottom portion 8 of the circular side wall 3 opposite the main combustion chamber 9 of the heating chamber, a plurality of pairs of horizontally disposed burners 12, namely, four pairs in the present instance, and there is arranged between each of the pairs of burners 12 a horizontally disposed single burner 13. Both the pairs of burners 12 and the single burner 13 are arranged preferably in the same plane angularly relative to the circumference of the side wall 3 and substantially tangential to the annular main combustion chamber 9 so as to provide for substantially tangential firing thereof into the combustion chamber whereby the gases will pass through the same in one direction with sufficient velocity to remain in the combustion chamber for several turns, thus diluting the burning gases with products of combustion and increasing the

volume of gas brought to uniform temperature which is finally forced into the center of the heating chamber between and around the ingots or articles therein by the incoming gases. The stack draft is controlled by means of a suitable damper (not shown) which maintains a substantially balanced furnace pressure through the removal of the products of combustion as rapidly as they are formed.

There is arranged directly opposite each of the outermost burners 14 of each of the pairs of burners 12 in the bottom portion 8 beyond the main combustion chamber 9 and communicating therewith, an enlarged opening or combustion chamber 15 having the outer side wall 16 of each of them arranged substantially parallel to their respective burners 14 at a spaced distance from the main cumbustion chamber 9 and terminating in a side wall 17 which is substantially tangent to the inner side wall of the heating chamber and outer side of the combustion chamber so that the heat produced by the outermost burners 14 associated with the enlarged openings or combustion chambers 15 will be radiated inwardly by the side walls 16 and 17 thereof toward the center of the heating chamber so as to heat the outer portions of the articles, as is clearly shown in Figure 1 of the drawings, with the hot gases adapted to circulate and heat those portions of the articles not directly affected or heated by such radiation.

The outermost burners 14 associated with each of the enlarged openings or combustion chambers 15 are supplied preferably with a relatively high temperature preheated air draft, preferably from 1600° F. to 2000° F. and the innermost burner 18 of each of the pairs of burners 12 together with each of the single burners 13 is supplied preferably with an unheated or relatively low temperature air draft, preferably 1200° F. maximum. Thus it will be seen that due to the fact that the outermost burners 14 together with the enlarged combustion chambers 15 associated therewith are located a considerable distance from the ingots, a short sharp flame may be used, and it is permissible to provide a temperature which need necessarily be limited only by the refractories from which the side walls 16 and 17 of the combustion chambers 15 are made, thus permitting the use of air preheated from 1600° F. to 2000° F.

During the first part of the cycle, when the furnace is charged either with cold ingots or ingots from which the molds have been recently stripped, and which contain considerable residual heat, it is permissible to carry a higher temperature in the furnace than when the ingots approach the rolling temperature at which they are to be drawn, this temperature varying with the type of steel or other material to be heated from 2200° F. to possibly 2600° F. During this part of the cycle, all burners are used, with the high temperature air supplied to burners 14.

When the temperature of the ingots or articles to be heated rises, the fuel input to burners 18 and 13 may be reduced, and the greater part of the heating done by means of burners 14. Under these conditions, with little or no heat input from burners 18 and 13, it would be impossible to heat uniformly by convection and conduction. To overcome this objection, the vertical walls 16 and 17 are thus provided and so arranged that radiant heat will be supplied backwards to the intermediate ingots, while the hot gases themselves circulate and heat those portions of ingots not directly affected by such radiation.

The operation may be accomplished in several ways, either manually or automatically, but preferably is accomplished through automatic control (not shown) as follows:

A temperature control of any known type may be inserted in the furnace at one or more points adjacent the material being heated to maintain a rate of heat input sufficient to raise the temperature within the furnace at a regulated rate to a predetermined maximum temperature, which temperature is then maintained until the heating cycle is completed, and the ingots or other articles to be heated are ready to be withdrawn from the furnace. The control is arranged to regulate both sets of fuel burners. The outermost burners 14, or those associated with the large combustion chambers will be supplied with air from conventional recuperators or other heat exchangers at a high temperature, while the remainder of the burners, namely, burners 13 and 18, will be supplied with air at lower temperature with the air either being heated in an independent recuperator of a smaller capacity or taken from the high temperature recuperator at a point where the air has been heated to the desired lower temperature, but has not remained in the recuperator in contact with the heating elements long enough to attain the maximum temperature required for the high temperature burners.

In operation, the control opens the fuel valves of all burners to the maximum position at the beginning of the cycle, when the furnace is relatively cool, in order to maintain the maximum rate of heat input. As the temperature of the furnace rises and the ingots begin to heat up, the control, at a predetermined temperature, begins to reduce the fuel admitted to the burners 13 and 18 using the lower temperature air. At the same time, the known fuel-air ratio control, which proportions the fuel and air to all burners, reduces the air required for cumbustion in proportion to the adjusted fuel flow. Under some conditions, it may be preferable for the temperature control to regulate the amount of air for combustion, in which case the fuel ratio control will proportion the fuel to the regulated amount of air. The reduction of fuel to the lower temperature burners continues to a second predetermined temperature, at which point the fuel may be reduced to a pilot flame, of a volume only sufficient to maintain ignition. Instead of reducing the fuel input in this manner, it may be desirable to reduce it independently of the higher temperature, cutting off fuel at a definite rate per unit of time, until the minimum input required by the pilot flame is reached.

During either of these operations, the high temperature burners 14 continue to operate at the maximum rate of heat input, until the furnace temperature reaches the predetermined maximum, at which time the control regulates the fuel input to the high temperature burners to maintain any desired temperature until the ingots are ready to be withdrawn from the furnace.

In Figures 3 and 4 of the drawings, there is shown a furnace of a slightly modified construction in accordance with the present invention. In this construction the furnace is substantially square or rectangular in shape having a heating chamber 20 arranged therein with a hearth 21 upon which the ingots or articles to be heated

are placed. There is arranged centrally of the hearth 21, as before, an outlet port 22 for removal of the waste gases from the heating chamber. The hearth 21 together with the ingots or articles to be heated is arranged so as to provide a main combustion chamber 23 therearound between the inner walls of the heating chamber and the ingots or articles therein. At each corner of the furnace there is arranged in the side walls adjacent the bottom thereof a horizontally disposed burner 24, similar to the outer burners 14 in the preferred construction, which are substantially tangent to the main combustion chamber 23 with each burner having an enlarged opening or combustion chamber 25 associated therewith in the adjacent side wall of the furnace similar to the enlarged combustion chambers 9 in the furnace of the preferred construction and communicating with the main combustion chamber 23. Each of the enlarged combustion chambers 23 has a side wall 26 disposed substantially parallel to its respective burner 24 and the main combustion chamber, and which terminates in an angularly disposed side wall 27 so that the heat produced by the burners will be radiated inwardly toward the center of the furnace as before.

In this modified construction the burners 24 are supplied preferably with a relatively high temperature preheated air draft as are the burners 14 of the preferred construction and after the furnace has reached a predetermined maximum temperature and it is desired to withdraw the ingots or articles being heated from the furnace, the fuel inflow of those burners is regulated and reduced as desired as before. In such construction it will be seen that the low temperature draft burners, such as burners 13 and 18 in the preferred construction have been eliminated.

While we have shown and described one embodiment and a modification thereof of the present invention, it will be seen that we do not wish to be limited exactly thereto, since various other modifications may be made without departing from the scope of the invention, as defined by the following claims.

We claim:

1. In a furnace of the class described for heating ingots and the like including a heating chamber having a hearth arranged in the center of the heating chamber upon which the articles to be heated are placed with an outlet port arranged centrally of the hearth through which the waste gases pass out from the heating chamber, and a main combustion chamber arranged around the furnace and the hearth at the bottom of the heating chamber, a plurality of pairs of horizontally disposed burners arranged at spaced apart intervals in the furnace wall around the main combustion chamber substantially tangential thereto and communicating therewith with the burners of each pair arranged substantially parallel to each other a single burner arranged between each of said pairs of burners, said burners all being arranged in substantially the same plane, and an enlarged primary combustion chamber arranged in the wall of the furnace directly opposite one of the burners of each of said pairs and communicating with said main combustion chamber, each of said enlarged combustion chambers having the side walls thereof constructed and arranged so that the heat produced from the burners associated with each of them will be radiated inwardly thereby toward the central portion of the heating chamber so as to heat the outer portions of the articles adapted to be heated.

2. In a furnace of the class described for heating ingots and the like including a substantially square heating chamber having a hearth arranged in the center of the heating chamber upon which the articles to be heated are placed, and a main combustion chamber arranged around the furnace at the bottom of the heating chamber through which the heating gases are adapted to pass in substantially a circular path, a horizontally disposed burner arranged at each of the corners of said heating chamber substantially tangential to the circular path of the gases in the main combustion chamber, and an enlarged primary combustion chamber arranged directly in line with each of said burners and positioned between the respective burners and the main combustion chamber and communicating therewith so that combustion of the gases directed into each of said enlarged combustion chambers is substantially completed before the gases enter said main combustion chamber, the outer side wall of each of said enlarged combustion chambers being arranged substantially parallel to its respective burner and terminating in an inwardly extending portion positioned substantially opposite the burner whereby the heat from the burners will be radiated inwardly thereby toward the central portion of the heating chamber so as to heat the outer portions of the articles adapted to be heated therein.

3. In a furnace of the class described having side and top walls, a heating chamber, a hearth arranged within said heating chamber upon which the articles to be heated are adapted to be placed, said heating chamber having a substantially annular main combustion chamber arranged therein adjacent the bottom thereof around the hearth whereby the heating gases are adapted to pass solely in one direction in substantially a circular path through the combustion chamber and therearound, a plurality of burners arranged in the side walls of said furnace around the heating chamber, said burners adapted to direct heating gases into said combustion chamber substantially tangential thereto and to the circular path of the gases therein, and an enlarged primary combustion chamber arranged in the side walls of the furnace directly in line with some of said burners and positioned between the respective burners and the main combustion chamber and communicating therewith so that combustion of the gases directed into each of said enlarged combustion chambers is substantially completed before the gases enter said main combustion chamber, each of said enlarged combustion chambers having a portion of the vertical side wall thereof arranged angularly relative to the path of the heating gases issuing forth from their respective burners, so that a portion of the heat will be radiated inwardly by the vertical side walls toward the central portion of the heating chamber.

4. In a furnace of the class described having a hearth arranged centrally thereof upon which the articles to be heated are adapted to be placed, and a main combustion chamber arranged therearound whereby the heating gases are adapted to pass around the hearth in substantially a circular path, a plurality of burners arranged in the side walls of said furnace for directing the heating gases into said main combustion chamber substantially tangential to the circular path of

the gases therein, an enlarged primary combustion chamber arranged directly in line with at least some of said burners and positioned between the respective burners and the main combustion chamber and communicating therewith so that combustion of the gases directed into each of said enlarged combustion chambers is substantially completed before the gases enter said main combustion chamber, the outer wall of each of said enlarged combustion chambers being arranged substantially parallel to its respective burner and terminating in an angular portion arranged substantially opposite the burner whereby the heat from the heating gases issuing forth from said burners will be radiated backwardly toward the central portion of the hearth and furnace.

5. In a furnace of the class described for heating ingots and the like including, a cylindrical heating chamber having a hearth arranged in the center of the heating chamber upon which the articles to be heated are placed with an outlet port arranged centrally of the hearth through which the waste gases pass out from the heating chamber, and a main combustion chamber arranged around the furnace and the hearth at the bottom of the heating chamber, a plurality of horizontally disposed burners arranged in the furnace wall around the heating chamber substantially tangential thereto and communicating with the main combustion chamber therein, a relatively small combustion chamber arranged in the wall of the furnace in line with some of said burners and communicating with the main combustion chamber, and an enlarged primary combustion chamber arranged in the wall of the furnace in line with the other of said burners and positioned between the respective burners and the main combustion chamber and communicating therewith so that combustion of the gases directed into each of said enlarged combustion chambers is substantially completed before the gases enter said main combustion chamber, each of said enlarged combustion chambers having the outer side wall thereof arranged substantially parallel to its respective burner and terminating in an inwardly extending portion positioned substantially opposite the burner whereby the heat produced from the burners associated with each of the enlarged combustion chambers will be radiated inwardly thereby toward the central portion of the heating chamber so as to heat the outer portions of the articles adapted to be heated.

6. In a furnace of the class described having side and top walls, a heating chamber, and a hearth arranged within said heating chamber upon which the articles adapted to be heated are placed with the heating gases adapted to pass into the heating chamber and therearound in substantially a circular path, a plurality of burners arranged in the side walls of said furnace for directing heating gases into said heating chamber substantially tangential to the circular path of the gases therein, a relatively small combustion chamber arranged in the wall of the furnace in line with some of said burners and communicating with said heating chamber, and an enlarged primary combustion chamber arranged in the wall of the furnace directly in line with the other of said burners and positioned between the respective burners and the heating chamber and communicating therewith so that combustion of the gases directed into each of said enlarged combustion chambers is substantially completed before the gases enter said heating chamber, the outer side wall of each of said enlarged combustion chambers being arranged substantially parallel to its respective burner and terminating in an inwardly extending portion positioned substantially opposite the burner whereby the heat produced by the burners associated with the enlarged combustion chambers will be radiated thereby inwardly toward the central portion of the furnace so as to heat those portions of the articles disposed therein not heated by convection and conduction.

HAROLD G. ELDER.
JOHN F. MOWAT.