May 9, 1933. C. E. FRAZIER 1,907,777

ANNEALING FURNACE

Filed Sept. 30, 1931 3 Sheets-Sheet 1

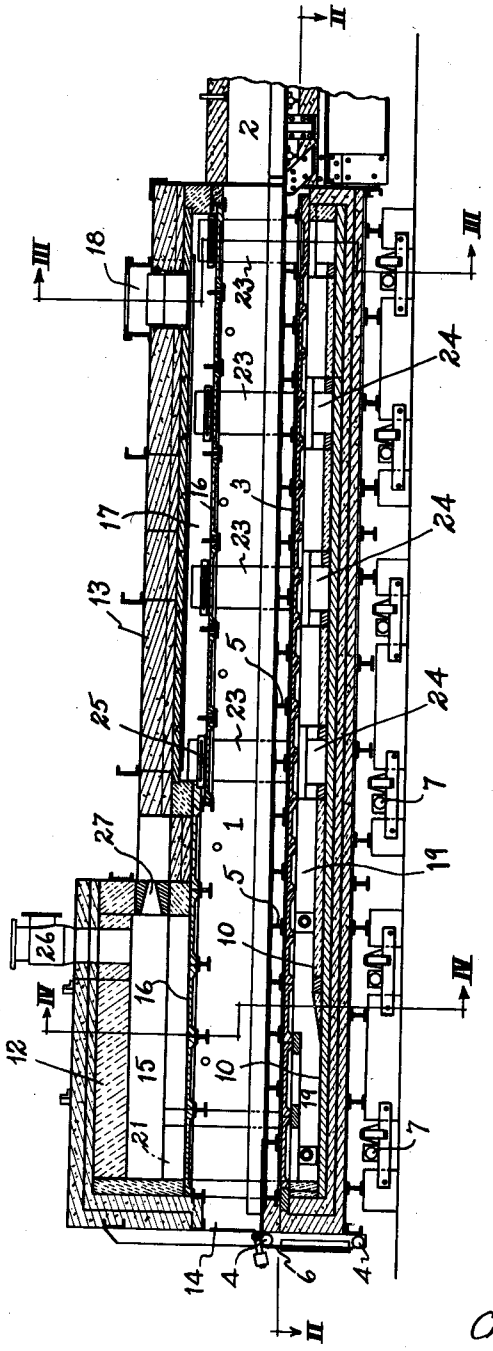

Fig. 1

INVENTOR

Chauncey E. Frazier

by Christy Christy and Wharton

his attorneys.

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C. E. FRAZIER

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3 Sheets-Sheet 2

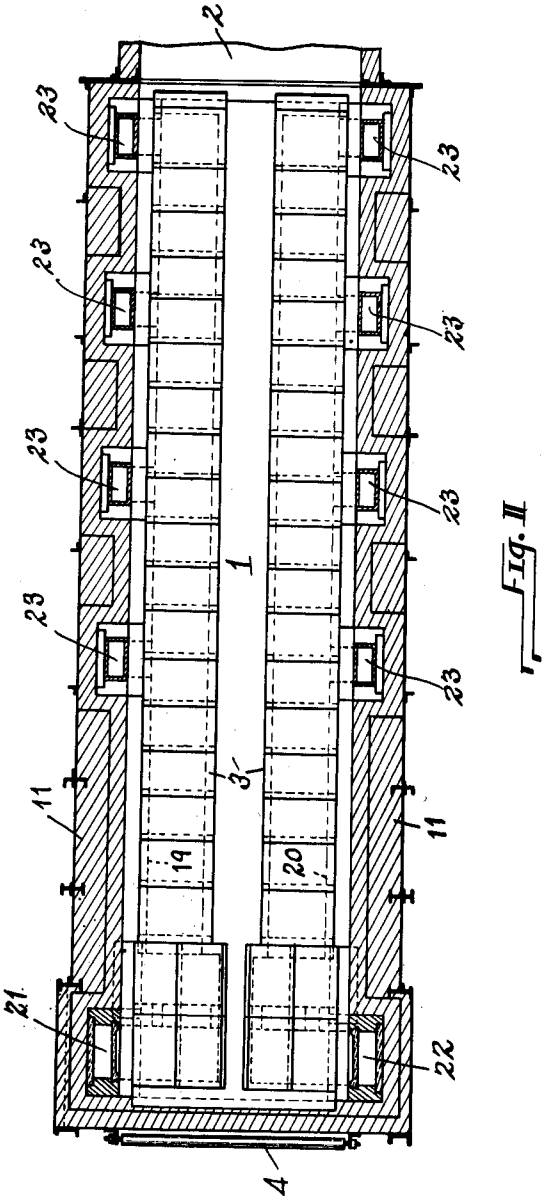

Fig. II

INVENTOR

Chauncey E. Frazier

by Christy Christy and Wharton

his attorneys.

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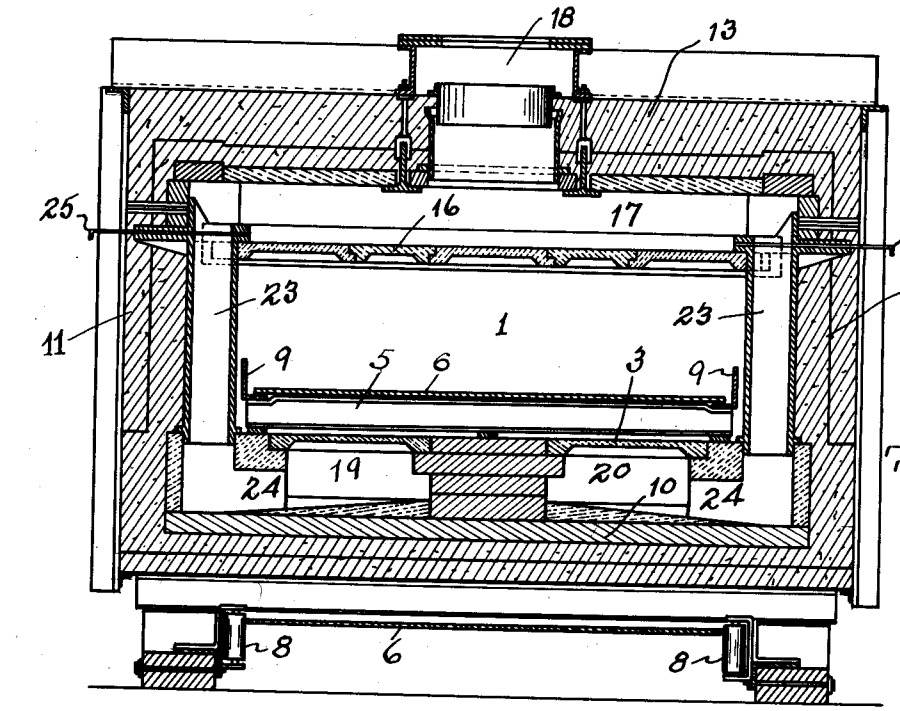

FIG. III

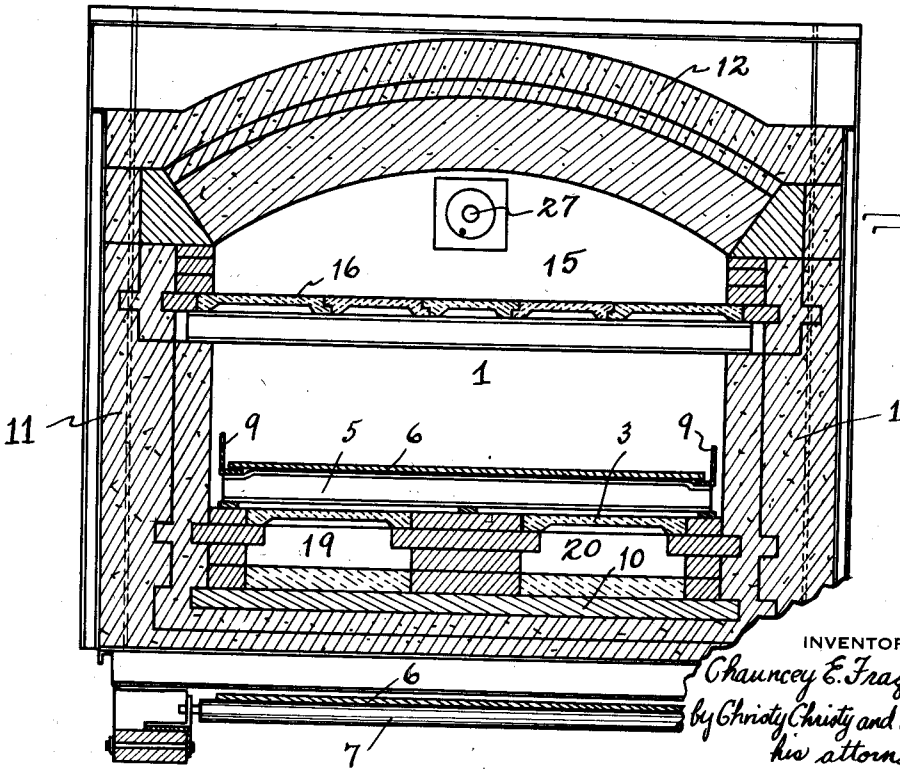

FIG. IV

INVENTOR
Chauncey E. Frazier
by Christy Christy and Wharton
his attorneys.

Patented May 9, 1933 1,907,777

UNITED STATES PATENT OFFICE

CHAUNCEY E. FRAZIER, OF WASHINGTON, PENNSYLVANIA, ASSIGNOR TO SIMPLEX ENGINEERING COMPANY, A CORPORATION OF DELAWARE

ANNEALING FURNACE

Application filed September 30, 1931. Serial No. 566,018.

My invention relates to heating furnaces in general, and more specifically it is directed to kilns and annealing furnaces used for the heat treatment of articles formed of various materials, including glass, earthenware and metal. The invention consists in furnace structure which admits of a more precise control and distribution of heat within the furnace chamber.

In general, my invention comprises improvements upon the structure disclosed in Letters Patent of the United States No. 1,525,644, granted to me February 10, 1925, and, while I have said that the invention is applicable to heating furnaces generally, and while I so claim it, I shall in the following specification, for purposes of illustration, describe it as it may be embodied in a lehr for annealing glassware, this being the particular application in which I have developed it.

In the accompanying drawings Fig. I is a view in vertical section, taken on the medial line of a lehr embodying the invention; Fig. II is a view of the lehr in horizontal section, taken on the plane II—II of Fig. I; and Figs. III and IV are views in cross-section, taken, respectively, on the planes III—III and IV—IV of Fig. I.

The lehr shown in the drawings is of muffle type and includes an annealing chamber 1 and a delivery passageway 2 continuous with the annealing chamber. Through the annealing chamber and passageway an endless conveyor is caused to advance, and in this case I employ a woven belt conveyor which is trained over rollers 4 adjacent the entering end of the lehr and extends in its upper reach above the floor 3 of the lehr where it is borne upon a line of cross supports 5. The reference numerals 6 is applied to the woven belt, which is fragmentarily indicated in Fig. I. In its lower reach the conveyor belt conveniently is supported upon rollers 7 (cf. Figs. I and IV) and is guided laterally by means of rollers 8 (cf. Fig. III), while in its upper reach the belt is guided by angle members 9 secured to the cross supports 5.

A muffle chamber surrounds and envelops the annealing chamber 1. The muffle chamber has a floor 10 and side walls 11. The roof of the muffle chamber comprises an arched section 12 located above the forward end of the annealing chamber, and a flat section 13 located over the rearward end of the latter chamber. These general features of construction are well known and require no extended description here; suffice it to say, that the structure is built of brickwork and refractory material, framed, strengthened, braced, and tied together with iron in familiar manner, as illustrated in the drawings. It is with the arrangement and structure of the muffle chamber, and the consequent course of the burning fuel and of the products of combustion that the invention is primarily concerned.

Due to the fact that the mouth 14 of the lehr must be uncovered during charging, whether such charging be manual or mechanical, the heat radiation and other heat losses are greater at the front of the lehr than at points rearwardly thereof. Accordingly, it is necessary to apply more heat at the front of the lehr, to compensate for these greater heat losses. When attempting to do this in accordance with present practice, by applying heat to the bottom of the lehr, so much heat is required that the refractories are damaged and require frequent repair. Additionally the conveyor belt becomes exceedingly hot, causing it to stretch, and quite often the conveyor becomes so hot as to leave imprints on the bottoms of the articles being annealed, thus weakening their structure and destroying their marketability.

To overcome this objection, I apply heat to the top of the lehr chamber; that is, I introduce fuel to a fire-box or inlet chamber 15 on top of the lehr and direct the flow of burning fuel toward the front of the lehr, in a direction opposite to that in which the articles are moved by conveyor 6.

The fire-box 15 is located between the arched roof 12 and the roof 16 of the annealing chamber, and constitutes an element of the muffle chamber proper. Between the roof 16 of the annealing chamber and the flat roof 13 of the muffle chamber, there is provided an outlet or flue gas chamber 17 which is connected adjacent its rearward end to a stack or

chimney; the stack is not shown in the drawings, but the outlet 18 indicates where connection is made to it. The annealing chamber is so built within the muffle chamber that there are formed tunnel flues 19 and 20, extending longitudinally beneath the annealing chamber. At the forward end of the fire-box, vertical front flues 21 and 22 communicate respectively with the tunnel flues 19 and 20, and rearwardly of the flues 21 and 22 a plurality of side flues 23 are provided. The side flues are arranged at an interval from one another and are disposed along the sides of the annealing chamber, as shown. In this case I show four side flues 23 on each side of the lehr, and each side flue is connected by a passage 24 (cf. Figs. I and III) to one of the tunnel flues 19, 20. A damper 25 is organized to control the flow of gases in each side flue.

The inlet chamber or fire-box 15 is the primary combustion chamber. If producer gas is used as fuel, a suitable burner or burners may be connected to the inlet 26 in the rearward region or roof 12 of the fire-box. If the fuel be natural gas or oil, the burner or burners may be placed in the opening or openings 27 in the rear wall of the fire-box. In either case the fuel is introduced in the rearward region of the fire-box and is caused to flow forwardly therein. The burning fuel and the products of combustion sweep forward, over the roof 16 of the annealing chamber 1, and thence flow down vertical flues 21, 22, at the front of the lehr, and enter the tunnel flues 19 and 20. In flowing along the tunnel flues the hot gases find escape through passages 24 into the several side flues 23, whence they rise and enter the outlet chamber 17. In chamber 17 the hot products of combustion flow along the roof 16 toward the rear of the lehr, and finally are drawn through opening 18 into the stack.

It will be observed that there are duplicate sets of flues symmetrically arranged on opposite sides of the mid-line of the lehr; that each set includes a longitudinal tunnel (19 or 20) beneath the floor of the annealing chamber; that a vertical flue (21 or 22) connects each tunnel flue with the fire-box, at the entering end of the lehr; and that a series of spaced side flues connect each tunnel flue with the outlet chamber 17. It will be further observed that the burning fuel sweeps toward the front of the lehr when it is introduced to the fire-box, and that during combustion the hot products are carried down the sides of the lehr adjacent the mouth of the annealing chamber 1 where they enter the tunnel flues 19, 20 extending beneath the floor 3 of the chamber 1. The dampers 25 in the vertical side flues 23 permit selective regulation of the flow of hot gases from the tunnel flues to the outlet chamber, whereby temperature conditions at various points in the annealing chamber may be nicely determined.

Upon entering the outlet chamber, the products of combustion flow rearwardly of the lehr, i. e. in the direction of ware-movement through the lehr, and as they so flow they give up heat to the roof 16 of the annealing chamber. It is characteristic of my structure that heat is supplied to the top, bottom and sides of the annealing chamber, thus providing a uniform temperature at the top and bottom of the ware. In effecting the flow of the burning fuel and the products of combustion in the above described courses, I provide sufficient heat at the entrance of the lehr to compensate for heat radiation and other heat losses arising during the charging of ware. The heating effect is more uniform, there being no localized overheating, tending to injure the refractories and conveyor belt, and tending to mar the bottoms of the articles being treated. The control afforded by the dampered side flues 23 admits of such distribution of the flowing gases that practically any desired temperature condition may be maintained in the lehr; in the words of the art, any "annealing curve" or "heat gradient" may be established in the lehr. Accordingly, the ware upon entering the lehr and while still in unannealed condition, is not subject to such inequalities of temperature in different parts as to break. Both the annealing efficiency and the combustion or fuel efficiency are increased in the lehr of my invention. The lehr has greater capacity and is effective in providing more uniform heating and cooling during the annealing process.

I claim as my invention:

1. In an annealing furnace, the combination with a lehr chamber, of a fire-box overlying said lehr chamber, a tunnel flue extending longitudinally beneath said chamber, a front flue in each of the opposite side walls of the furnace and connecting said fire-box with said tunnel flue adjacent the entrance of said furnace, means for introducing fuel to said fire-box at such point that burning fuel and products of combustion are caused to flow forwardly of the furnace and to enter said tunnel flue by way of said front flues, and thereby produce a concentration of heat at the mouth of the lehr chamber, a flue gas chamber immediately above said lehr chamber, and a series of side flues arranged along the opposite side walls of the lehr to the rear of said front flues, which side flues establish communication between said tunnel flue and said gas flue chamber.

2. In an annealing furnace, the combination with a lehr chamber, of a fire-box overlying said lehr chamber, a tunnel flue extending longitudinally beneath said chamber, a front flue in each of the opposite side walls of the furnace and connecting said fire-

box with said tunnel flue adjacent the entrance of said furnace, means for introducing fuel to said fire-box at such point that burning fuel and products of combustion are caused to flow forwardly of the furnace and to enter said tunnel flue by way of said front flues, and thereby produce concentration of heat at the mouth of the lehr chamber, a flue gas chamber overlying the roof of said lehr chamber to the rear of said fire-box, a series of side flues arranged along the opposite side walls of the lehr and connecting said tunnel flue to said flue gas chamber, and a stack outlet so arranged in said flue gas chamber as to effect rearward movement of the products of combustion when they rise from said side flues and enter said chamber.

3. In an annealing furnace, the combination with a lehr chamber, of a fire-box overlying said lehr chamber, a tunnel flue extending longitudinally beneath said chamber, a front flue in each of the opposite side walls of the furnace and connecting said fire-box with said tunnel flue adjacent the entrance of said furnace, means for introducing fuel to said fire-box at such point that burning fuel and products of combustion are caused to flow forwardly of the furnace and to enter said tunnel flue by way of said front flues, and thereby produce concentration of heat at the mouth of the lehr chamber, an outlet chamber overlying the roof of said lehr chamber to the rear of said fire-box, a series of side flues arranged along the opposite side walls of the lehr and connecting said tunnel flue to said outlet chamber, dampers organized with said side flues for regulating the escape of the products of combustion at various points along the extent of said tunnel flue, and a stack outlet so arranged in said outlet chamber as to effect rearward movement of the products of combustion when they rise from said side flues and enter said outlet chamber.

4. In an annealing furnace, the combination with a lehr chamber, of an inlet chamber and a suceeding outlet chamber above the lehr chamber, two longitudinal tunnel flues beneath the lehr chamber disposed symmetrically, one on each side of its medial line, each of said tunnel flues having associated therewith a front flue affording, immediately at the entrance of said furnace, communication with said inlet chamber, means for introducing fuel to said inlet chamber at such point that burning fuel and products of combustion are caused to flow forwardly of the furnace and to enter said tunnel flues by way of said front flues, whereby a concentration of heat is provided at the mouth of the lehr chamber, a series of side flues in each of the opposite side walls of the furnace providing communication between each of said tunnel flues and said outlet chamber at intervals along the extent of the outlet chamber, and a stack outlet so arranged in said outlet chamber as to effect rearward movement of the products of combustion when they rise from said side flues and enter said outlet chamber.

5. In an annealing furnace, the combination with a lehr chamber, of an inlet chamber and a suceeeding outlet chamber above the lehr chamber, two longitudinal tunnel flues beneath the lehr chamber disposed symmetrically, one on each side of its medial line, each of said tunnel flues having associated therewith a front flue affording, adjacent the entrance of said furnace, communication with said inlet chamber, means for introducing fuel to said inlet chamber at such point that burning fuel and products of combustion are caused to flow forwardly of the furnace and to enter said tunnel flues by way of said front flues, whereby a concentration of heat is provided at the mouth of the lehr chamber, a series of side flues in each of the opposite side walls of the furnace providing communication between each of said tunnel flues and said outlet chamber at intervals along the extent of the outlet chamber, dampers organized with said side flues for regulating the escape of products of combustion at various points along the extent of said tunnel flues, and a stack outlet so arranged in said outlet chamber as to effect rearward movement of said products of combustion when they rise from said side flues and enter said outlet chamber.

In testimony whereof I have hereunto set my hand.

CHAUNCEY E. FRAZIER.