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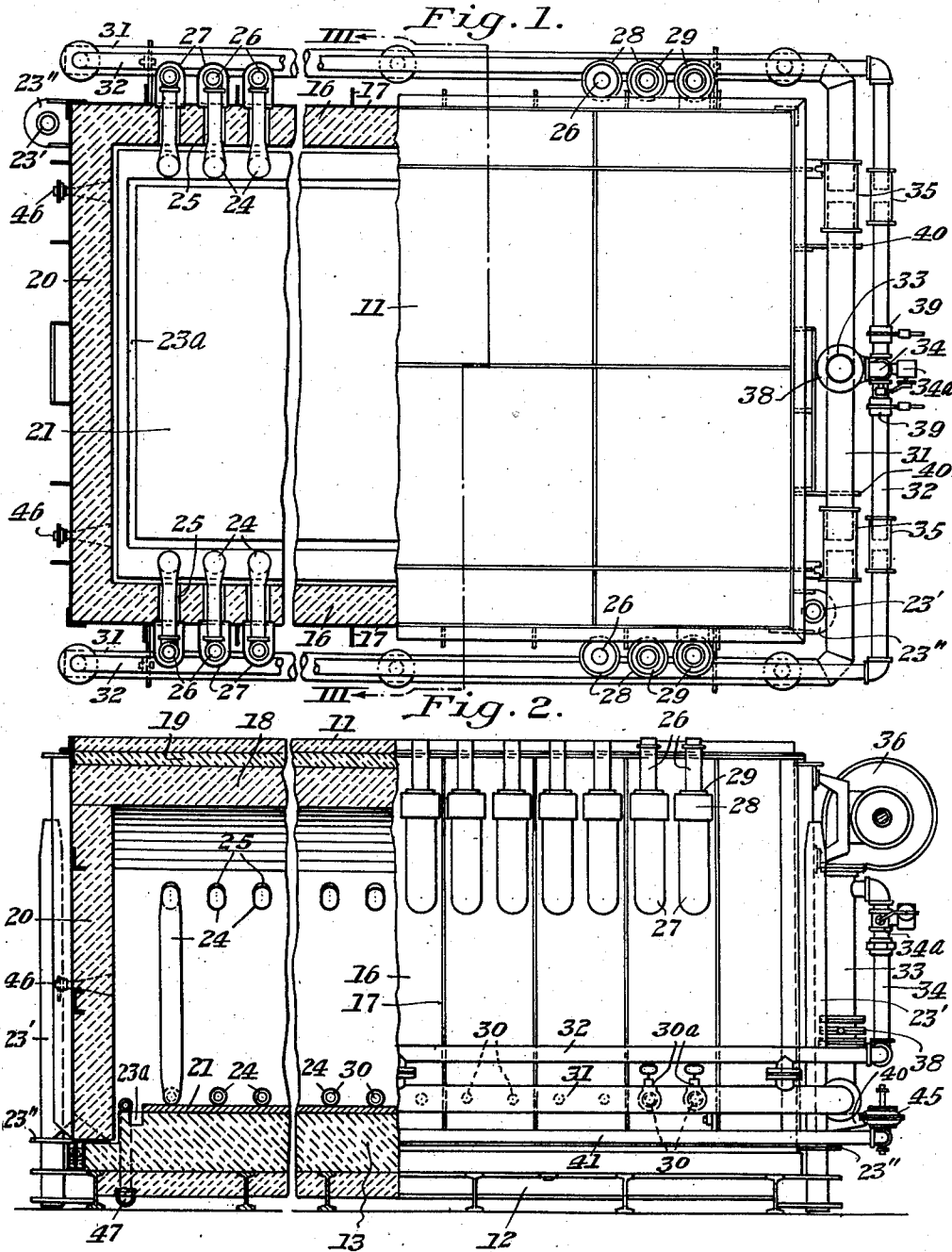
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2,086,970

ANNEALING METHOD AND FURNACE THEREFOR

Filed Feb. 23, 1935

2 Sheets-Sheet 1



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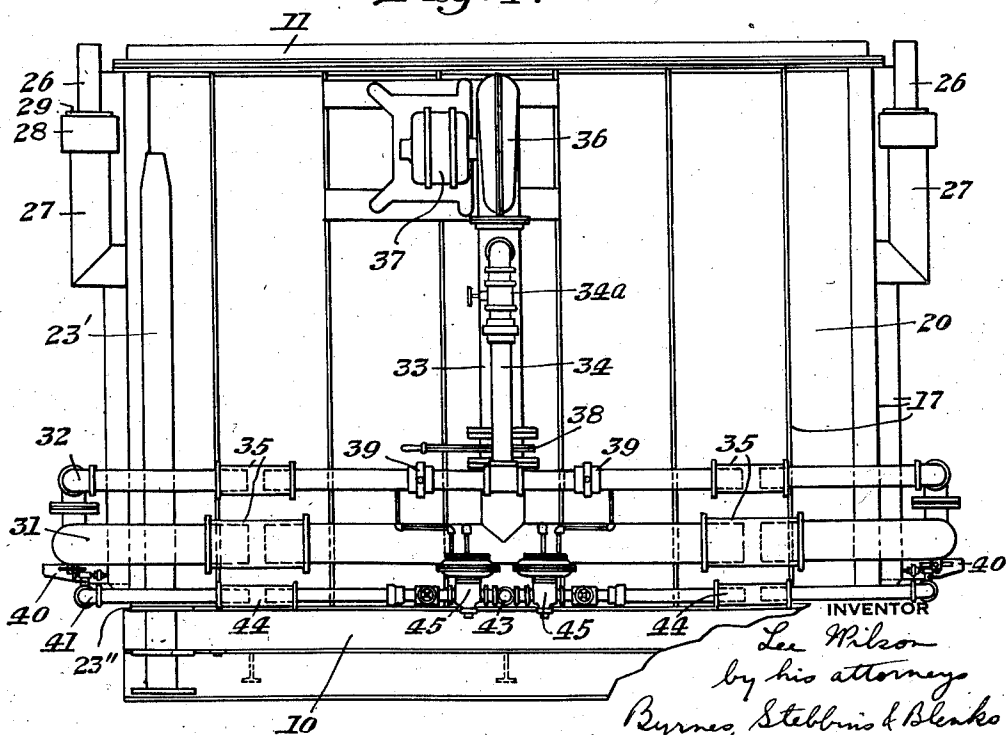
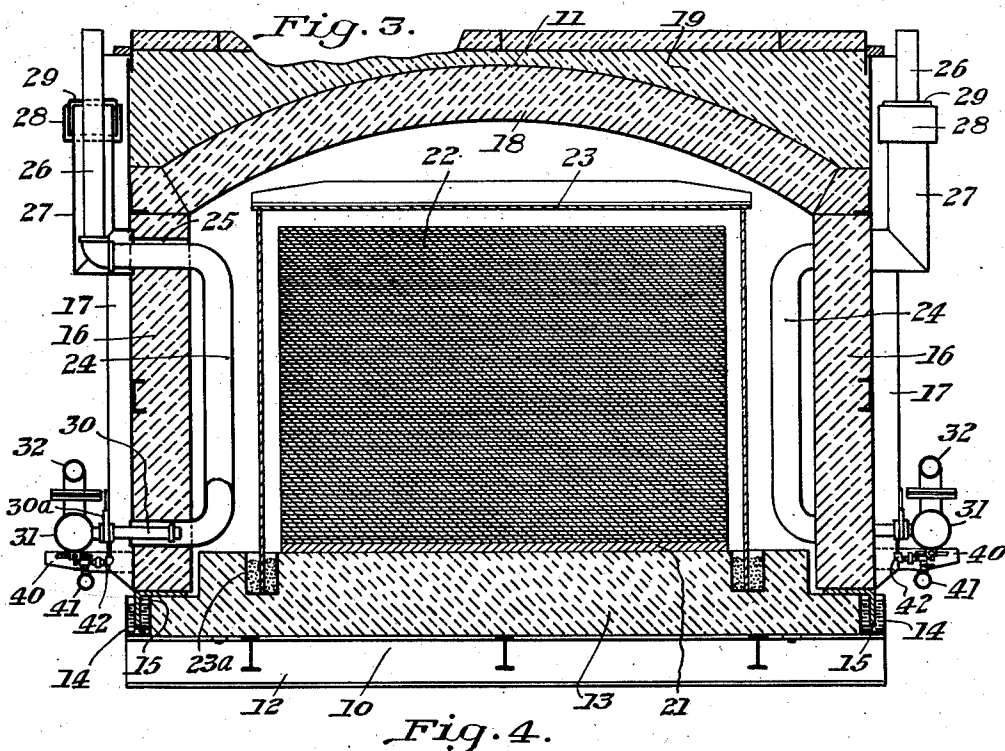
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## UNITED STATES PATENT OFFICE

2,086,970

ANNEALING METHOD AND FURNACE  
THEREFOR

Lee Wilson, Cleveland, Ohio

Application February 23, 1935, Serial No. 7,905

6 Claims. (Cl. 263—42)

This invention relates to annealing furnaces of the general type described in my U. S. Patent No. 1,952,402 and, specifically, to improvements in the construction of the furnace disclosed in said patent, and a new method of annealing adapted to be practiced with the aid of such improved furnace construction.

In the use of the furnace described in the patent before mentioned, I have discovered that the heat exchange tubes or muffles which convey the hot gases of combustion along the side walls of the furnace cover, and which are made of heat resistant alloy in order to stand up under the extreme conditions of temperature to which they are subject, exhibit a considerable tendency to expand and even to elongate permanently. If these tubes are fixed at both ends, therefore, objectionable stresses will be introduced in the operation of the furnace. One object of the present invention, therefore, is to provide a furnace in which the heat exchange tubes are fixed at one end only, the other end being permitted to "float", and at the same time, to provide a gas-tight connection between the floating end and the furnace wall.

Certain difficulties were experienced with the furnace roof, furthermore, because of the passage therethrough of the outlets for the spent heating gases. A further object of the invention, therefore, is to provide a furnace having outlets for the spent gases extending outwardly of the side walls and then upwardly thereof.

It has also been observed that in annealing stacks of sheets of different heights, the rates at which the temperatures of the various portions of the stack rise are not entirely uniform. Another object of this invention, therefore, is to provide a method and means whereby uniform heating of stacks of various heights may be obtained. In this connection, I also provide a method and means whereby the desired uniformity of heating along the length of the stack may likewise be obtained.

Other objects and advantages of the invention will be pointed out in the following detailed description and the novel features thereof will be specifically set forth in the appended claims. Reference is made to said description for a complete understanding of the invention, in connection with the accompanying drawings illustrating a present preferred embodiment. In the drawings—

Figure 1 is a view partly in plan with a portion thereof shown in horizontal section, certain parts being omitted for clearness;

Figure 2 is a side elevation with a portion in vertical section;

Figure 3 is a transverse sectional view taken along the line III—III of Figure 1; and

Figure 4 is an end elevation.

Referring now in detail to the drawings, the furnace of my invention comprises a base 10 and a cover 11. The base includes a structural frame 12 having a refractory hearth 13 supported thereon. A sheet metal channel 14 extends around the edge of the hearth and is adapted to receive a depending flange 15 carried on the lower edges of the side walls of the cover 11, to provide a fluid seal by virtue of sealing fluid contained in the channel 14.

The side walls of the cover 11, indicated at 16, are composed of refractory material assembled within a structural frame 17. A roof 18 is formed by a refractory arch sprung from the side walls 16, and a layer of insulating material 19 is superposed on the arch. End walls 20 similar in character to the side walls 16 complete the enclosure provided by the cover 11 in cooperation with the base 10.

The hearth 13 carries a flat supporting plate 21, conveniently a steel plate, which is adapted to receive the charge of material to be treated, indicated as a stack 22 of steel sheets. The cover 11, of course, is lifted from the base 10 while the furnace is being charged. An inner cover 23 is first disposed over the charge. The lower edges of the cover cooperate with a groove or recess 23a formed in the hearth 13 and adapted to be filled with sand, whereby to seal the interior of the inner cover from the space outside it. The cover 23 comprises simply an open bottomed metallic shell, the top being formed by a flat plate with suitable bracing members attached thereto. When the charge 22 and the cover 23 have been placed in position, the cover 11 is lowered onto the base 10. This operation is facilitated by guide pins 23' secured to and extending upwardly from the base 10 and guide rings 23'' secured to the lower edges of the cover 11 and adapted to slide down over the pins 23'.

Referring again to the construction of the cover 11, the side walls 16 thereof are provided with a plurality of heat exchange tubes 24. Only a few of these are shown in the drawings, but there is a continuous series of them on both sides of the cover. Although these tubes are shown vertical, they may be disposed in any convenient relation to the axes of the cover. The tubes 24 are reentrant, having generally a U-shape, the

lower ends being embedded in the refractory forming the side walls. The middle portions of the tubes extend upwardly of the side walls 16 and the upper ends extend outwardly thereof through openings 25 which are larger than the tubes themselves. The tubes are thus fixed only at their lower ends, the upper ends being permitted to float so that expansion of the tubes on heating, or permanent elongation thereof after considerable use, will not subject the tubes to any stress. Top flues 26 are connected to the upper ends of the tubes 24 to carry the spent heating gases upwardly of the furnace.

In order to seal the joints between the upper ends of the tubes 24 and the opening 25, I provide the flues 26 with L-shaped sleeves 27. The lower ends of the sleeve extend into the refractory side wall 16 and entirely enclose the outer ends of the holes 25. The upper ends of the sleeves are provided with sealing cups 28 adapted to contain sealing fluid. Sealing bells 29 carried on the flues 26 project downwardly into the cups 28 and the sealing fluid contained therein. Free expansion of the tubes 24 and the flues 26 is thus permitted, while the interior of the furnace is completely sealed from the atmosphere surrounding it.

The tubes 24 are disposed, as stated, along the side walls of the furnace cover, but preferably not on the ends, and, when combustion gases are passed through the tubes, the furnace charge is heated by convection and radiation to the annealing temperature. Currents of hot gases are set up within the cover and these currents generally rise in the space between the sides of the cover 11 and the inner cover 23, sweep over the top of the cover 23 and diverge toward the ends thereof from which they descend in the space between the ends of the inner cover and the cover 11 and then return to the lower portion of the space occupied by the tubes 24. The tubes may, alternatively, extend inwardly of the end walls and along the side walls, generally horizontally, by merely increasing the length of the elbows thereof to approximately the length of the cover.

Combustion gases for heating the interior of the furnace cover by passage through the tubes 24 are delivered to the latter by burners 30 projecting into the lower ends of the tubes. Air for combustion is delivered to the burners through manifolds 31, by manifolds 32 extending along the lower edges of the side walls of the cover 11. Individual valves 30a control the volume of air delivered to the burners from the manifolds. The lower ends of the tubes 24 are open for the induction of secondary air.

The manifolds 31 and 32 extend around one end of the cover as shown in Figure 4, and connect with T's 33 and 34. The horizontal branches of the T's are connected to the manifolds by slip joints 35, which permit the manifolds to be moved laterally of the T's without breaking the connection therebetween. Flexible hose connections may be used instead of the slip joints. The vertical branch of the T 33 is connected to the discharge port of a blower 36 mounted on the end of the cover and adapted to be driven by a motor 37 similarly mounted. A gate valve 38 controls the volume of air delivered to the manifolds 31 by the blower 34. This arrangement is provided for artificial cooling of the furnace as will be explained later. The T 34 is tapped into the T 33 above the valve 38 for supplying air to the burners during firing. Individual valves 39 in the horizontal branches of the T 34 permit the

distribution of air blast between the two sides of the furnace and, therefore, the rates of combustion on such sides, to be varied. The vertical branch of the T 34 includes a valve 34a.

The manifolds 31 and 32 are adjustably supported on brackets 40 extending outwardly from the side walls of the cover 11. Clamping bolts extend through suitable holes in lugs depending from the manifold and slots in the brackets, whereby the manifolds 31 and hence the burners 30, may be adjusted toward or away from the side walls 16. This adjustment permits the "hot spot" or zone of maximum temperature of the combustion gases to be shifted along the tubes 24.

With the burners in their extreme "in" position, the point of maximum combustion rate is obviously farther up the tubes 24 than when the burners are in their extreme "out" position. Between these two extremes, considerable latitude is afforded for placing the hot spot at the proper level, depending on the height of the stack 22, to supply the heat absorbed by the base plate and to insure that all portions along the height of the stack will have their temperature increased at substantially the same rate, whereby uniformity of heating and annealing is obtained.

The fuel supply for the burners 30 includes gas manifolds 41 having individual valved connections 42 to the burners 30. The manifolds 41 are suspended on the manifolds 31 by these connections and move therewith. The manifolds 41 are connected to a T 43 through slip joints 44 and regulators 45, the latter serving to maintain a constant pressure in the manifolds. The slip connections, of course, permit lateral adjustment of the manifolds. The T 43 is connected to a source of gaseous fuel by any convenient means such as a flexible hose line. Although the furnace disclosed herein is shown as adapted for gaseous fuel, the construction may be modified to burn other types of fuel such as liquid fuel.

By manipulating the valves controlling the supply of fuel to the individual burners, it is possible to vary the rate of combustion along the length of the side walls of the furnace. Considerable heat is absorbed by the ends of the sheets in the stack from the gaseous currents descending thereover as above explained, and I therefore prefer to adjust the fuel valves of the burners adjacent the ends of the cover to supply less fuel to the burners than supplied by the valves of the burners toward the middle of the side walls. Overheating and welding of the sheets adjacent the ends is thus avoided, and uniformity of annealing assured.

It is sometimes desirable to cool the charge after annealing at a rate greater than that caused by natural radiation. To this end, valve 34a is closed and valve 38 opened, reversing their relative positions during firing. Air can thus be circulated through the tubes 24 to cool the charge at the desired rate.

Sight cocks 46 permit the space within the cover to be observed when the latter is placed on the hearth or base. Conduits such as that indicated at 47, permit the introduction of an atmosphere of any desired gas into the interior of the cover after it is in position, as well as the eduction of the air trapped by the cover as it is lowered.

It will be apparent that the method and apparatus of my invention disclosed herein are characterized by numerous advantages over the structures and procedures known heretofore. Fine control of the temperatures of the various

portions of the charge is made possible with a resulting uniformity in the product, which is greatly to be desired. The proper adjustment of the points of maximum temperature may be easily obtained as regards both the height and the length of the charge.

The heat exchange tubes or muffles are mounted with one end floating to prevent stressing the latter as a result of expansion and contraction, but a perfect seal is maintained at all times to prevent infiltration of air. Other advantages will occur to those skilled in the art without specific enumeration.

Although I have illustrated and described herein but one preferred construction and practice of my invention, it will be apparent that changes therein may be made without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. A furnace comprising a hearth, side and end walls and a roof, manifolds extending along the side walls for supplying an element of combustion to burners spaced along said side walls, a connection adjacent one of the end walls to a source of said element, and extensible joints between said connections and said manifolds.

2. In a method of heating a furnace chamber to treat a charge of material therein, the steps including introducing combustion gases into the chamber, confining them out of direct contact with said material, and moving the point of delivery of the gases to vary the location of the hottest zone produced thereby.

3. In a method of annealing in a liftable, open-bottomed furnace chamber having side and end walls, to treat uniformly a charge of material therein, the steps including supplying combustion gases to the chamber at spaced points along

the side walls, confining the gases out of contact with the material, and supplying a greater quantity of such gases per unit length of side wall to the middle portion thereof than to the portions adjacent the end walls.

4. In a method of annealing in a liftable, open-bottomed furnace chamber having side and end walls, to treat uniformly a charge of material therein, the steps including supplying combustion gases to the chamber at spaced points along the side walls, and restricting the supply of such gases adjacent the end walls.

5. In a method of heating a charge of material in a chamber, the steps including introducing combustion gases into the chamber adjacent the bottom of the charge, confining them out of direct contact with said charge while conducting them upwardly alongside the charge, and shifting the point of delivery of said gases and, therefore, the point of maximum combustion rate, vertically of the charge to cause uniform heating of the material throughout the height of the charge.

6. An annealing furnace comprising a base adapted to receive a charge of material, a cover adapted to be positioned on the base to enclose the charge, heat-exchange tubes extending through the side wall of the cover adjacent the base, upwardly along the side wall, and outwardly therethrough adjacent the top of said wall, burners cooperating with said tubes for supplying hot combustion gases thereto for heating a charge within said cover, said walls having openings for said tubes adjacent the roof, the openings being substantially larger than the tubes, sleeves extending outwardly from the walls and surrounding the tubes and openings, and a seal between each sleeve and its tube.

LEE WILSON.