United States Patent

[11] **3,540,710**

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[21] Appl. No. **782,158**
[22] Filed **Dec. 9, 1968**
[45] Patented **Nov. 17, 1970**
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[32] Priority **Dec. 14, 1967, Dec. 30, 1967**
[33] **Japan**
[31] **42/105666, 42/110824 and 42/110825**

[54] **GAS ANNEALING FURNACE**
4 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **263/41**
[51] **Int. Cl.** **F27b 5/00**
[50] **Field of Search** 263/40, 41, 42, 42R; 266/5B

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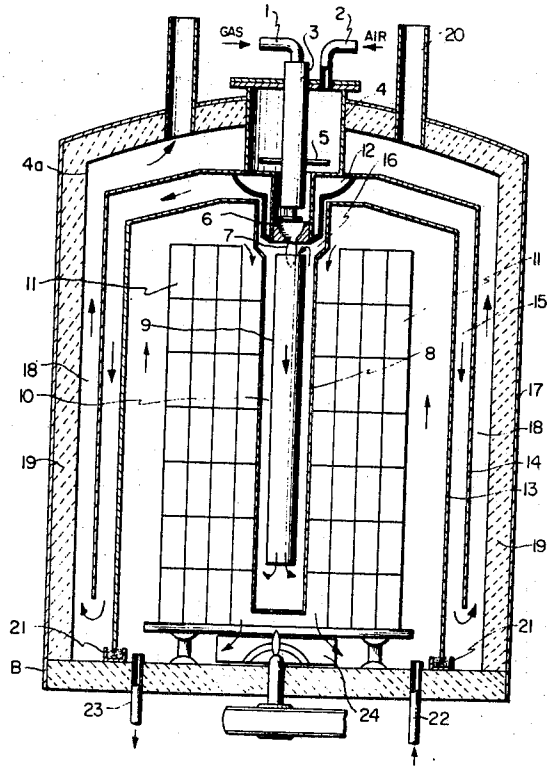
ABSTRACT: A gas annealing furnace. An inner bell-shaped cover has a radiant heat tube depending into said inner cover. An outer bell-shaped cover surrounds said inner cover and a burner assembly depends from the outer cover in alignment with said radiant heat tube for directing a stream of combustion gases into said radiant heat tube. A middle bell-shaped cover is secured to said burner assembly and is positioned between the inner and outer covers. Combustion gases from said burner assembly flow along said radiant heat tube, then downwardly between the inner and middle covers to heat the space within the inner cover, and then flow upwardly between the inner and outer cover to insulate the inner cover from the atmosphere outside the outer cover.



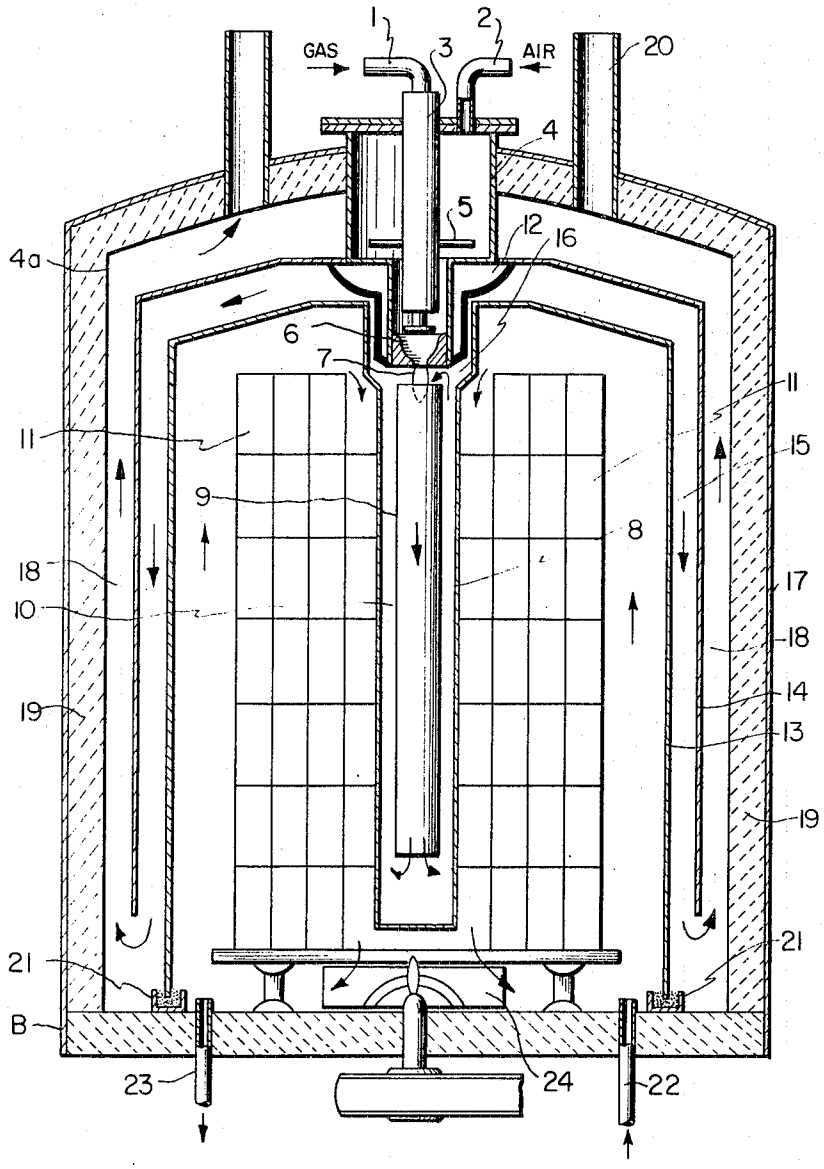


FIG. 1

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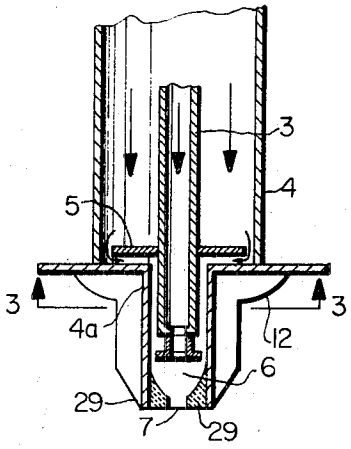

FIG. 2

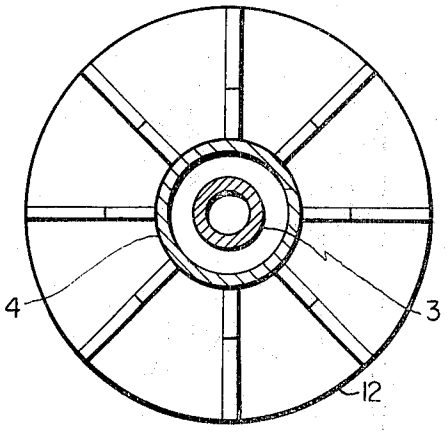

FIG. 3

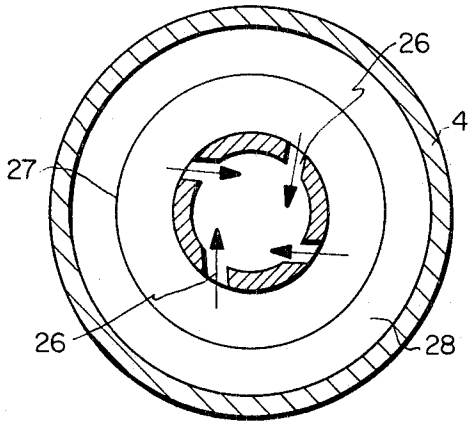

FIG. 5

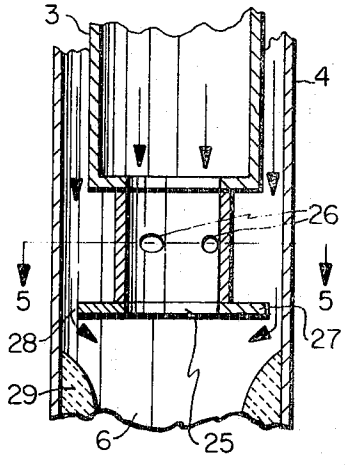

FIG. 4

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GAS ANNEALING FURNACE

This invention relates to a gas fired, bell-type furnace used particularly for annealing of coiled steel.

In conventional furnaces of this type, the workpiece to be heat treated is usually indirectly heated, electrically or by gas, from outside of an inner cover which surrounds said workpiece. Therefore, with such furnaces, a sizable heat loss occurs, resulting in poor thermal efficiency and uneven temperature distribution in the radial direction thereof. In addition, slow heating and cooling speeds make it necessary to use a long time for completing one cycle of heat treatment.

The invention is designed to overcome the disadvantages inherent to the conventional devices and to accomplish the following objects.

It is a primary object of the present invention to greatly enhance the thermal efficiency of a gas fired, bell-type furnace and to thereby reduce heating costs. A second object of the invention is to improve the temperature distribution, particularly in a radial direction. A third object is to increase the heating speed so as to reduce the time required for heat treatment. A fourth object is to make possible a reduction in the temperature of the inner cover to thereby increase its expected life span. A fifth and last object of the invention is to reduce the weight of the outer cover to permit the operator to handle it with ease and safety.

These objects are achieved by providing a gas annealing furnace comprising an inner bell-shaped cover, a radiant heat tube depending into said inner cover and having the lower end closed, and an outer bell-shaped cover around said inner cover and having the walls thereof spaced from the walls of said inner cover. A burner assembly depends from the outer cover in alignment with said radiant heat tube for directing a stream of combustion gases into said radiant heat tube, and a middle bell-shaped cover is secured to said burner assembly and positioned between the inner and outer covers and has the walls thereof spaced from each of the inner and outer covers and blocking passage of combustion gas past said burner assembly. The depending wall of the middle cover terminates short of the ends of the depending walls of the inner and outer covers, and the radiant heat tube has the upper end open into the space beneath the middle cover. The outer cover has exhaust openings in the upper portion thereof. Combustion gases from said burner assembly flow along said radiant heat tube, then downwardly between the inner and middle covers to heat the space within the inner cover, and then flow upwardly between the inner and outer cover to insulate the inner cover from the atmosphere outside the outer cover.

The invention will now be described in detail with reference to the accompanying drawings illustrating an embodiment of the invention, and in which:

FIG. 1 is a longitudinal sectional view of an apparatus according to the present invention;

FIG. 2 is an enlarged sectional view of a burner assembly;

FIG. 3 is a sectional view taken on the line 3–3 of FIG. 2;

FIG. 4 is an enlarged longitudinal sectional view of an air nozzle means; and

FIG. 5 is a sectional view taken on the line 5–5 of FIG. 4.

Referring to FIGS. 1—3, a gas inlet tube 1 opens into a gas pipe 3 and an air inlet tube 2 opens into an air pipe 4 for guiding gas and air, respectively, to a burner. A disc-shaped plate 5 is mounted on the gas pipe 3 just above the entrance to a narrow air pipe portion 4*a*, said disc plate serving to speed the flow of the air to a combustion chamber 6 at the lower end of the air pipe portion 4*a*. An outlet 7 for combustion gas is provided in the lower end of combustion chamber 6, said outlet 7 for the combustion gas being a burner end portion. A radiant heat tube 8 has an inner tube 9 disposed concentrically within it and terminating just above the closed lower end thereof.

The combustion gas jetted at high speed from the combustion gas outlet 7 is first introduced into the inner tube 9 and guided downwardly therein until it reaches the bottom end of the inner tube 9, where it is forced to change its direction by 180° so as to make its way upward through a space 10 between the radiant heat tube 8 and the inner tube 9. This upward flow of combustion gas supplies heat to the radiant heat tube 8 which in turn heats the material 11 to be heat treated from inside thereof. The combustion gas which returns toward the burner assembly heats fins 12 secured to the outside of the narrow air pipe portion 4*a* to preheat the air flowing in the air pipe 4. It then enters a space 15 between an inner bell-shaped cover 13, from the middle of which radiant heat valve 8 is suspended, and a middle bell-shaped cover 14 extending outwardly and downwardly generally parallel to inner cover 13. The fins 12 have the dual purposes of effecting heat exchange as described above and serving as a guide for mounting the burner assembly concentrically with respect to the radiant heat tube 8. For these purposes, the tapered fins 12 are mounted on the narrow air pipe portion 4*a* so that it will fit in an enlarged part 16 formed at the upper end of the radiant heat tube 8.

The combustion gas entering the space 15 flows down therein while heating the inner cover 13 from outside until it reaches the bottom end of the middle cover 14, where its direction is changed by 180° and it enters a space 18 between an outer bell-shaped cover 17 and the middle cover 14. The combustion gas flowing through this space 18 acts mainly to maintain the temperature of the inner cover 13.

Thus, the material 11 to be heat treated and positioned within the inner cover 13 is heated not only from its center by the radiant heat tube 8 but also from outside thereof by the combustion gas flowing through the spaces 15 and 18 and along the outside of the inner cover 13, so that the temperature distribution in the radial direction is greatly improved and also the speed of heating-up is increased. For cooling, the gas flow is stopped and only air is admitted. Cooling is thus also effected from both inside and outside of the material to be heat treated so that the cooling speed is greatly increased. This permits full utilization of the sensible heat of the combustion gas, with the result that thermal efficiency is greatly improved.

The surface temperature of the inner cover is generally higher than the heat treatment temperature. However, when compared with the conventional furnaces in which heating is effected only from outside the material to be heat treated, such surface temperature is far lower in the present apparatus, so that a great increase in the life of the inner cover 13 is realized. The inner surface of the outer cover 17 is lined with a heat insulation material 19. However, the combustion gas flowing in the space 18 itself has a temperature-maintaining effect and besides, the temperature thereof is relatively low, so that the heat insulation 19 can be an inexpensive material. It is sufficient to make the lining with a thickness of about 50 to 100 mm. This permits a 75 to 80 percent reduction in weight of the outer cover 17, as compared with the conventionally used outer cover having heating means mounted all over the inner surface thereof and provided with lining of massive fire bricks. This in turn results in such benefits as safe and easy movement of the outer cover and consequent reduction of power required therefor.

Exhaust pipes 20 for exhausting combustion gas are provided in the top of outer cover 17, and a trough 21 filled with sand or similar material is provided on the base B for sealing the lower edge of inner cover 13. An inlet 22, an outlet 23, and a recirculation fan are provided in base B for circulating gas through the material 1 in the direction indicated by arrows in FIG. 1, to thereby make the temperature distribution more uniform as well as to expedite heating and cooling.

Referring now to FIGS. 4 and 5, the gas flowing in the gas pipe 3 is jetted through a circular hole 25 into the combustion chamber 6. The air flowing in the air pipe 4 is divided into two portions, one portion entering the gas pipe 3 through circular air holes 26 as primary air. As will be seen in FIG. 5, the circular air holes 26 are directed tangentially and are spaced around the circumference of the gas pipe 3, so that the air entering therethrough into the gas pipe 3 is violently mixed with gas, thereby producing an extremely stable revolving flame. The other portion of the air, which serves as secondary air,

flows down through a space **28** between a disc **27** on the end of gas pipe **3** and the air pipe **4** into the combustion chamber **6**. This portion of the air acts chiefly to prevent the overheating of a burner tile **29** in the combustion chamber **6**. The conventional burners of this type tend to provide unstable combustion and produce large combustion noise. Such inconveniences, however, are completely overcome by the present device having the above described construction which enables maintenance of stable as well as quite combustion.

While the ends and features of our invention have been described above, various changes and modifications in the construction and configuration of each part can be made within the spirit of the present invention. The particular embodiment described and shown in this specification is only an exemplification of one practical application of the present invention.

We claim:

1. A gas annealing furnace comprising an inner bell-shaped cover, a radiant heat tube depending into said inner cover and having the lower end closed, an outer bell-shaped cover around said inner cover and having the walls thereof spaced from the walls of said inner cover, a burner assembly depending from and attached to the outer cover in alignment with said radiant heat tube for directing a stream of combustion gases into said radiant heat tube, and a middle bell-shaped cover secured to said burner assembly and positioned between the inner and outer covers and having the walls thereof spaced from each of the inner and outer covers and blocking passage of combustion gas past said burner assembly, the depending wall of the middle cover terminating short of the ends of the depending walls of the inner and outer covers, the radiant heat tube having the upper end open into the space beneath the middle cover and the outer cover having exhaust openings in the upper portion thereof, whereby combustion gases from said burner assembly flow along said radiant heat tube, then downwardly between the inner and middle covers to heat the space within the inner cover, and then flow upwardly between the inner and outer cover to insulate the inner cover from the atmosphere outside the outer cover.

2. A gas annealing furnace as claimed in claim **1** in which said radiant heat tube has a downwardly extending inner tube therein terminating short of the closed bottom end of the radiant heat tube and isolated from said burner for guiding combustion gases from the burner assembly downwardly in the center of the radiant heat tube and then upwardly along the inner surface of the radiant heat tube.

3. A gas annealing furnace as claimed in claim **1** in which the upper end of the radiant heat tube has an enlarged portion, and said burner assembly has outwardly extending fins thereon fitting into said enlarged portion for centering the burner assembly in said radiant heat tube.

4. A gas annealing furnace as claimed in claim **1** in which said burner assembly includes a central gas pipe having an opening at the lower end thereof and a plurality of tangential primary air holes spaced therearound just ahead of said end, an air pipe positioned around said gas pipe, said air pipe extending past the end of the gas pipe to define a combustion chamber at the end of the gas pipe, a disc on the end of said gas pipe extending to a point close to the inner surface of the wall of said air pipe for permitting flow of secondary air around the periphery of the disc into said combustion chamber.