July 8, 1952 E. A. CORNS 2,602,440

COMBUSTION TUBE HEATING APPARATUS

Filed Sept. 20, 1948 2 SHEETS—SHEET 1

Fig. 2.

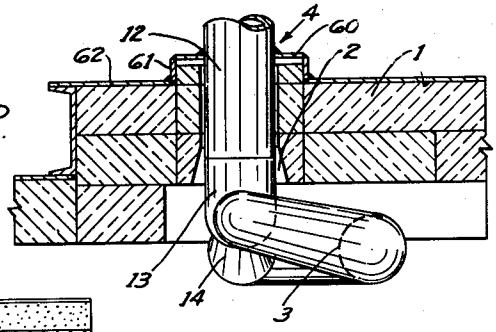
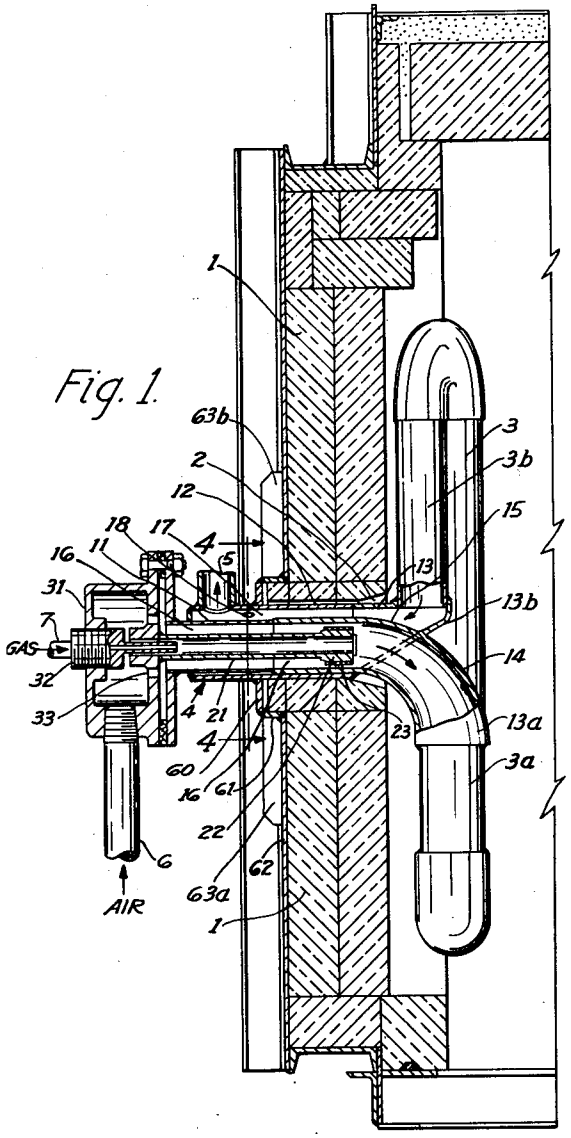


Fig. 1.



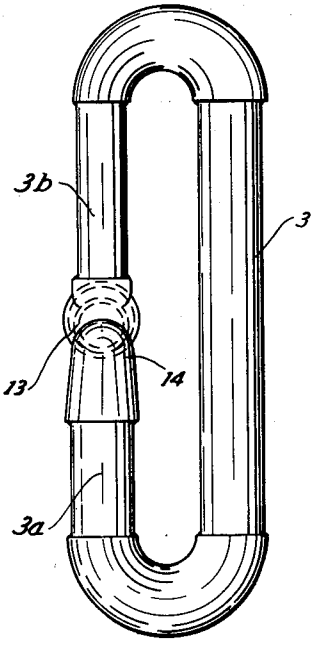


Fig. 3.

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COMBUSTION TUBE HEATING APPARATUS

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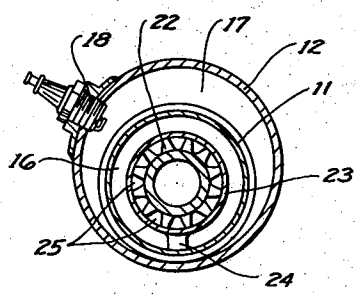


Fig. 4.

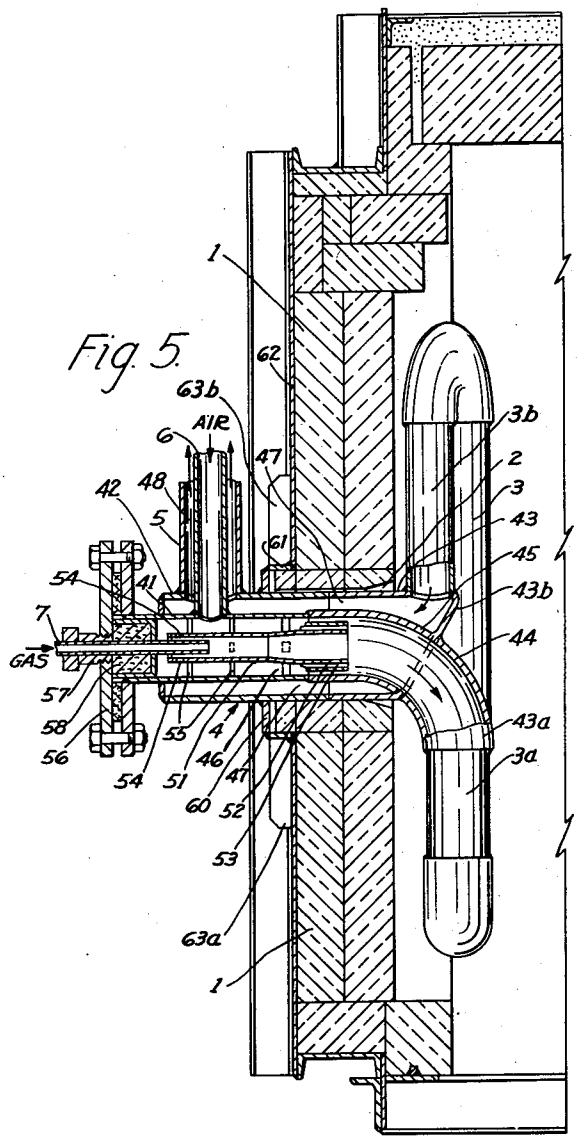


Fig. 5.

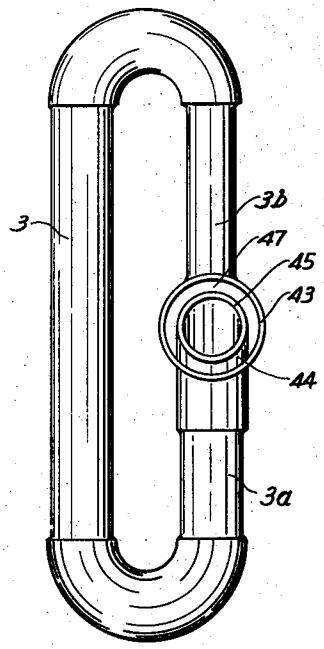


Fig. 6.

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UNITED STATES PATENT OFFICE

2,602,440

COMBUSTION TUBE HEATING APPARATUS

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Application September 20, 1948, Serial No. 50,061

8 Claims. (Cl. 126—91)

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This invention relates to furnaces, particularly industrial furnaces of a kind sometimes used for annealing, provided with heating elements of the radiant-tube type.

In the past, industrial furnaces have been proposed employing radiant-tube heating elements extending transversely into and even entirely across the interior of the furnace, thereby correspondingly decreasing the space available for the material to be heat-treated. In other instances, efforts have been made to provide radiant-tube heating elements paralleling the side walls of the furnace. In both cases, difficulties have been experienced in so arranging the parts, particularly the burner parts, as to escape the necessity for having a plurality of openings through the furnace wall, one for each end of the heating element, in addition to which it has been found necessary to use supporting hangers of costly alloy metals or refractory supports interfering with heat transfer at the supporting points. Also, expansion of the metal of the heating element due to its changing temperature has required special provisions, such as sliding joints or seals, to permit expansion without objectionable stress and distortion of the heating elements.

The present invention resolves these and other difficulties by means of a novel construction in which a heating element of the radiant-tube type is employed which is formed into a closed vertical loop, the same cooperating with a fitting obviating the need for supporting means located inside the furnace and requiring but a single opening in the furnace wall. Accordingly, the invention may be said to have for its principal objects to provide simple, improved, more efficient installations in which closed-loop heating elements of the radiant-tube type are employed to decrease the number of openings in the furnace wall and increase the space available within the furnace.

The invention comprehends the constructions illustrated in Figures 1 to 6 of the accompanying drawings, in which Figure 1 shows a vertical section, with parts in elevation, of one preferred embodiment of the invention; Figure 2 is a sectional plan corresponding to Figure 1; Figure 3 is an elevation of the heating element of Figures 1 and 2 as seen from the right in Figure 1; Figure 4 is a vertical section, with parts in elevation, along line 4—4 of Figure 1, but on an enlarged scale; Figure 5 is a vertical section corresponding to Figure 1 but illustrating a second preferred embodiment of the nature of a modification; and Figure 6 is an elevation of the heating element of Figure 5 as seen from the left in Figure 5.

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The installation illustrated in Figure 1 makes use of an upright peripheral portion 1 of an annealing furnace, which portion may be either an end wall or a side wall, having therein an opening 2 for a burner assembly which opening is preferably slightly flared at the end thereof adjacent the interior of the furnace. Inside the furnace is a closed-loop heating element of the radiant-tube type, the same being generally oval in shape, extending normally to opening 2, lying in a plane paralleling the upright portion of the furnace, and conveniently comprising a plurality of parallel tubular members interconnected by elbows as shown in Figure 3. While the arrangement and proportions may vary widely, the heating element shown extends on opposite sides of the burner assembly approximately equal distances above and below opening 2, is narrow in width in proportion to its length, and diminishes in cross section from a maximum in the zone where it receives incoming gases to a minimum in the zone where it returns outgoing gases.

The ends of the heating element 3 receiving incoming and returning outgoing gases are respectively designated 3*a* and 3*b*.

At one side of the oval, heating element 3 is connected to a multiple-wall fitting comprising part of the burner assembly. The latter, generally designated 4, has ports at each of the two ends of the fitting for incoming and outgoing gases, the ports at the end of the fitting adjacent the interior of the furnace communicating with ends 3*a* and 3*b* of heating element 3 and those at the opposite end of the fitting, that is to say at the end thereof that projects out of the furnace, communicating with a discharge stack 5, an air inlet conduit 6, and a gas inlet conduit 7. The fitting which, together with other elements, makes up burner assembly 4 comprises three principal elements; viz., an inner cylindrical shell 11, an outer cylindrical shell 12, the latter including an annular closure welded in place at the end of the fitting which projects out of the furnace, and, welded to either or to both of inner shell 11 and outer shell 12, a two-branch coupling member 13 that may conveniently be cast as an integral unit. Branch 13*a* of coupling member 13 is welded to end 3*a* of heating element 3; branch 13*b*, to end 3*b* of the heating element.

As illustrated in Figures 1 and 3, coupling 13 is cut away at an angle of about 45° immediately below branch 13*b*, this in order to permit it to receive a tubular connecting member 14 which, at its outer end, constitutes branch 13*a* of coupling

member 13. At its inner end, tubular connecting member 14 is characterized by an elbow 15 extending toward and communicating with the space in the interior of the fitting, particularly space 16 within inner shell 11. Preferably, but not necessarily, elbow 15 extends through the furnace wall and at its inner end is welded to inner shell 11.

Preferably, but not necessarily, inner shell 11 is mounted eccentrically to outer shell 12, conveniently being tangent thereto in the 6 o'clock position as seen from either end. Thus there is formed between inner shell 11 and outer shell 12 a generally annular passage 17 shown to best advantage in Figure 4 through which passage products of combustion received from end 3b of heating element 3 by branch 13b of coupling member 13 can pass on their way to discharge stack 5. Into this generally annular passage projects an igniter 18 which, as shown, takes the form of a spark plug. The latter may be mounted at any suitable place but is illustrated as located outwardly of the furnace between the furnace wall and the port in outer shell 12 communicating with discharge stack 5.

Projecting into inner shell 11 from the outer end thereof is a burner tube 21 which is mounted in concentric relation to inner shell 11. The end of burner tube 21 carries a burner nozzle 22, the latter being received within a supporting ring 23 retained in the desired concentric relation to inner shell 11 by means of spacer 24 (Figure 4). In the periphery of burner nozzle 22 is formed a series of air passages 25 which extend longitudinally of the nozzle within supporting ring 23. The function of these air passages is to admit air to the combustion zone.

Burner tube 21 is welded to and carried by a flanged housing 31 which is removably mounted, as by bolts, on a registering flange at the outer end of inner shell 11; preferably, a suitable packing material, such as an asbestos gasket, is interposed between the two flanges. An adjustable coupling 32 connected to gas inlet conduit 7 projects through housing 31 into burner tube 21, but is spaced therefrom to permit primary air to pass between them. A series of ports 33 is provided in the inner wall of housing 31 to admit secondary air into the generally annular space 16 between burner tube 21 and inner shell 11. Air inlet conduit 6 is coupled directly to housing 31 as indicated in Figure 1.

In placing the apparatus in use, gas is permitted to pass through gas inlet conduit 7 into burner tube 21, thence into branch 13a of coupling member 13, thence into heating element 3, thence into branch 13b of coupling member 13, and thence into the generally annular passage 17 between inner shell 11 and outer shell 12. At this stage, the resulting mixture of air and gas is ignited by means of spark plug 18. The mixture burns back through heating element 3 to burner nozzle 22, to which additional air is supplied in the meanwhile through air inlet 6. Part of the air so supplied passes through burner tube 21 as previously described; another part passes through generally annular passage 16 into air passages 25 in the periphery of burner nozzle 22; the remainder passes through generally annular passage 16, around supporting ring 23, and into branch 13a of coupling member 13, where it mixes with gas and air issuing from burner nozzle 22.

In operation, air passing through generally annular passage 16 is pre-heated by products of combustion passing through generally annular passage 17 on their way to discharge stack 5.

The embodiment of the invention illustrated in Figures 5 and 6 contemplates the installation, in an opening 2 in the wall 1 of an industrial furnace, of a somewhat differently constructed multiple-shell fitting which, together with other elements, makes up burner assembly 4. As before, the fitting has separate ports for incoming and outgoing gases communicating at the inner end of the fitting with heating element 3 and at the outer end thereof with air inlet conduit 6, gas inlet conduit 7 and discharge stack 5. In the embodiment of the invention shown in Figures 5 and 6, unlike that shown in Figures 1 to 4, air inlet conduit 6 takes the form of an air intake stack concentric with and surrounded by discharge stack 5, thus permitting additional pre-heating of the incoming air.

The fitting, which, with other elements, goes to make up burner assembly 4, comprises an inner shell 41 communicating directly with air-intake stack 6 and, surrounding inner shell 41, an outer shell 42, the latter carrying an annular closure at the end thereof which projects from the furnace and terminating at its other end in a two-branch coupling member 43. Branch 43a of coupling member 43 communicates with end 3a of heating element 3; branch 43b, with end 3b of the heating element. Coupling member 43 is cut away as shown to permit it to receive an integral tubular connecting member 44 having elbow 45 communicating with a generally annular passage 46 within inner shell 41. Between inner shell 41 and outer shell 42, which, as shown, are mounted in concentric relation to each other, is a generally annular passage 47 through which products of combustion received from end 3b of heating element 3 through branch 43b of coupling member 43 are transmitted to the annular space 48 between air intake stack 6 and discharge stack 5.

If desired, a park plug (not shown) may be provided as in the installation illustrated in Figures 1 to 4.

Projecting into inner shell 41 from the outer end thereof is an open-ended burner tube 51 carrying a burner nozzle 52 provided with longitudinally extending air passages 53. A series of ports 54 for admitting air from inner shell 41 and air intake stack 6 is provided at the open end of burner tube 51, which is held in place in concentric relation to inner shell 41 by spacing elements 55. Inner shell 41 is provided at its outer end with an upstanding flange registering with but separated by an asbestos gasket from closure 56, into which is threaded a coupling 57 which receives gas inlet conduit 7. A packing assembly 58 occupies the extreme outer end of inner shell 41, the packing assembly being so designed as to permit gas inlet conduit 7 to project therethrough into the open end of burner tube 51.

In operation, gas is admitted through gas inlet conduit 7 into burner tube 51 and thence through coupling member 43 into heating element 3. Air is admitted through air intake stack 6 to the generally annular space 46 between burner tube 51 and inner shell 41. This air gains access to the interior of burner tube 51 through ports 54, air so admitted constituting the primary air. The remainder, constituting the secondary air, travels outside burner tube 51 to and beyond burner nozzle 52. This secondary air is pre-heated by products of combustion formed in branch 43a of coupling member 43 and heating

element 3: these products are returned through end 3b of heating element 3 to branch 43b of coupling member 43, proceeding thence through the generally annular passage 47 in outer shell 42 to the annular space 48 within discharge stack 5.

In both embodiments of the invention, the heating element and fitting are welded or otherwise sealed in gas-tight relation to each other and to the metal shell of the furnace. For example, an annular flange 60 welded to burner assembly 4 may itself be welded to a collar 61, the latter being welded to metal shell 62. In such case, central stiffening ribs 63a and 63b may be welded to collar 61, thus assisting in preventing canting of burner assembly 4 under the bending moment imposed by the weight of the heating element at the opposite end of the fitting. The resulting structure obviates the need for alloy metal hangers or refractory supports located in the interior of the furnace, accomplishing the same end from the exterior, and at the same time effectively seals the furnace against escape of unburned gas and products of combustion.

In both embodiments, those parts that are subjected to high temperatures; e. g., the burner tube, burner nozzle, inner shell, outer shell, coupling member and heating element, are made of heat-resistant alloy steels such as chrome-nickel steel containing about 25% chromium and about 12% nickel. As indicated, parts are preferably welded together in gas-tight relation, especially at points where there is danger of escape of gas or products of combustion. However, these and like considerations are not necessarily of the nature of limiting factors, particularly in the event that some fuel other than gas is used; as a matter of fact, numerous modifications in composition, arrangement and proportions of these and other features may be made without departing from the spirit of the invention.

It is intended that the patent shall cover, by suitable expression in the appended claims, whatever features of patentable novelty reside in the invention.

I claim:

1. A heat-treating furnace having a peripheral wall; means defining an opening in the wall; a burner tube extending into the opening from a point outside the wall, said burner tube carrying a burner nozzle at the inner end thereof; a fitting mounted in the opening in surrounding relation to the burner tube and extending from a point outside the wall to a point inside the wall, said fitting comprising an outer shell that is substantially concentric with the opening in the wall, an inner shell that is substantially concentric with the burner tube, and an elbow located at the inner end of the inner shell to change the direction of travel of the efflux from the burner tube immediately upon its discharge from the burner nozzle; and, supported by the fitting itself in close proximity and substantial parallelism to the wall, a radiant tube heating element taking the form of a generally oval loop having an inlet end on one side of said loop at a point between the ends of said side and connected in sealed relation to the said elbow located at the inner end of the inner shell and an outlet end adjacent said inlet end and connected in sealed relation to the inner end of said outer shell, the flow in all portions of that side of the loop in which said inlet and outlet ends are disposed being in the same direction and the flow in all portions of the opposite side of the loop being in the opposite direction.

2. A heat-treating furnace as in claim 1 in which the inner shell is substantially concentric with the outer shell.

3. A heat-treating furnace as in claim 1 in which the inner shell is eccentric to the outer shell.

4. A heat-treating furnace as in claim 3 in which the inner shell is tangent to the outer shell.

5. A heat-treating furnace as in claim 4 in which the point of tangency betweeen the inner and outer shells is at the six-o'clock position.

6. A heating unit comprising a combustion tube member of generally elongated oval form having substantially parallel side sections and curved sections connecting said side sections, said combustion tube member having one of its side sections provided with adjacent inlet and outlet ends disposed between said curved sections; a tubular discharge member connected in sealed relation to and extending from said outlet end of said combustion tube member in a direction substantially perpendicular to the plane of said combustion tube; a tubular inlet member of smaller cross-sectional area than said discharge member and disposed within said tubular discharge member, said tubular inlet member being connected in sealed relation at one end thereof to said inlet end of said combustion tube; and connecting members for holding said tubular discharge and inlet members in fixed relation to each other.

7. A heating unit as in claim 6 in which the connecting members hold the discharge and inlet members in concentric relation to each other.

8. A heating unit as in claim 6 in which the connecting members hold the discharge and inlet members in eccentric relation to each other.

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