June 16, 1964 W. R. KEOUGH 3,137,486

BURNER CONSTRUCTION

Filed Nov. 28, 1962 2 Sheets-Sheet 1

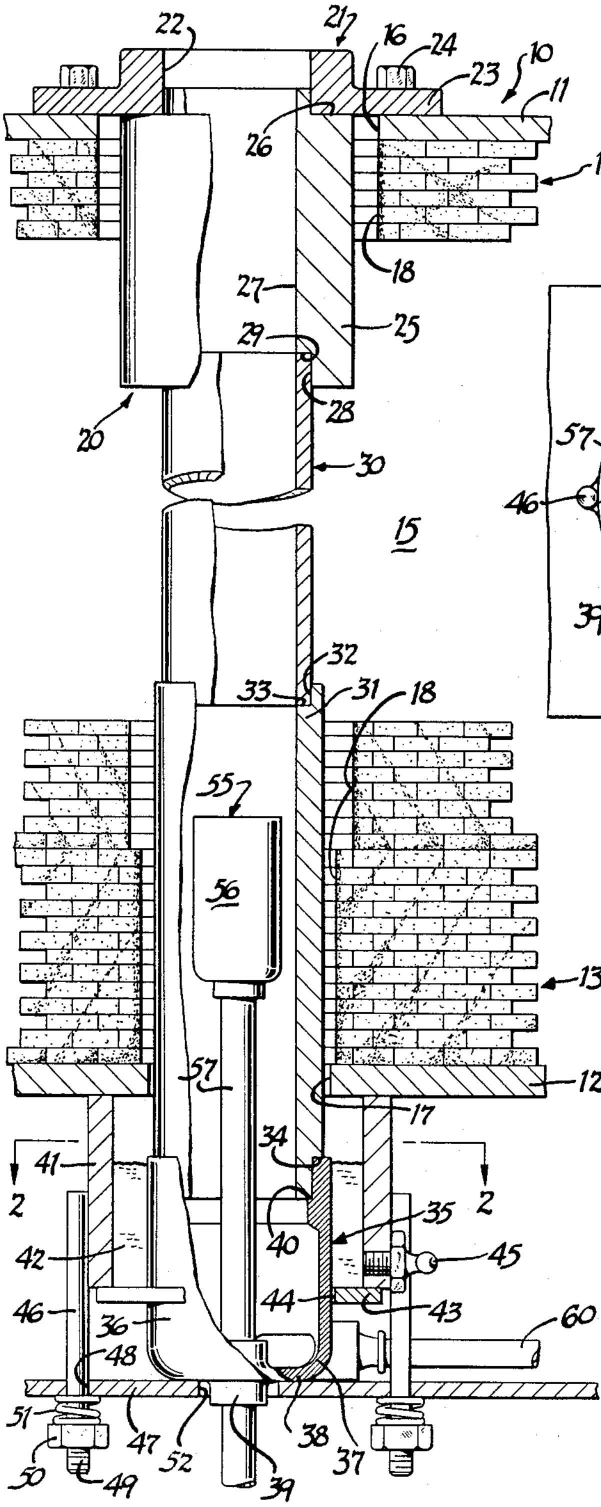

Fig. 1

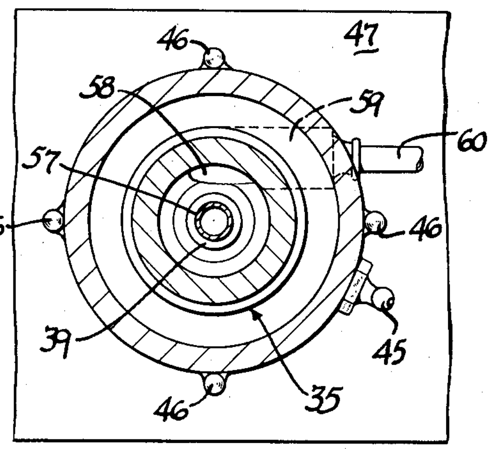

Fig. 2

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2 Sheets-Sheet 2

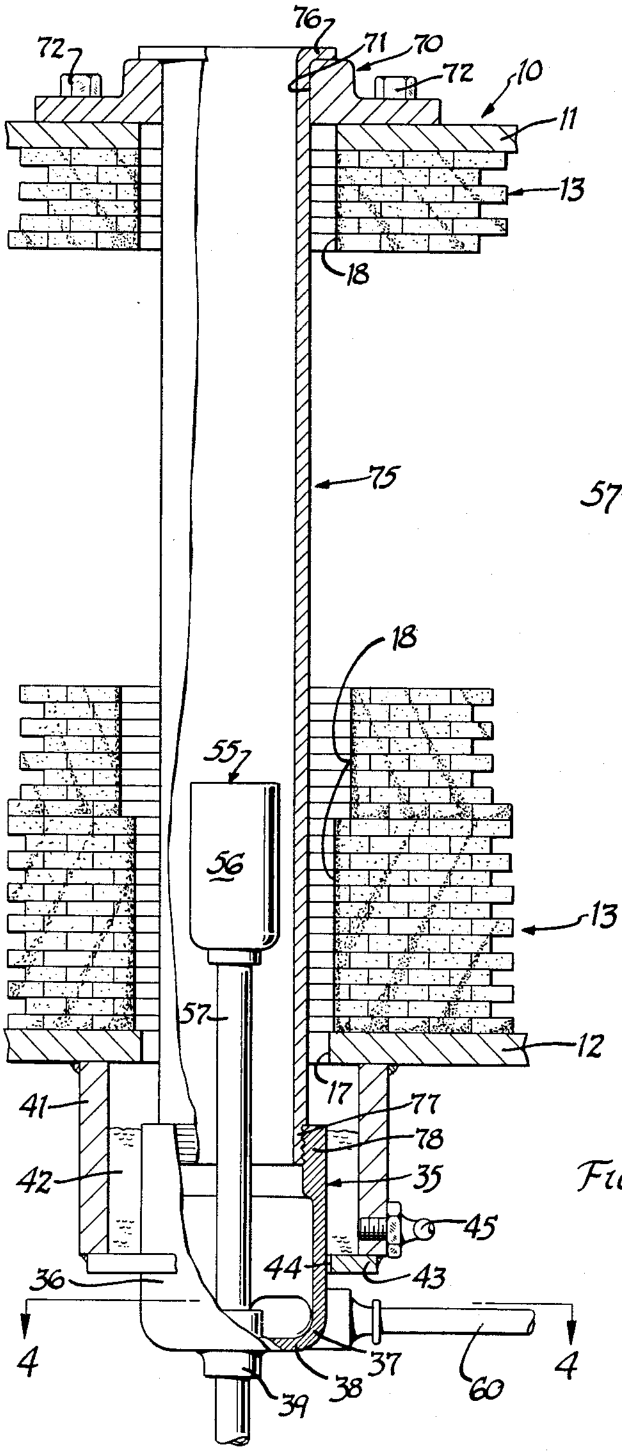

FIG. 3

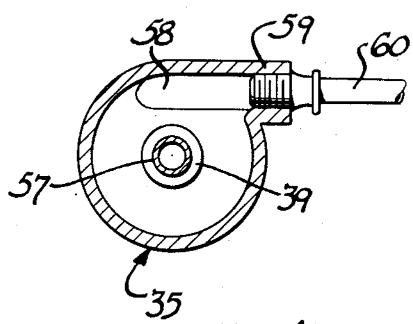

FIG. 4

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1

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BURNER CONSTRUCTION

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The present invention relates to a burner construction and more particularly to a burner of the radiant tube type for use in heat treating furnaces or the like.

The desirability of radiant tube heating in heat treating furnaces, such as annealing furnaces, lehrs, controlled atmosphere furnaces and the like, has long been recognized. However, conventional radiant tube burners leave much to be desired in several respects, e.g. the combustion efficiency is low, severe limitations are normally placed on the maximum temperatures which can be attained, difficulties are encountered in sealing the tubes against loss of atmosphere in a controlled atmosphere furnace, and satisfactory structural designs have not yet been accomplished to permit the usage of high temperature ceramic materials as radiant tubes.

The present invention proposes a new and useful burner construction which solves these difficulties.

More particularly, this invention provides an improved radiant tube burner composed of three basic components, i.e. the radiant burner tube, a combustion burner through which combustible fuel is supplied to the tube, and a means for providing additional combustion air or other combustion medium to the tube independently of the combustion burner.

This last means preferably is in the form of a casting closing one end of the burner tube, the casting receiving the combustible burner therethrough and supplying additional combustion medium, such as air, in a peripheral direction for flow in a helical path about the burner. As a result of the helical air flow through the casting, combustion occurs in a helical path throughout the length of the burner tube, with the combustible gas and the products of combustion scrubbing the interior periphery of the burner tube throughout substantially the length of the burner to provide an elongated, swirling path of flow which heats the burner tube.

This structure is particularly well adapted for utilization with furnaces in which a controlled atmosphere is maintained, for example a reducing atmosphere, such as hydrogen; a treating atmosphere, such as hydrogen cyanide; or even an oxidizing atmosphere, such as oxygen. Since the air-supplying casting projects exteriorly of the furnace, preferably therebelow, the exterior surface of the casting can be readily surrounded by a retaining collar to which a sealing medium can be readily supplied. The maintenance of such a sealant is made possible by the flow of air through the casting and the lack of combustion within the casting maintains the casting at substantially room temperature, so that ordinary petroleum-based greases or similar fluid or semi-fluid materials may be utilized as the sealing medium in surrounding relation to the casting.

Further, by utilizing the casting, burner and tube assembly, it is possible to mount the tube within the furnace in several different structural arrangements, the specific arrangement being dependent upon the specific type of tube desired. When the tube is metallic, as for example, a chromium-nickel-steel alloy, the tube may merely be suspended from the roof of the furnace and the casting secured to the lower end of the tube by conventional means, such as threads. Where the tube is ceramic and does not have all of the structural strength of a metallic element, the tube may be mounted under compression between the roof and the floor of the furnace, and a specific,

2

hereafter fully described, compression arrangement may be utilized to retain the tube in position under compression and without subjecting the tube to any material tensile load.

It is, therefore, an important object of the present invention to provide a new and improved burner of the radiant tube type for utilization in a heat treating furnace or the like.

Another important object of the present invention is to provide an improved radiant tube burner structure wherein the flow of combustion gases and combustion products is accomplished in a swirling helical path effectively scrubbing the interior surface of the burner tube and increasing the heating efficiency of the complete burner structure.

It is a further object of this invention to provide an improved burner construction for a heat treat furnace or the like and in which a controlled atmosphere is maintained, the burner tube being sealed to the furnace to retain the controlled atmosphere therein.

Yet another, and no less important, object of the present invention is the provision of an improved radiant tube burner for a heat treating furnace or the like utilizing a high temperature ceramic material to form the radiant tube, the ceramic tube being retained in the furnace under a compression load to avoid structural failure of the tube.

It is still another important object of the present invention to provide a radiant tube construction for a furnace wherein a metallic tube is suspended in the furnace to be supplied at its lower end with a combustible fuel and additional combustion medium passing through the tube in a swirling, helical path.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

On the drawings:

FIGURE 1 is a vertical sectional view taken through a heat treating furnace and illustrating one form of radiant tube burner construction of the present invention;

FIGURE 2 is a sectional view taken along the plane 2—2 of FIGURE 1;

FIGURE 3 is a view similar to FIGURE 1 illustrating a different form of radiant tube burner construction of the present invention; and

FIGURE 4 is a view taken along the plan 4—4 in FIGURE 3.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

As shown on the drawings:

In FIGURE 1, reference numeral **10** refers generally to a heat treating furnace having an upper wall or roof **11** and a lower wall or floor **12**. Several layers or courses of refractory brick, indicated generally at **13**, are utilized to line the furnace, as is conventional.

The furnace **10** may be any desired heat treating furnace utilized for any desired purpose, the invention being broadly applicable to such furnaces whether they are utilized for annealing or normalizing, to provide a controlled reducing, oxidizing or treating atmosphere, and whether the materials being treated are metallic or ceramic, such as glassware, or the like. In any event, the structural elements, namely the roof **11** and the floor

12 and the several courses of refractories 13 enclose an interior heat treating space indicated generally at 15.

It will be noted that the roof 11 and the floor 12 are provided with vertically aligned apertures 16, 17, respectively, and the refractory linings 13 are also provided with similar apertures 18 to accommodate installation of a burner of the present invention indicated generally at 20.

The burner 20 is secured to the roof 11 by means of a standard pipe flange indicated generally at 21, the flange having a central aperture 22 and a surrounding, outwardly projecting flange 23 secured to the metallic roof plate 11 by suitable means, as by nuts 24. Abutting the undersurface of the flange is a generally cylindrical bushing or "stub" 25, preferably formed of refractory material, such as mullite. Mullite is a conventional refractory material of somewhat variant composition and containing alumina and silica in varying relative proportions. It will be noted that the mullite stub 25 is provided with an upper shoulder 26 abutting the undersurface of the pipe flange 21, with a cylindrical interior bore 27 and with a radially enlarged lower recess 28 concentric with the bore 27 and defining therewith a downwardly facing shoulder 29.

Seated against the shoulder 29 and snugly received within the recess 28 is a cylindrical radiant burner tube indicated generally at 30. This tube 30, in that form of the invention illustrated in FIGURE 1 of the drawings, is preferably ceramic and is formed of pure silicon carbide fired at a temperature of 2900° C., such material being available commercially from the Carborundum Company of Perth Amboy, New Jersey, under the trade name "K.T." Such material is suitable for utilization in radiant tube furnaces, since it is capable of withstanding the maximum temperature of all gas fired fuels utilizing air in admixture with the fuel for combustion, i.e. up to a temperature of about 3700° F. However, as will be later explained, this material is of low tensile strength and can be utilized as a radiant tube only when subjected only to compression loads, by the structure to be hereafter more fully described.

The lower end of the radiant tube 30 is received in a lower mullite stub 31 which is also generally cylindrical in configuration and of the same or substantially the same composition as the stub 25. This lower stub 31 is provided with an upper radially enlarged recess 32 providing a lower shoulder 33 abutting the free lower end of the radiant tube 30, the stub 31 being of sufficient length to extend completely through the lower courses of the refractory 13 and to project freely downwardly beyond the floor 12 of the furnace.

The stub 31 is provided, at its lower end, with a downwardly facing shoulder 34 abutting a lower metallic casting 35. This casting 35 is provided with generally cylindrical side walls 36 smoothly blending, as at 37, into a lower or end wall 38 having located centrally thereof an axially projecting embossment 39 which is internally threaded, the embossment projecting both above and below the end wall 38. An internal mounting shoulder 40 is provided in the casting side wall 36, the shoulder being annular to receive thereagainst the extreme lower end of the stub 31.

Secured to the floor 12 of the furnace by suitable means, as by welding, is an annular, downwardly projecting wall 41 peripherally enclosing the lower end of the stub 31 and the upper portions of the casting side walls 36, this wall 41 cooperating with the exterior peripheral portions of the stub 31 and the exterior periphery of the casting 35 to define therebetween an annular sealant chamber 42, this chamber 42 being closed at its lower end by means of an annular, inwardly projecting ring 43 secured to the wall 41 and projecting inwardly into closely spaced relation to the side walls 36 of the casting, the inner periphery of the annular member 43 terminating in closely spaced relation to the casting, as at 44. The wall 41 is provided with one or more conventional grease fittings, commonly known as "zerk" fittings 45 by means of which the sealant space 42 may be filled with grease or a similar sealant.

Secured to the exterior periphery of the wall 41 are a plurality of depending mounting rods 46 projecting vertically downwardly beyond the lower end of the casting 35, these rods receiving thereon a compression plate 47 provided with apertures 48 registering with the support rods 46 to receive the rods therethrough. The lower ends of the rods 46 are threaded, as at 49, to receive thereon securing nuts 50. Compression springs 51 are interposed between the lower surface of the plate 47 and each of the nuts 50 to urge the plate 47 upwardly relative to the furnace 10. The plate is centrally apertured, as at 52 to receive the threaded embossment 39 projecting beyond the bottom wall 38 of the casting 35, those portions of the plate surrounding the aperture 52 abutting the exposed lower surface of the casting, so that the springs 51 urge the casting upwardly.

These springs 51 serve to maintain in removable assembly the casting 35, the stub 31, the radiant tube 30, the stub 25, against the metallic pipe flange 21. By virtue of the telescopic assembly of the various elements, it is not necessary to cement, grout or otherwise fixedly secure the elements to one another, although such fixed securing may be utilized if desired.

As best illustrated in FIGURE 1 of the drawings, the threaded embossment 39 of the casting 35 threadedly receives therethrough and secures in position within the stub 31 a burner assembly indicated generally at 55 and comprising a burner head 56 of any desired design surmounting a pipe 57 threaded into the casting portion 39.

As best illustrated in FIGURES 2 and 4 of the drawings, the casting 35 is provided with an aperture 58 which is located tangentially of the side wall 36 of the casting in the area 37 of the casting joining the side walls 36 and the bottom wall 38 thereof. This aperture communicates with an embossment 59 integral with the casting and projecting therebeyond to receive therein a supply pipe 60 connected to a suitable source of combustion-supporting gas, such as air. A flow of a combustion-supporting gas, such as air, is maintained through the pipe 60 during operation of the burner assembly 20, this gas entering the casting in a path which is tangential to the casting side wall, so that the gas under pressure is necessarily deflected into a helical path by the interior surfaces of the casting side walls 36 to rise spirally within the casting for entry into the stub 31.

At the same time, a combustible fuel, such as natural gas in admixture with air, is introduced through the pipe 57 of the burner assembly 55, ignition of this combustible mixture occurring exteriorly of the burner head 56, i.e. somewhere within the upper regions of the stub 31 or the lower regions of the radiant tube 30. The air or other gas flowing spirally through the stub 31 provides additional combustion atmosphere for the mixture introduced through the burner assembly 55 and ignited therebeyond. The additional combustion atmosphere increases the combustion efficiency of the burner 55 and the swirling or helical path of the air induces a similar swirling or helical path of the combustion gases, so that the entire inner periphery of the radiant tube 30 is contacted by the burning mixture, this burning mixture effectively scrubbing the interior surface of the radiant tube and imparting heat thereto for radiant dissipation into the furnace space 15. After substantially complete combustion has occurred within the radiant tube 30, and the tube has been heated by such combustion, the products of combustion escape upwardly through the upper stub 25 to exit through the aperture 22 of the flange 21.

It will be specifically noted that there is neither combustion nor heat of combustion within the casting 35, any such combustion necessarily occurring at or above the upper end of the burner assembly 55. Further, the swirling of combustion air through the casting 35 will continually cool the interior surface of this casting and of the lower extremity of the stub 31. As a consequence, the sealant chamber 42 will remain relatively cool, i.e. in actual practice, the exposed lower end of the casting 35 and the walls 41 are cool to the touch. As a result, the grease or other sealant within the chamber 42 remains viscous and in its original condition, so as to effectively seal the atmosphere within the furnace interior 15 from the exterior atmosphere, despite the possibility of the escape of the furnace atmosphere through the refractory apertures 18 and the floor aperture 17 which are necessarily spaced peripherally from the exterior surface of the stub 31. Thus, effective sealing of the furnace atmosphere is obtained by the utilization of a conventional, cheap and readily available sealant such as a common grease.

In that embodiment of the invention illustrated in FIGURES 3 and 4, the structure for supporting a radiant tube internally of a furnace is substantially simplified by the utilization of a metallic radiant tube. Reference numerals in FIGURES 3 and 4 identical with reference numerals in FIGURES 1 and 2 refer to identical portions of the apparatus.

It will be noted that the furnace structure 10 is substantially the same, including the furnace roof 11, the furnace floor 12, and the refractory linings 13 for these elements. A similar form of pipe flange is utilized, this flange being identified by reference numeral 70. The flange 70 is substantially the same as that utilized in the embodiment of FIGURES 1 and 2, the flange having a straight-through axial aperture 71. Again, the flange is secured to the furnace roof by suitable means, as by bolts 72.

Projecting through the flange aperture 71 is a metallic radiant tube 75 having an out-turned upper marginal flange 76 overlying the upper surface of the standard flange 70. Of course, the flange 76 may be either integral with the radiant tube 75 (as illustrated) or may be secured thereto by suitable means, as by welding.

The radiant tube 75 is preferably a high temperature resistant steel alloy, such as a chrome-nickel alloy, such alloys being well known and being capable of withstanding temperatures on the order of 1850° F. without distortion and without loss of tensile strength to an extent such as to endanger their utilization in the manner shown in FIGURES 3 and 4. Thus, although the metallic radiant tube 75 illustrated in FIGURES 3 and 4 is not capable of withstanding the temperatures to which the ceramic tube 25 of the embodiment of FIGURES 1 and 2 may be subjected (on the order of 3700° F.) the simplification of the structure indicates the desirability of utilization of such metallic tubes where undue temperatures, on the order of 1850° F. or less, are encountered.

The tube 75 projects vertically downwardly from the flange 70 and terminates in an externally threaded lower end 77 which is threadedly received by the threaded upper end 78 of a lower casting 35 substantially identical with the casting illustrated and heretofore described in connection with the embodiment of FIGURES 1 and 2. It will be noted that the complete radiant tube-casting assembly is suspended vertically from the flange 70, inasmuch as the metallic tube 75 is capable of withstanding the tensile loads so imposed thereon, in contrast to the corresponding incapability of the ceramic radiant tube 25 heretofore described.

The remainder of the structure is substantially as heretofore described, with the exception that it is not necessary to utilize the compression loading and supporting structure of FIGURES 1 and 2 and the burner assembly projects freely vertically directly into the metallic radiant tube 75. One again, the surrounding sealant space is utilized, such space being cool by virtue of the fact that combustion occurs well above the casting 35 and the casting 35 is continuously swept at its interior periphery by the helically flowing stream of coolant entering through the conduit 60.

From the foregoing discussion, it will be readily appreciated that the present invention provides a new and novel radiant tube burner construction for heat treating furnaces. The principles of the present invention are broadly applicable to any desired heat treating furnace, as earlier summarized, the radiant tube itself may be either ceramic or metallic and may be disposed interiorly of the furnace so as to be subjected only to compression loads (in the event the tube is ceramic) or to pure tensile loads (in the event that the tube is metallic). In either event, the atmosphere within the furnace is completely sealed from the exterior atmosphere by means of a conventional, readily available, inexpensive sealant, such as grease, which is maintained at substantially an ambient or normal air temperature completely divorced from the temperature interiorly of the furnace. In each form of the invention the upper end of the tube is also sealed from the furnace atmosphere and the flange 21, 70 seals the roof aperture 16.

Having thus described my invention, I claim:

1. In a heat treat furnace having top and bottom wall means defining a treating space therebetween, a substantially cylindrical radiant tube disposed interiorly of said furnace and traversing said treating space, upper and lower hollow elements having annular inner wall surfaces registering with said tube and carried by said wall means to support said tube therebetween, means defining a sealant chamber disposed exteriorly of said treating space and supported by said bottom wall means to surround said lower hollow element, means for supplying a combustion mixture to the tube for combustion therein, means for supplying additional combustion-supporting fluid to the lower of said hollow element beneath the bottom wall means and means for flowing said additional fluid tangentially of the annular inner wall surface of said element for travel therethrough in a helical path to maintain said lower hollow element and said sealant space at a temperature substantially less than the temperature interiorly of said furnace.

2. In a heat treating furnace having roof and floor elements defining therebetween an interior treating space containing a treating atmosphere, a radiant tube burner assembly comprising a radiant tube vertically traversing said treating space and projecting downwardly through an aperture in said floor element, means fixing the upper end of said tube to said roof element and providing an exit for combustion products from said tube, a fitting located beneath said floor element closing the lower end of said tube and carrying a burner for supplying a combustible mixture to the tube for combustion therein, said burner projecting upwardly from said fitting into the interior of said tube, and a conduit tangential to the inner wall surface of said fitting for supplying air under pressure tangentially to the interior of said fitting for upwardly spiralling passage therethrough into said tube to be admixed in said tube with said combustible mixture, the upwardly spirilling flow of air through the fitting and the tube cooling the fitting exposed beneath said floor element, and sealing means disposed between said floor element and the exterior of said fitting at a region of said fitting cooled by the upwardly spiralling flow of air for sealing the aperture in said floor element.

3. In a heat treating furnace having an aperture therein, a radiant tube burner assembly for imparting radiant heat to an enclosed treating space interiorly of said furnace, comprising a radiant tube in said treating space having one end projecting freely through said aperture to the exterior of said furnace and open at its opposite end, a fitting located exteriorly of said furnace closing said one end of said tube, means traversing said fitting for supplying a combustion mixture to the interior of said tube for combustion therein, the products of combustion escaping from the open opposite end of said tube, means for sup-

plying air under pressure to said fitting in spaced relation from said one end of said tube, and means defining a sealant chamber at least partially surrounding said fitting and enclosing said aperture, and means in said air-supplying means for introducing air from said supplying means into said fitting in a direction tangential to the inner periphery of said tube so that the flow of air through said fitting cools said sealant chamber during the resultant spiral flow of air through said fitting into said tube.

4. In a heat treating furnace having roof and floor elements defining therebetween an interior treating space containing a treating atmosphere, a radiant tube burner assembly comprising a metallic radiant tube vertically traversing said treating space, an annular collar secured to said roof element and suspending said tube therefrom, said collar providing an exit for combustion products from said tube, a fitting secured to the lower end of said tube and carrying a burner for supplying a combustible mixture to the tube for combustion therein, means for supplying air under pressure to said fitting for passage therethrough in an upwardly spiralling path into said tube to be admixed in said tube with said combustible mixture, said fitting being located beneath said furnace floor element, said floor element being apertured to receive said burner assembly therethrough, a depending wall secured to the undersurface of said floor element and surrounding said floor element aperture and at least a portion of said fitting, said wall and said fitting portion defining therebetween a sealant chamber, and means for filling said sealant chamber with sealant, the flow of air through said fitting chilling said chamber despite the free communication of said fitting with said radiant tube.

5. In a heat treating furnace having roof and floor elements defining therebetween an interior treating space containing a treating atmosphere, a radiant tube burner assembly comprising a ceramic radiant tube vertically traversing said treating space, upper means traversing said roof element and abutted by said tube to provide an exit for combustion products from said tube, a lower fitting means sealingly abutting the lower end of said tube and carrying a burner for supplying a combustible mixture to the tube for combustion therein, means for supplying air under pressure to said fitting means for upwardly spiralling passage therethrough into said tube to be admixed in said tube with said combustible mixture, said fitting means projecting beyond said furnace floor element, said floor element being apertured to receive said burner assembly therethrough, a depending wall secured to the undersurface of said floor element and surrounding said floor element aperture and at least a portion of said fitting means, said wall and said fitting means portion defining therebetween a sealant chamber, means for filling said sealant chamber with sealant, the upwardly spiralling flow of air through said fitting means chilling said chamber despite the free communication of said fitting means with said radiant tube, and means biasing said fitting means and said tube upwardly toward said upper means to maintain said tube in position under a compression load only.

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