May 19, 1953 J. A. DOW 2,638,889

HEAT-TREATING ELEMENT FOR HEAT-TREATING FURNACES

Filed May 8, 1947 2 Sheets-Sheet 1

FIG. 1

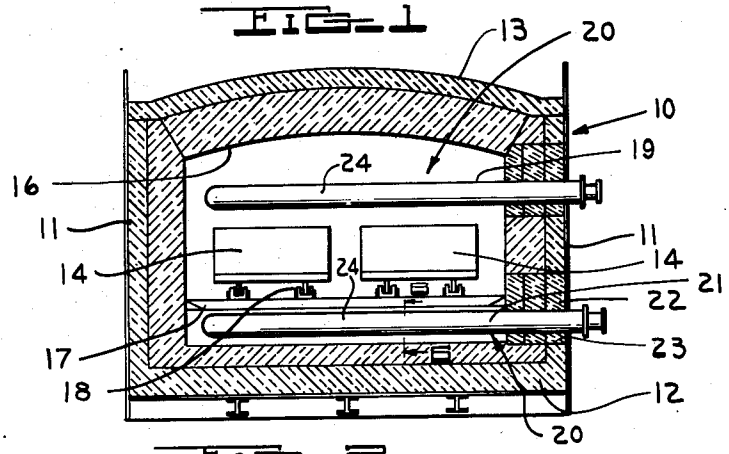


FIG. 2

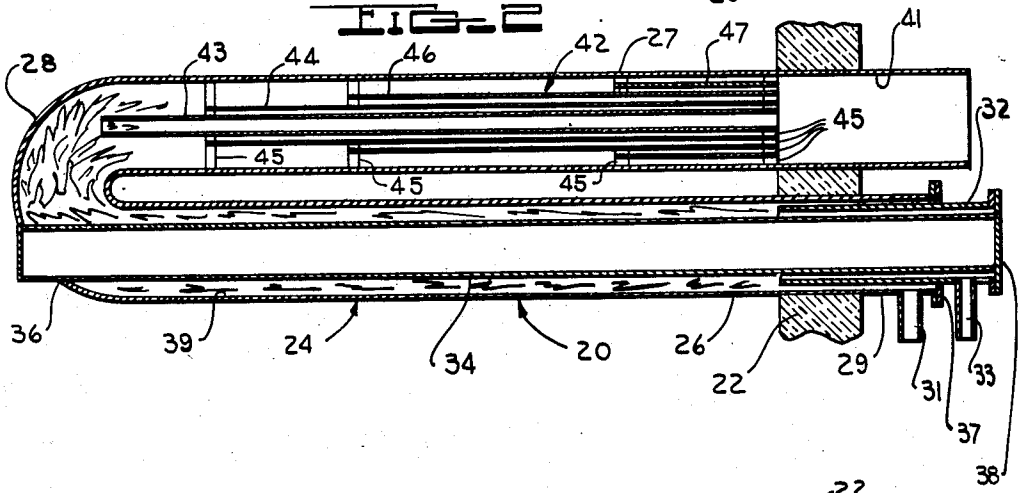
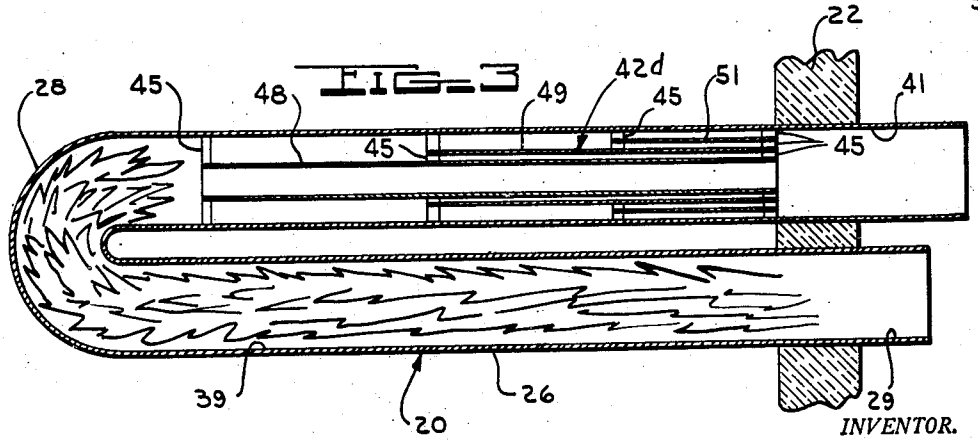


FIG. 3



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HEAT-TREATING ELEMENT FOR HEAT-TREATING FURNACES

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FIG-4

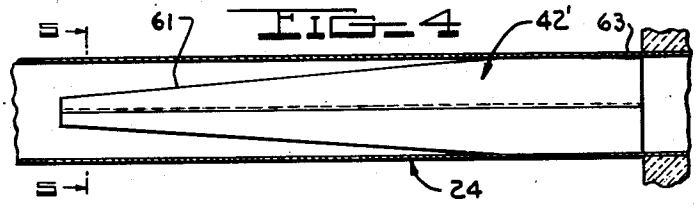


FIG-5

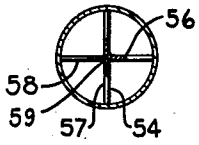


FIG-6

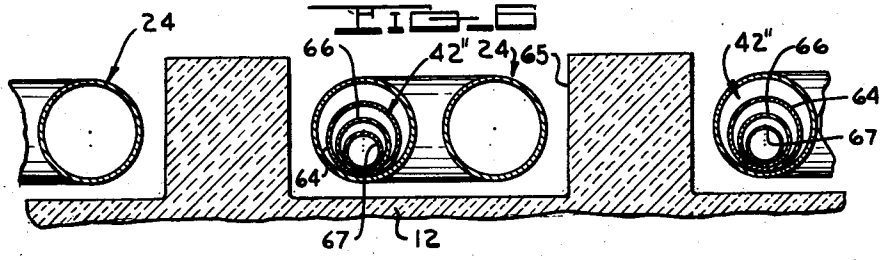


FIG-7

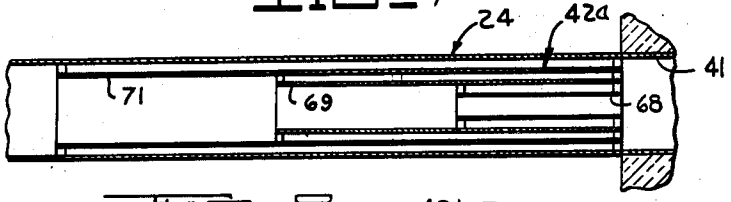


FIG-8

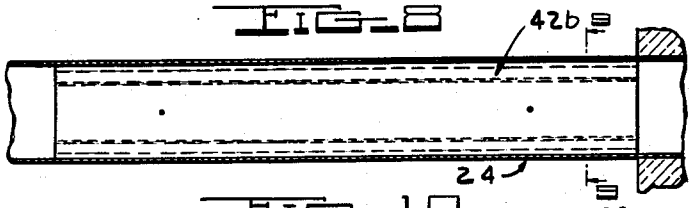


FIG-9

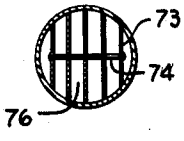


FIG-10

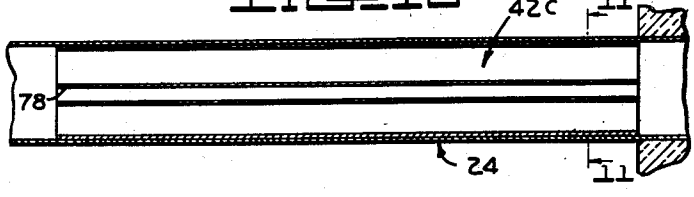


FIG-11

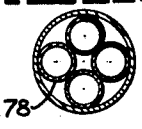


FIG-12

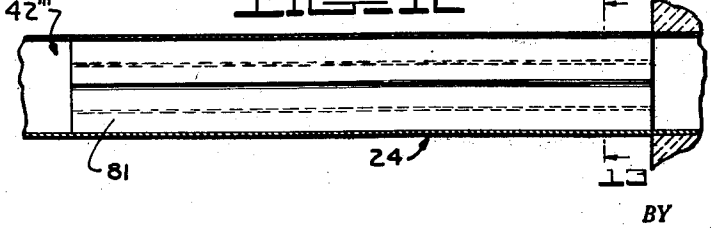


FIG-13



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UNITED STATES PATENT OFFICE

2,638,889

HEAT-TREATING ELEMENT FOR HEAT-TREATING FURNACES

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Application May 8, 1947, Serial No. 746,724

3 Claims. (Cl. 126—91)

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This application is a continuation in part of the subject matter contained in my copending applications for United States Letters Patent, Serial No. 664,948 for Liquid Salt or Fusible Metal Bath, filed April 25, 1946, now abandoned, and Serial No. 670,436 for Heat Treating Furnace, filed May 17, 1946.

The invention relates to improvements in radiant heating elements or tubes to be employed in heat treating furnaces and has particular relation to heating elements of this type in which a combustible mixture is employed internally thereof for the purpose of heating the elements or tubes to radiant temperatures.

In heating elements of this type as these have been constructed heretofore, it has been a problem to construct the tubes so that the exterior surface thereof would be of uniform temperature from one end thereof to the other. In such heating elements there has arisen the difficulty that some parts of the surface were considerably hotter than the average temperature of the entire surface and consequently these hot spots would burn out and hence make necessary the replacement of an element, when perhaps the larger portion of the heating element was in condition to render service for a considerably longer period of time. Also these hot spots and such irregular heating made it necessary to use a greater amount of heating surface in any given furnace than would be required were it possible to employ heating elements of uniform temperature from one extremity thereof to another. Such lack of uniformity of temperature in a furnace employing these heating elements also caused nonuniform heating of the work in radiation furnaces and sometimes caused nonuniform heating of the circulating medium in convection furnaces.

Not only have heating elements of this type been subject to nonuniform temperatures throughout the length thereof to a considerable extent but it has been characteristic thereof that the temperature of the surface tended progressively to decrease toward the outlet ends thereof. Under such circumstances it has generally been considered not the best practice to place all of the tubes in the furnace from one side wall thereof. Instead of such desirable practice it has been necessary heretofore to insert one row of tubes in the furnace from one side wall thereof and another from the opposite side of the furnace. This practice of inserting the tubes in this manner from opposite side walls has tended to provide more uniform heating throughout the entire furnace, but it has required a considerable increase in the amount of floor space necessary for the installation of any number of furnaces due to the fact that a considerable amount of space is required at one side beside a furnace for operating and servicing the heating tubes. If this work has to be done from both sides of a furnace, then more space must be utilized than would otherwise be required.

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It has been proposed heretofore to attempt to improve the performance of such tubes by employing devices therein to increase the velocity and the turbulence and surface scrubbing action of the heating fluid within the tubes in particular regions therein where it was considered desirable to increase the surface temperature of the elements. These expedients have been objectionable from the standpoint that they created other hot spots in the heating elements which likewise reduced the life thereof. Also these expedients tended to greatly reduce and render nonuniform the space provided for the combustible fluid within the heating elements and consequently made it necessary either to make the heating elements larger or to tolerate inefficient combustion of the combustible fluid employed.

According to the present invention, heat absorbing and radiating material is placed in the tubes in such manner as to absorb heat from the combustible fluid by direct contact therewith and radiation therefrom and then to transfer such heat by radiation through the combustible fluid to the heat radiating surface of the heating elements. It is furthermore proposed to employ relatively uniform heat absorbing and radiating means of this character which will not create excessive turbulence or scrubbing action and will not excessively increase and decrease the velocity of the combustible fluid within the heating element.

Such means may be arranged within the heating elements in such manner as to progressively increase the radiation of heat to the exterior surface of the heating elements toward the outlet thereof so that the heating effect of the elements will remain relatively constant notwithstanding the reduction in temperature in such region of the combustible fluid contained therein.

Also such means may be employed merely for the purpose of increasing the capacity of the heating tubes employed in any furnace. Such increase in capacity will result from the improved efficiency in absorbing and radiating heat resulting from the combustion of fuel supplied to the tubes and from a more efficient combustion of the fuel in the tubes employing such means.

One of the objects of the invention is to provide a heating element having a temperature throughout the extent of the heat radiating surface thereof in which the variation from the average temperature of the surface of the heating element is reduced to a minimum.

Another object of the invention is to increase the life of heating elements employed in heat treating furnaces by eliminating hot spots from the elements which tend to burn out and to cause replacement of the elements sooner than would otherwise be necessary.

Another object of the invention is to provide for more uniform heating of radiant heating elements from one end of such elements to another so that all of the elements can be placed in a furnace from one side of the furnace, and as a consequence thereof the floor space required for heat treating work will be reduced.

A further object of the invention is to increase the capacity of radiant heating tubes employed in such furnace by increasing the heat transfer rate from the products of combustion to the heat radiating surfaces of the tubes, and consequently the rate at which heat may be transferred from said surfaces to the work being processed.

A still further object of the invention is to increase the combustion efficiency within radiant heating tubes of such type by increasing the amount of heat absorbing and radiating surfaces within the tubes and with which surface the burning gases are brought into intimate contact during the combustion process.

Other and further objects of the invention will be apparent by reference to the accompanying drawings of which there are two sheets, which by way of illustration show preferred embodiments and the principles thereof and what I now consider to be the best mode in which I have contemplated applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims. I also contemplate that of the several different features of my invention, certain ones thereof may be advantageously employed in some applications separate and apart from the remainder of the features.

In the drawings:

Fig. 1 is a cross sectional view of a heat treating furnace employing heating elements or tubes embracing the principles of the invention;

Fig. 2 is a longitudinal sectional view through a heating element such as those employed in the structure disclosed by Fig. 1;

Fig. 3 is a longitudinal sectional view of a modified form of heating element such as might be employed in the structure disclosed by Fig. 1;

Figs. 4 and 7 are longitudinal sectional views through the outlet sections of heating tubes such as those disclosed by Figs. 2 and 3 and illustrating other forms of heat radiating and absorbing means that may be employed therein;

Fig. 5 is a cross sectional view of the heating tube disclosed by Fig. 4 taken substantially in the plane of line 5—5 thereon;

Fig. 6 is a cross sectional view of a lower portion of the furnace illustrated by Fig. 1 disclosing the transversely disposed passages formed in the lower wall in which the heating elements are disposed and disclosing another form of heat radiating and absorbing means which may be employed within the heating elements employed therein;

Figs. 8, 10 and 12 are longitudinal sectional views through heating tubes or elements employing other forms of heat absorbing and radiating means therein; and

Figs. 9, 11 and 13 are cross sectional views through the structures disclosed by Figs. 8, 10 and 12 taken respectively in the planes of lines 9—9, 11—11 and 13—13 thereof.

Referring particularly to Fig. 1, the numeral 10 indicates a heat treating furnace of conventional design comprising side walls 11, a lower wall 12, and an upper wall 13. An opening in the front wall, not shown, provides means for inserting work baskets or containers 14 within the heat treating compartment 16 provided by the walls of the container, these work baskets being supported on a supporting rack 17 having wheels or rollers 18 mounted thereon, on which the work baskets are adapted to roll easily into and out of the furnace.

The heating chamber 16 of the furnace 10 is adapted to be heated by a plurality of heating elements indicated at 20, the heating elements being divided into an upper row indicated at 19 and a lower row indicated at 21. These heating elements may be positioned in the furnace in any desired angular position, although in the structure shown by Fig. 1 they are positioned horizontally in spaced relation to one another from front to rear of the furnace and are provided with removable heads indicated at 22 adapted to be inserted in openings 23 formed in one of the furnace side walls 11.

It will be noted that the openings 23 are all formed in the same side wall 11 of the furnace 10 thereby permitting the changing of all of the tubes or the servicing or adjustment thereof from the same side of the furnace. Since this work requires considerable space, there will be a considerable saving in the over all space required for a number of furnaces due to the fact that two furnaces can be placed very close together when all of the heating elements are available from the adjacent sides thereof.

In the form of heating element disclosed by Fig. 2 the heating elements 20 comprise U-shaped tubes 24 similar to the tubes disclosed by copending application Serial No. 670,436 previously referred to. In such structure the tubes 24 each comprise a straight tubular inlet section 26, a straight tubular outlet section 27, the two sections being connected at one end by a curved tubular section 28. The inlet section 26 has an inlet end 29 projecting through the head 22 and into which is introduced by a conduit 31 the combustible gas employed in heating the tubes. Inside the inlet 29 and disposed in spaced and concentric relation thereto is a short section of tubing indicated at 32, the interior of which is connected to a conduit 33 employed in introducing air required to form the combustible charge within the interior of the tube 24. The air emerges from the inner end of the tube 32 and there mixes with the combustible gas supplied by the conduit 31 to the interior of the inlet 29 of the tube 24. Within the interior of the tube 32 there is concentrically disposed a smaller and longer heat absorbing and radiating means, member or tube 34 which is adapted to extend from one end to another of the straight section 26, the opposite end thereof being secured in an opening formed at 36 in the curved section 28. The tube 32 projects outwardly beyond the end of the straight

tubular section 26, and the space between the tubes at the end of the section 27 is closed by an annular cap 37. The tubes 32 and 34 terminate in the same region and the ends thereof are likewise closed by a disc 38.

While such is not essential, the space within the tube 34 may be employed in producing a controlled gas atmosphere to be circulated in the heating chamber 10, as such space is employed in the structure disclosed by my copending application Serial No. 670,436. However, the tube 34 can be utilized simply for radiating and absorbing heat and for transferring this heat by radiation to the section 26 of the tube 24 for the purposes herein stated.

Beyond the inlet 29 the space inside the tube 24 comprises a combustion chamber indicated at 39, the outlet to which is indicated by the numeral 41. This outlet forms a portion of the straight section 27 which projects outwardly of the furnace through the head 22. The combustible mixture to be burned in the combustion chamber 39 is supplied to the conduits 31 and 33 and ignited in the combustion chamber by any suitable means for this purpose, not shown. The mixture in the tubes is generally ignited merely by throwing a lighted match into the outlet end of a tube when the mixture is turned on. Also the products of combustion discharged from the outlet 41 may be carried away and discharged to the atmosphere by a suitable exhaust manifold, not shown.

As is indicated by the drawing, the combustion of the combustible mixture introduced into the tube 24 occurs principally in the straight section 26 and the curved section 28, the fluid therebeyond in the combustion chamber 39 being principally products of combustion from which it is desired to remove all the heat possible prior to the discharge thereof from the outlet 41. It will be noted that the portion of the combustion chamber 39 formed in the straight section 26 comprises an annular passage surrounding the tube 34 and that this passage is practically uniform throughout the length of the section 26. The tube 34 is disposed in the straight section 26 coaxially with respect thereto and consequently the surface of the tube 34 and the interior and exterior surfaces of the section 26 are parallel to one another.

In the curved section 28 where the direction of motion of the combustible fluid within the tube 24 reverses so as to pass into the section 27 and from the outlet 41, the cross section of the combustion chamber 39 is the same as the cross section of the tube 24, this being desirable to permit the turbulent flow in the gaseous mixture which results. The annular combustion chamber formed in section 26 is of uniform cross section practically throughout the length of the section 26, and although the volume thereof is somewhat reduced, it will be apparent that the heated surface with which the mixture comes in contact is greatly increased. The smooth exterior and interior surfaces of the tube 34 and the section 26, respectively, cause only slight local turbulence in the combustible fluid therein, but due to the increase in heated surface, combustion in this part of the heating element will be relatively uniform and efficient, and consequently no relatively hot and cold spots will develop in the exterior surface of the section 26, and the surface temperature of the tube will be as great as though the volume of the combustion chamber in this region had not been reduced. The curved section 28 being uniform in cross section and enlarged in the region where the turbulent reversal in the flow of the combustible gases occurs, there also will be little variation in the temperature of the exterior surface of the tube 24 in this region. In both of the sections 26 and 28 the flame is relatively uniformly luminous and consequently heats the exterior surface of the sections at a substantially uniform rate.

Beyond the curved section 28 the combustion of the combustible fluid in the tube 24 is substantially complete and under normal circumstances the section 27 will progressively decrease in temperature toward the outlet 41. However, in the structure disclosed by Fig. 2 there is employed a radiant heat absorbing and radiating member or means indicated generally at 42, such means or member comprising a plurality of relatively thin tubes 43, 44, 46 and 47 secured in spaced relation inside the section 27 by any suitable spacers or spiders such as are indicated at 45. These tubes are formed of sheet metal or other material capable of withstanding the degree of heat encountered in such heating elements and are adapted to absorb heat by direct contact with the combustible mixture or products of combustion encountered in the section 27, and as a result thereof to become radiant and hence to radiate heat through the fluid thereabout to the interior surface of the section 27. The tubes 42 are of progressively increasing lengths and diameters, the inner tube 43 being disposed coaxially with respect to the section 27. The tube 43 also is approximately the same length as the section 27 and is disposed concentrically thereto to receive the hot core of the flame emerging from the section 28 both internally and externally thereof. This core of burning fluid and the products of combustion therefrom contact both the interior and exterior surfaces of the tube 43 from one end thereof to another and consequently heat the tube to a temperature approaching the temperature of the fluid. The tubes 44, 46 and 47 each are of progressively decreasing length and all terminate opposite the outlet end of the tube 47. The tubes 44, 46 and 47 also are of progressively increasing diameters and are disposed in concentric relation to the tube 43 and the section 47. The difference between the diameters of the tubes 43, 44, 46 and 47 and the diameter of the section 27 is such that the interior of the combustion chamber 39 within the section 27 is divided into a plurality of parallel annular passages through all of which flow the products of combustion as such products approach the combustion chamber outlet 41. As the combustible fluid in the combustion chamber 39 engages the interior and exterior surface of the tubes 43, 44, 46 and 47, there is exposed to the combustible fluid a progressively increasing amount of heat absorbing surface, and this surface tends to increase as the temperature of the combustible fluid decreases. This increase in the amount of heat absorbing surface as the temperature of combustible fluid decreases tends to increase the amount of heat available for radiation to the interior surface of the section 27 as the combustible fluid approaches the outlet 41. The tubes 43, 44, 46 and 47 radiate this heat through the combustible fluid therebeyond and from the surface of one tube to another and to the interior surface of the section 27.

This progressive radiation of heat upon the interior surface of section 27 tends to maintain the exterior surface temperature of the section 27 relatively constant from one end to the other of such section and at practically the same value as the average temperature of the sections 26 and

28. Also when the products of combustion pass beyond the ends of the tubes 43, 44, 46 and 47, the temperature thereof can be maintained at the lowest possible value that the temperature of such fluid can be and still maintain the temperature of the section 27 at a substantially uniform value.

It will be noted that the combustible fluid, practically from one end to another of the tube 24, encounters only relatively smooth surfaces and passages of somewhat different but relatively uniform cross section. This tends to cause the combustible fluid to flow in relatively straight lines, thereby producing a relatively uniform rate of combustion in the fluid during the period of combustion of the fluid within the combustion chamber 39. Thereafter the heat absorbing and radiating surface is increased within the combustion chamber so as to absorb and radiate heat at an increasing rate during the period just prior to the discharge of the products of combustion from the tube 24. During such period the combustible fluid is not luminous to as great an extent as before and consequently more surface is required to absorb the heat from the products of combustion and more surface is required to radiate such heat to the section 27 to maintain a relatively constant rate of radiation from such section from one end to the other thereof.

In the structure disclosed by Fig. 3, where corresponding reference numerals are employed to indicate elements similar to those disclosed by Fig. 2, the straight section 26 is employed as a combustion chamber throughout the entire extent of the cross sectional area thereof, and as the luminous products of combustion pass therethrough such products radiate heat to the interior surface of the section at a substantially uniform rate. The heat radiating means or member 42*d* employed in the section 27 comprises open end tubes 48, 49 and 51 similar to the heat radiating and absorbing tubes employed in Fig. 2 except that there is a less number of said tubes and the centrally disposed tube is somewhat larger and shorter. Such variation in the heating elements may be made when it is not desired to employ means such as tube 34 in the inlet end of the combustion chamber 39 and when a lesser amount of heat absorbing and radiating surface is desirable in the outlet end of such combustion chamber. In this structure any suitable means such as that employed in the structure disclosed by Fig. 2 may be employed for supplying combustible fluid to the inlet end 29 of the heating element 20.

Figs. 4 and 5 disclose a section of a heating element or tube 24 having a heat absorbing and radiating member or means 42' disposed therein consisting of a pair of strips of sheet metal 54 and 56. The strips 54 and 56 each are bent along a middle longitudinal element thereof to provide portions 57 and 58 disposed at right angles to one another. The strips may be welded together at 59 along the longitudinal bent portions thereof so as to secure the strips together to provide a single unit, the strips being secured together in such manner that the portions 57 and 58 of the two strips extend radially outwardly from the axis of the section of the tube 24 at right angles to one another. The portions 57 and 58 are cut away as is indicated at 61 to provide longitudinally extending portions of decreasing width, the presence of which in the element 42' provides a progressive increase in the amount of metal and surface comprising the element 42' from the inlet toward the outlet ends thereof. The portions 61 terminate a short distance from the outlet end of the element 42' to provide supporting flat portions 63 at one end thereof so as to support the member 42' within the interior of the section of the tube 24. It will be apparent that as the hot gases or products of combustion within the tube 24 pass along the smooth exposed surfaces of the element 42', the element surfaces will absorb from the gases a progressively increasing amount of heat and will thereafter radiate such heat to the interior surface of the tube 24 from whence it will be picked up by convection or radiated to the circulating medium or work being processed within a furnace in which the tube is employed.

In the structure disclosed by Fig. 6 there is employed in the tubes 24 a heat absorbing and radiating member 42 consisting of a plurality of tubes 64, 66 and 67 disposed one within another and being respectively of decreasing diameters to provide parallel crescent shaped spaces between the tubes to provide for the flow of heated gases or products of combustion within the tubes. It will be noted that the tubes 64, 66 and 67 are not concentrically disposed within the heating tube or element 24 but extend along the bottom of the tube 24 in such manner that the surface of one tube rests upon and is tangent to the surface of another along a longitudinal portion of the length of the tube 24. When located in such position the tubes 64, 66 and 67 can merely be placed within one or more sections of a tube 24 without requiring any supporting means or spacers for properly positioning the tubes within the heating element 24.

In Fig. 6 the heating tubes 24 are positioned in transversely disposed wells 65 formed in the heat insulating fire brick or other suitable material of which the bottom or lower wall 12 with which a furnace such as that disclosed by Fig. 1 is provided. Due to the nonconcentric position of the tubes 64, 66 and 67 in the section of the tube 24, as disclosed by Fig. 6, it will be apparent that the closer proximity of the surfaces of the tubes 64, 66 and 67 adjacent the bottom portion of the tube 24 will tend to decrease the amount of heat which can be absorbed and radiated by such surfaces in such region. In other words, the top longitudinal portions of the tubes 64, 66 and 67 will absorb and radiate a maximum amount of heat due to the greater separation of the surfaces of the tubes and the greater amount of gases which may affect such surfaces.

From the tops of the tubes the amount of heat which it is possible for the tubes to absorb and radiate progressively decreases toward the bottom of the tubes due to the progressively closer spacing of the surfaces thereof and the progressively decreasing amount of the products of combustion which may affect such surfaces. The tubes 64, 66 and 67 therefore provide a directional heating effect in the heating element 24 in which they are employed to such an extent that a minimum amount of heat will be radiated by the heating element 24 to the portion of the bottom wall 12 directly beneath the heating element, a progressively increasing amount of heat laterally to the side walls of the well 65 and a maximum amount upwardly in the direction of the work containers 14.

Fig. 7 discloses a section of a heating element or tube 24 provided with a heat absorbing and radiating element 42*a* consisting of a plurality of concentric tubes 68, 69 and 71 disposed therein in such manner that all the tubes terminate di-

rectly opposite one another and adjacent the outlet 41 of the tube 24. The tube 68 at the center is the shortest tube, the tube 69 is longer, and the tube 71 is the longest of the three tubes. When arranged in this manner the tubes tend to absorb and to irradiate to the interior surface of the heating element 24 a progressively increasing amount of heat as the hot products of combustion flow between the tubes toward the outlet 41. However, since the hottest portion of the products of combustion within the heating element 24 usually is that portion flowing along the longitudinal axis of the tube 24, it will be apparent that this hot core of gas will be considerably reduced in temperature by the time it reaches first the tube 69 and then 68. This expedient will tend to prevent the tubes of the heat absorbing and radiating member from burning out and requiring a replacement as quickly as might otherwise be the case, and in the event the tubes adjacent the center do burn out, then only a short tube, such for example as the tube 68, may require replacement.

In the structure disclosed by Figs. 8 and 9 the heat absorbing and radiating member or means 42b located within the heating element or tube 24 comprises a plurality of sheet metal members 73 of varying widths, secured together by spacing and securing means indicated at 74, in such manner as to divide the interior of the tube 24 into a plurality of parallel passages 76. These passages may be arranged to extend in any desired direction, but it is apparent that the member 73 will radiate a greater amount of heat perpendicularly with respect to the surfaces thereof than will be radiated in any other direction. As a matter of fact, the maximum amount of heat absorbed by the members 73 will be radiated perpendicularly with respect thereto and a progressively decreasing amount will be radiated in opposite angular directions until the minimum amount of heat radiated therefrom will be radiated in opposite directions coextensive with the surfaces thereof. Assuming the members 73 to be disposed in vertical position, as shown by Fig. 9, it is apparent therefore that the maximum amount of heat radiated by the tube 24 will be radiated horizontally in opposite directions therefrom, and that such radiation of heat will progressively decrease in opposite angular directions therefrom with a minimum amount of heat being radiated upwardly and downwardly. The members 73, while varying somewhat in cross section so as to fit the inside surfaces of the tube 24 are nevertheless all of the same length as is disclosed by Fig. 8. By making these elements the same length, the amount of heat absorbed and radiated by the member 42b will not vary due to the variation in the surface of the member 42b exposed to the products of combustion, as has been disclosed with respect to the structures disclosed by Figs. 2, 3, 4, 5 and 7. Without such variation in length, the heat absorbing and radiating member, as disclosed in Figs. 8 and 9, will merely increase the capacity of the tube 24, and such structure can be employed in any kind of heating element or tubes 24 when it is desired merely to increase the capacity of the tubes and the efficiency of the combustion therein.

In the structure disclosed by Figs. 10 and 11 the heat absorbing and radiating member 42c comprises a plurality of tubes 78 all of the same diameters and lengths, these tubes being merely disposed within the heating element 24 in such manner as to fill up the interior of the heating element and to divide the combustion chamber therein into a plurality of parallel and variably shaped passages. Assuming four of the tubes 78 as are disclosed by Figs. 10 and 11, it will be apparent that the heat radiated will be approximately the same in opposite directions both horizontally and vertically, as distinguished from the structure disclosed by Figs. 8 and 9 which will radiate a greater amount of heat horizontally than vertically.

In the structure disclosed by Figs. 12 and 13 the heat absorbing and radiating element 43''' comprises a plurality of V-shaped strips indicated at 79, all welded together at the axis of the heating element 24 in such manner that the legs 81 of the V-shaped members 79 extend radially within the interior of the tube 24 for the purpose of dividing the latter into a plurality of parallel V-shaped passages indicated at 82. The V-shaped members 79 are of the same length as is disclosed by Fig. 12 and may be placed in any portion of a heating element or tube 24 merely for the purpose of increasing the heating and radiating capacity and the efficiency of combustion therein.

It will be noted that the sheet metal members comprising the heat absorbing and radiating elements 42b, 42c and 42''', as disclosed in Figs. 8 to 13, all have the same amount of heat radiating surface from one end thereof to another, while the heat absorbing and radiating members 42, 42d, 42' and 42a, disclosed by Figs. 2, 3, 4, 5 and 7 illustrate variable lengths of elements comprising the heat absorbing element. It will be apparent, however, that this expedient has been followed merely for the purpose of illustration and that in any of the figures of the drawings the surface of the heat absorbing element or member can be made constant or variable from one end to another merely by changing the length of the sheet metal members or elements of which the heat absorbing and radiating element is composed.

While I have illustrated and described preferred embodiments of my invention, it is understood that these are capable of modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. A heating element for heat treating furnaces comprising a heating tube adapted to be disposed within a furnace for heating work to be disposed therein, the interior of said heating tube providing a combustion chamber for the combustion of a gaseous combustible mixture to be supplied thereto, the exterior of said heating tube providing a heating surface for heating said work in response to the combustion of said mixture therein, said heating tube being provided with inlet and outlet means for supplying thereto and discharging therefrom said mixture and the products of said combustion respectively, and radiant heat absorbing and radiating means disposed within said combustion chamber for increasing the heating effect of said heating element, said means comprising a closed end tube projecting inwardly of said heating tube from the inlet thereof and a plurality of open end tubes arranged within said heating element and spaced axially inwardly of said closed tube and adjacent the outlet portion of said heating tube, said tubes being of such length and so arranged relative to each other so as to tend to maintain the exterior

surface temperature along the outlet portion of said heating tube relatively uniform and at a value which approximates the average temperature of said tube along the inlet portion thereof, said radiant heat absorbing and radiating means comprising an elongated thin-walled structure dividing the interior of said heating tube into a plurality of substantially parallel paths of flow for the products of combustion without materially obstructing or deflecting the flow of said products of combustion and affording an extended radiating surface presented toward but spaced from the heating tube wall.

2. A heating element for heat treating furnaces comprising a heating tube adapted to be disposed within a furnace for heating work to be disposed therein, the interior of said heating tube providing a combustion chamber for the combustion of a gaseous combustible mixture to be supplied thereto, the exterior of said heating tube providing a heating surface for heating said work in response to the combustion of said mixture therein, said heating tube being provided with inlet and outlet means for supplying thereto and discharging therefrom said mixture and the products of said combustion respectively, and radiant heat absorbing and radiating means disposed within the outlet portion of said combustion chamber for increasing the heating effect of said heating element at said portion, said radiant heat absorbing and radiating means comprising an elongated thin-walled structure dividing the interior of said heating tube into a plurality of substantially parallel paths of flow for the products of combustion without materially obstructing or deflecting the flow of said products of combustion and affording an extended radiating surface presented toward but spaced from the heating tube wall, said means being formed of a plurality of sheet material members having opposite surfaces parallel to one another and with longitudinal portions thereof parallel to the interior surface of said heating tube, said members being of different lengths and arranged to provide increasing heat absorbing and radiating areas from the inlet end to the outlet ends thereof so as to tend to maintain the exterior surface temperature along the tube at the outlet portion thereof relatively uniform and at a value which approximates the average temperature of the tube at the inlet portion thereof.

3. A heating element for heat treating furnaces comprising a heating tube adapted to be disposed within a furnace for heating work to be disposed therein, the interior of said heating tube providing a combustion chamber for the combustion of a gaseous combustible mixture to be supplied thereto, the exterior of said heating tube providing a heating surface for heating said work in response to the combustion of said mixture therein, said heating tube being provided with inlet and outlet means for supplying thereto and discharging therefrom said mixture and the products of said combustion respectively, and radiant heat absorbing and radiating means disposed within the outlet portion of said combustion chamber for increasing the heating effect of said heating element at the outlet portion thereof so as to tend to maintain the exterior surface temperature along the tube at the outlet portion thereof relatively uniform and at a value which approximates the average temperature of the tube at the inlet portion thereof, said means comprising a plurality of sheets of material having parallel opposite surfaces, said sheets being of different lengths, said lengths decreasing from said inlet toward said outlet.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
759,404	Stone	May 10, 1904
941,618	Churchill	Nov. 30, 1909
1,421,939	Hachalachti	July 4, 1922
2,081,612	Woodson	May 25, 1937
2,146,410	Vaughn	Feb. 7, 1939
2,188,133	Hepburn	Jan. 23, 1940
2,230,221	Fitch	Feb. 4, 1941
2,400,653	O'Dowd	May 21, 1946
2,410,881	Hunter	Nov. 12, 1946
2,411,324	Gagnon	Nov. 19, 1946
2,431,753	Holderle et al.	Dec. 2, 1947