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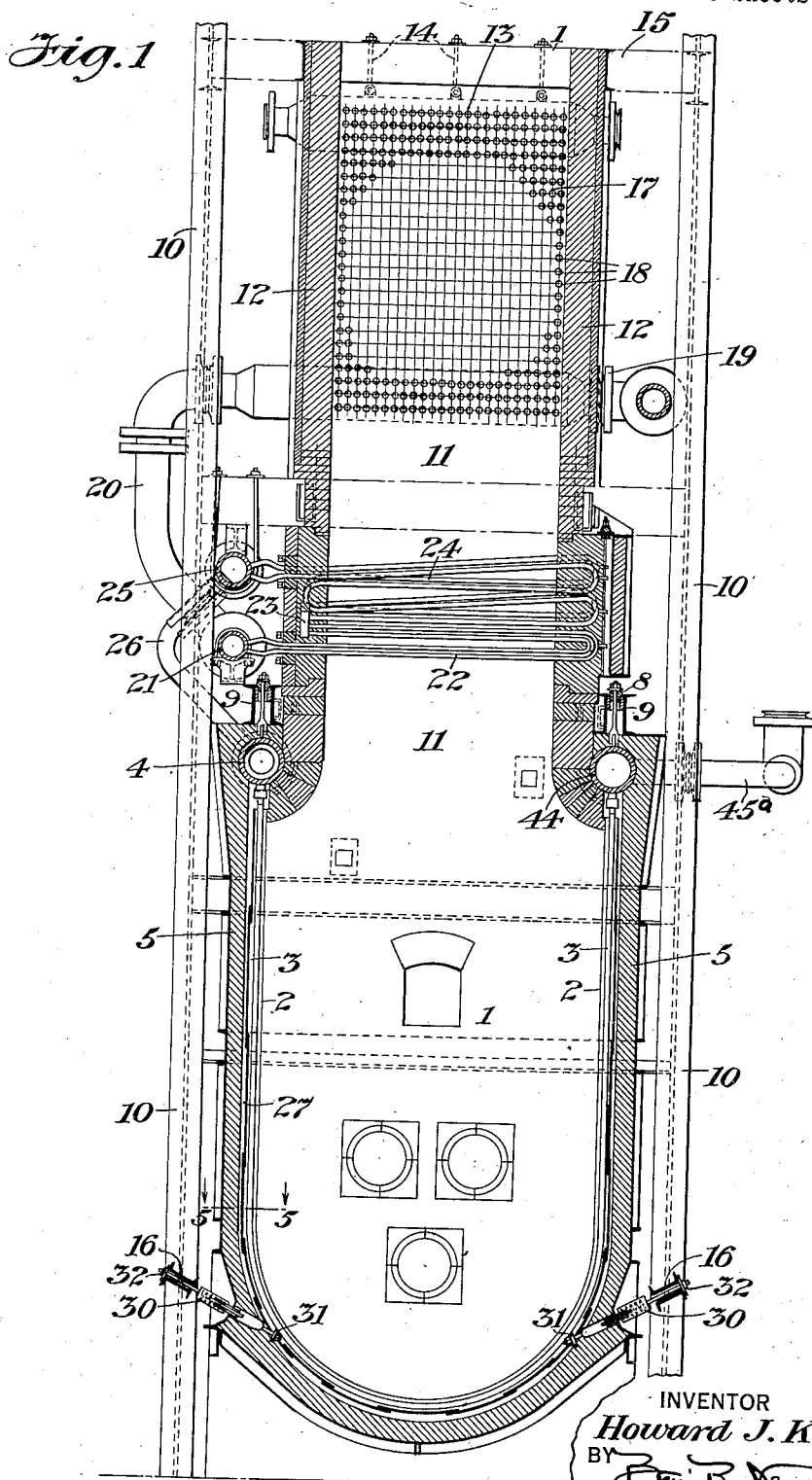
H. J. KERR

2,013,985

FLUID HEATER

Filed Feb. 6, 1931

3 Sheets-Sheet 1



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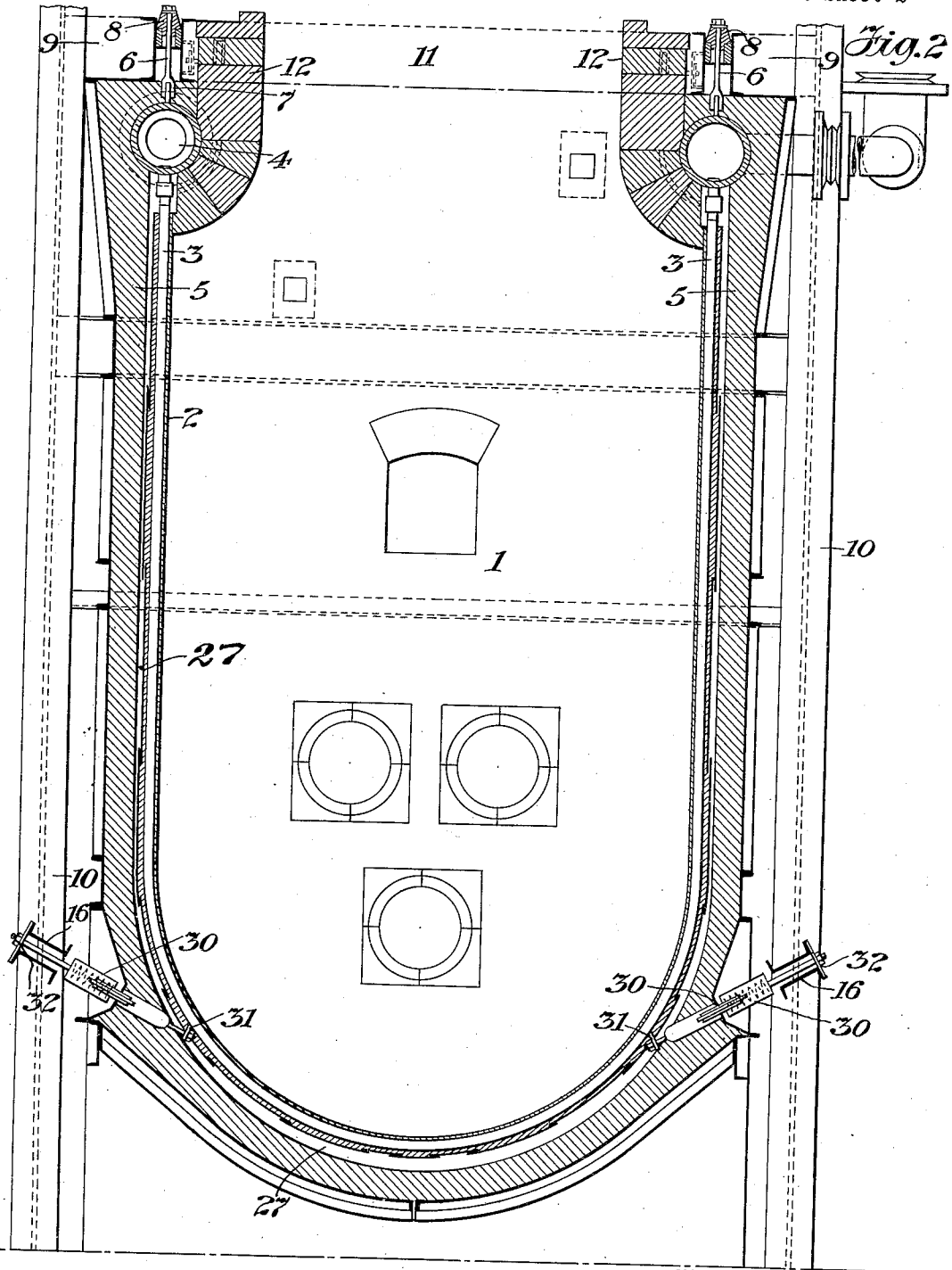
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FLUID HEATER

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3 Sheets-Sheet 2



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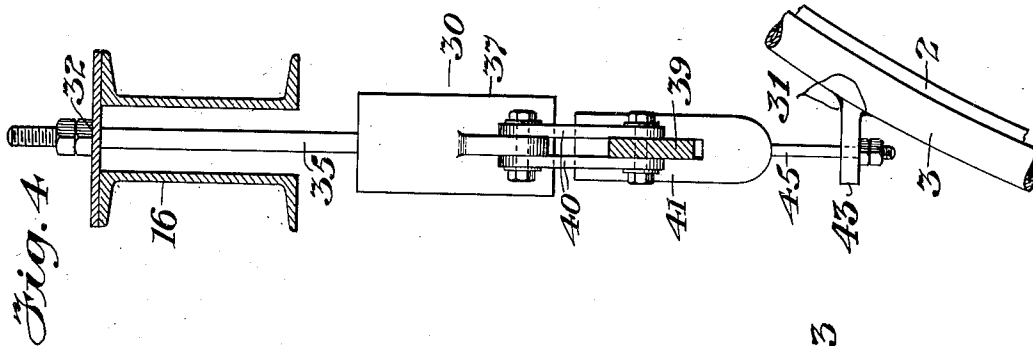
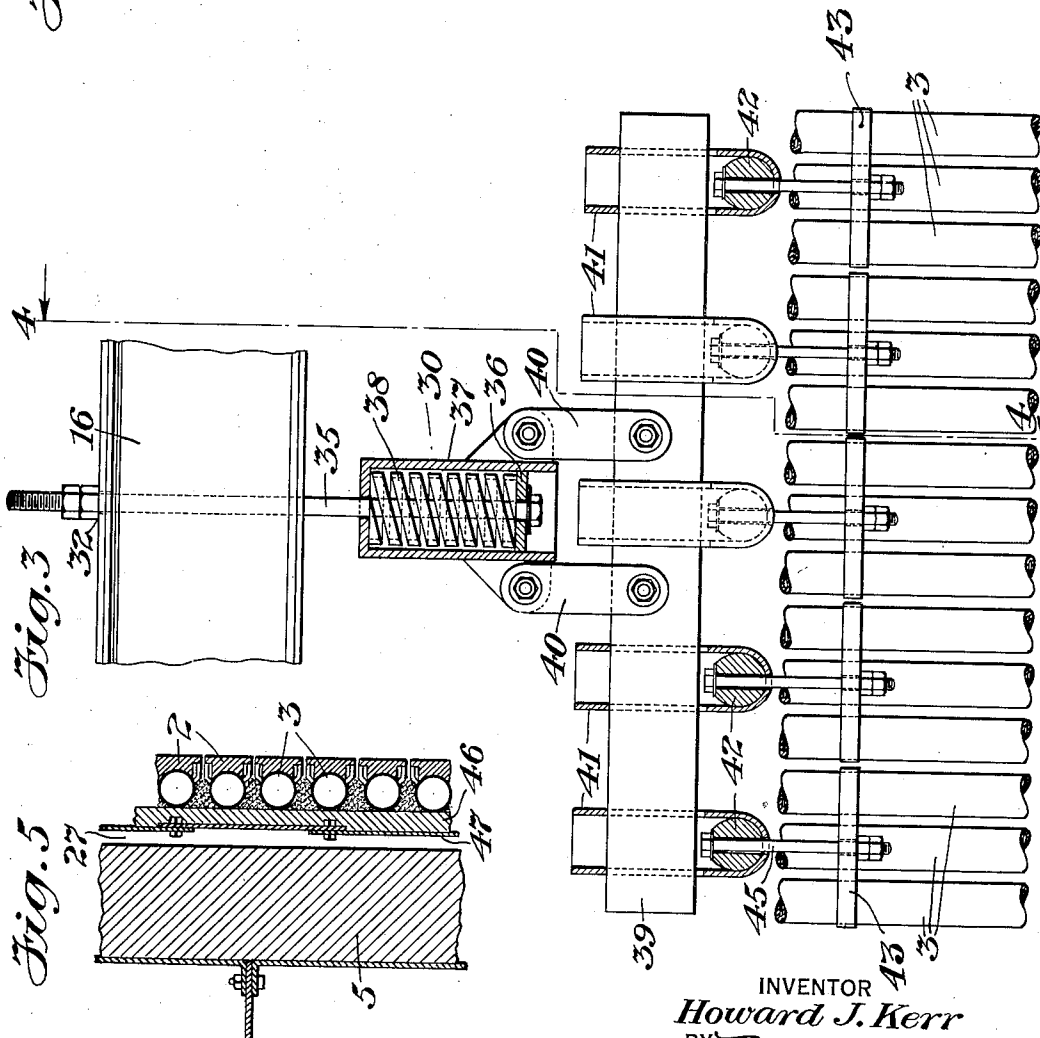
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FLUID HEATER

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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FLUID HEATER

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21 Claims. (Cl. 122—485)

This invention relates in general to the construction of fluid heaters and more particularly to direct fired fluid heaters, such as separately fired steam superheaters, capable of heating a circulating fluid to a relatively high temperature.

An object of this invention is to provide a superheater arrangement capable of imparting high temperatures to vapor admitted thereto.

Another object of the invention is to provide an arrangement of units in a superheater capable of withstanding the high temperatures to which it is subjected, without injury thereto.

A further object of the invention is to provide supporting members for certain units of the superheater to prevent the distortion of those units during operation of the superheater.

These and other objects will be apparent to those skilled in this particular art from the description in the specification in connection with the drawings in which—

Fig. 1 is a front elevation, in section, of the device embodying this invention;

Fig. 2 is an elevation, in section of an enlarged view of a portion of the device embodying this invention;

Fig. 3 is a side view of a detail of the invention;

Fig. 4 is a section taken at right angles to Fig. 3 along the line 4—4;

Fig. 5 is a fragmentary view, in section, of a detail of the invention taken along the line 5—5 of Fig. 1.

That embodiment of the invention which is shown in the accompanying drawings for the purposes of illustration includes a combustion chamber lined on its side and bottom with refractory material 2 secured to tubes 3 connected to and supported by headers 4, 44 to form a superheater section subject to the radiant heat of the combustion chamber. The headers 4, 44 are located in the upper portion of the main body of the combustion chamber wall 5 at the junction of the combustion chamber 1 and flue 11, and are protected from the hot gases of combustion of the combustion chamber by the refractory walls 12 of the flue. The headers are supported by horizontal beams 9 of the framework 10 by means of rods 6 through heat insulation supports. The flue 11 extends upwardly from the combustion chamber and is lined with refractory material 12.

A superheater 17, which is located in the upper portion of flue 11 and is contacted by the hot gases passing therethrough, has a header 13 supported near the upper portion of the flue from a horizontal beam 15 of the framework 10 by suitable supports 14. The tubes 18 of this super-

heater extend across the upper portion of the flue 11 and are connected to a header 19 and connect the headers 13 and 19 with each other. The lower header 19 is connected by pipe 20 to a header 21 to which the lower ends of the tubes of a superheater section 22, which is immediately above the combustion chamber and below the tubes 18 of the superheater section previously mentioned, are connected. The tubes of the superheater section 22, which connect the header 21 to headers 23 located in the wall 12, are exposed to the gases of combustion from the combustion chamber at extremely high temperatures and may be made of a special heat resisting alloy material for protective purposes. The inlet ends of the tubes making up a superheater section 24 are also connected to the headers 23 and these tubes extend across the flue 11 in one or more return bends to be connected with a header 25. The header 25 is connected to the header 4 by suitable connecting pipe 26.

As shown in more detail in Fig. 2, the tubes 3 are connected to the headers 4, 44 and are suspended thereby. A positioning member 30, to be described in detail later, is secured to the tubes 3 as indicated at 31 and to the frame member 10 at 32. The length of the tubes 3 and the dimensions of the combustion chamber wall 5 are such that an adequate space 27 is provided between the tubes 3 and their refractory covering and the 30 sides of the furnace wall 5 to take care of any unequal expansion and contraction that might occur during the operation of this superheater.

The positioning member 30 is shown in detail in Figs. 3 and 4 secured to the framework 10 at the upper end of a rod 35. A member 36 is connected to the lower end of the rod within an inverted cup member 37, and a spring 38 is located between the member 36 and the closed portion of the inverted cup member and cooperates therewith. A horizontal bar 39 is connected to the inverted cup member 37 by links 40, and extends through slots in the sidewalls of cup members 41 which are spaced longitudinally thereof. Insulating members 42 are located within the cup like members 41 and support horizontal bars 43 through rods 45. The tubes 3 are secured to the bars 43 in any suitable manner, preferably by welding. The insulation members prevent thermal contact between the metallic portions of the positioning members exposed to the high temperatures of the combustion chamber and the metallic portions thereof connected with the metallic frame-work, and thus prevent needless dissipation of heat from the combustion chamber

and prevent supporting structure from becoming overheated.

When the refractory lining 2 consists of refractory faced blocks the long U-shaped tubes 3 are not only supporting their own masses from positions at the headers 4 and 44, but they are additionally supporting all of the lining 2 and the plates 47 located rearwardly of the layer 45. This entire mass has a tendency to distort the mid-portions of the tubes. That tendency is increased when the tube metal is softened by reason of the high temperature which it reaches in the operation of the furnace. This tendency is especially marked in a radiant heat superheater of the type disclosed in this application.

The tendency of the combustion chamber tubes to become distorted at high temperature is prevented from collapsing the lower end of the combustion chamber and otherwise interfering with the operation of the furnace by the positioning structures above specifically described. As the temperature of the combustion chamber and the supporting tubes is increased, the tendency toward distortion of the tubes is accordingly increased. This increased tendency receives compensation in the action of the spring 38. Any movement of the bottom of the inner wall of the combustion chamber through the spaces 27 toward the bottom outer wall puts the spring under compression and thus increases the force with which the tension device opposes the distortion tendency.

Fig. 5 illustrates in some detail furnace tubes 3 covered on their combustion chamber sides with refractory material 2 which may be applied in the form of bricks cemented to the tubes or which might be applied while in plastic condition. The tubes 3 are backed with insulating material 46 which is held in place by metallic sheets 47. This figure also illustrates the space 27 between the tubes with their covering, and the main wall 5 of the furnace, which allows for relative expansion and contraction between these two structures.

In the operation of the unit, a vapor to be superheated (such as steam) is admitted to the header 13 from an external source. The vapor passes through the superheater tubes 13 in a direction generally counter-current to the flow of hot combustion gases which contact with the tubes and give up their heat to the steam. The partly superheated steam then passes through the outlet header 19 and connection 20 to the inlet header 21 of the intermediate superheater section 22. The steam next passes through the section 22 of the intermediate superheater to the headers 23 and then passes through the section 24 to the outlet header 25. In passing through the superheater sections 22 and 24 of the intermediate superheater section to the outlet header 25, the steam is flowing in a generally parallel direction to the flow of the hot combustion gases. From the header 25 the steam flows through the connection 26 to the header 4, and then through the superheater tubes 3 to the outlet header 44 from which it is delivered through the connection 45a to an external system for use for power or other purposes.

The suspended tubes 3 support considerable weight, due to the refractory covering 2 and backing 46, 47, and during operation are heated to such a high temperature as to grow relatively soft, and unless prevented therefrom tend to become deformed. The positioning member 39 maintains the desired form of these superheater

tubes and prevents deformation due to the high temperatures in the combustion chamber under normal operating conditions. The normal expansion and contraction due to changes in temperature will not be interfered with by the positioning member.

As the tubes 22 and 24 of the intermediate superheater section, especially at the lower part, are subjected to the gases of combustion from the combustion chamber at extremely high temperatures and are also subjected to the radiant heat of the combustion chamber, the superheated vapor is admitted at the lower part of the section and passed through the tubes in a direction parallel to the combustion gases. The vapor at its lowest temperature is in this manner passed through the tubes of the intermediate superheater which are contacted by combustion gases at their highest temperature, and this prevents the tubes from reaching too high a temperature and being injured.

In addition to the precautions against burning out the tubes exposed to combustion gases at extremely high temperature, already set forth, the cross-sectional area of the tubes providing a path for the flow of superheated vapor may be so dimensioned that the vapor flowing through these sections exposed to the gases of combustion at their highest temperatures will flow with the greatest velocity, and in this manner will tend to keep down the temperature of the enclosing sections or tubes, and prevent them from being burnt out.

Other temperature conditions may arise wherein a section of tubes containing superheated vapor may tend to reach destructively high temperatures although not exposed to combustion gases at their highest temperature, and it is contemplated as a part of this invention that the cross-sectional area of the tubes providing a path for the flow of this vapor may be dimensioned so that the vapor will flow at high velocity through these sections under any conditions, determined by the design of the apparatus wherein destructively high temperatures of heat transfer parts tend to be reached.

The invention has been described in some detail in connection with one embodiment thereof, but it is obvious that changes, substitutions, additions and omissions may be made therein within the spirit and scope of the invention as defined in the appended claims.

I claim—

1. In a fluid heater of the class described, a combustion chamber having a substantially U-shaped cross section, supporting framework therefor, headers mounted adjacent the upper portion of said combustion chamber at the sides thereof, said headers being supported by the combustion chamber framework through insulating supports, a row of tubes connected to said headers and supported thereby, said tubes being covered on their inner sides with refractory material and forming the inner side and bottom of the combustion chamber, supporting members engaging the tubes at their lower portion and tending to keep them in their original shape during the operation of the fluid heater.

2. In a fluid heater of the class described, a combustion chamber, headers mounted adjacent the upper portion of said combustion chamber at the sides thereof, a row of tubes connected to said headers and supported thereby, said tubes being covered on their inner sides with refractory material and forming the inner side and bottom of

the combustion chamber, positioning members engaging the tubes at their lower portion and adapted to keep them in their original shape during the operation of the fluid heater.

3. In a fluid heater of the class described, a combustion chamber, headers mounted adjacent the upper portion of said combustion chamber at the sides thereof, means for burning fuel within the chamber, a row of tubes connected to said headers and supported thereby, and means secured to the tubes for restraining converging movements of the chamber side walls, said tubes extending into the combustion chamber and forming the bottom and side walls thereof.

4. In a fluid heater of the class described, a combustion chamber, a row of tubes mounted therein and forming a portion of the side walls and bottom thereof, supports outside the combustion chamber, and positioning structures connected to the tubes and the supports and adapted to hold the tubes in shape during the operation of the fluid heater.

5. In a device of the character described, a rod, a tubular member mounted on said rod with a spring attached to the tubular member and to the rod therebetween, a link connecting the tubular member to a longitudinal bar, a substantially tubular member keyed upon said bar, a member of insulation material located in said last named tubular member, a rod extending therethrough and through the last named tubular member, a bar attached thereto, said bar being adapted to hold a row of tubes.

6. In a device of the class described, a tubular spring member, a longitudinal bar, a pivotal connection therebetween, members mounted upon said bar, and means adapted to be secured to a row of tubes secured in said members through an insulation connection.

7. In a device of the class described, a bar, substantially tubular members having restricted lower ends secured to said bar, insulation members located in the restricted ends of the tubular members, rods secured to said tubular members through the insulation members, said rods being connected to a plurality of tubes through a metallic member secured thereto.

8. In a fluid heater of the class described, a row of tubes defining the sides and bottom of a combustion chamber, positioning members secured thereto, said positioning members being adapted to permit ordinary expansion due to heat but tending to prevent any distortion of the tubes due to conditions of operation.

9. In a fluid heater of the class described, a combustion chamber, headers mounted adjacent the upper portion of said combustion chamber at each side thereof, a row of tubes connected to said headers and supported thereby, said tubes forming a portion of the side walls and bottom of said combustion chamber, a refractory material secured to the inner side of said tubes and supported thereby and positioning members secured to said tubes and adapted to prevent the distortion thereof due to their weight, under temperature conditions of operation.

10. In a fluid heater of the class described, a combustion chamber, headers mounted adjacent the upper portion of said combustion chamber at each side thereof, a row of tubes connected to said headers and supported in suspension thereby, said tubes extending into the combustion chamber and forming the bottom and side walls thereof, supports outside the chamber, and positioning structures interposed relative to the

tubes and the supports to hold the tubes in shape during the operation of the fluid heater.

11. In a fluid heater of the class described, a combustion chamber, a row of U-shaped tubes suspended therein and defining the sides thereof, positioning structures secured to the tubes to prevent any substantial distortion due to the weight of said tubes while permitting limited expansion and contraction due to changes in temperature of the tubes, and springs cooperating with the positioning structures to exert a force tending to prevent distortion of the tubes increasing in proportion to the amount of said distortion.

12. In a fluid heater, an inlet header at one side of the fluid heater, an outlet header at the opposite side of the fluid heater, a row of U-shaped fluid heating tubes connecting the headers and delineating and embracing a combustion chamber, heat resisting material supported by the tubes and positioned on the combustion chamber side of the tubes, means for burning fuel in said chamber, and opposite tension devices acting to exert upward and outward pulls on the sides of the bight portions of the tubes.

13. In a furnace presenting a combustion chamber, a row of U-shaped tubes embracing the combustion chamber, headers connected to the ends of the tubes to pendently support them and to supply fluid circulating through the tubes, a combustion chamber lining supported by the tubes, and outwardly pulling tension devices acting on the tubes at opposite sides of the lower part of the chamber near the bight portions of the tubes.

14. In a fluid heating furnace U-shaped in vertical cross-section and provided with a gas outlet at its top, and outer refractory furnace wall U-shaped in vertical cross-section, an inner furnace wall spaced from the outer wall and including a row of U-shaped fluid conveying tubes, a heat resisting lining carried by the tubes so as to be interposed between the tubes and the fire in the furnace, and means oppositely acting on the lower parts of the inner wall to maintain that wall in operative condition as it moves relative to the outer wall under the influence of temperature variations.

15. In a steam superheater, a combustion chamber, a flue leading from the combustion chamber to conduct gases therefrom, a superheater section comprising tubes of relatively large diameter extending across the flue, a radiantly heated superheater section comprising a plurality of tubes of small diameter extending across the flue in such a position that they are subjected to radiant heat from the fire in the combustion chamber, separate headers each connected to one of the large diameter and one of the small diameter tubes, a superheater inlet header, a superheater outlet header, and means for conducting steam to the inlet header, the arrangement of tubes and headers being such that all of the steam passing through the radiantly heated section subsequently passes through the other superheater section with materially decreased velocity.

16. In a fluid heat exchange device, a combustion chamber having a fixed outer wall consisting of heat insulating material, a fluid inlet header fixed at one side of the combustion chamber, a fluid outlet header fixed at the other side of the combustion chamber, a row of tubes communicating with the outlet header and extending into the combustion chamber along a plurality of sides thereof so as to form the base of the chamber, connections whereby the said

tubes communicate with the inlet header, heat resisting blocks secured to and supported by the tubes to constitute an inner heat resisting lining for the combustion chamber, plates enclosing the tubes of the inner lining, an insulating layer interposed between the tubes and said plates, supports positioned externally of the outer wall, and tension devices anchored to the supports and to the tubes near the base of the chamber to maintain operative spacing of the inner and outer walls under high temperature operation of the device.

17. In a furnace presenting a combustion chamber, a row of U-shaped tubes embracing the combustion chamber, a combustion chamber lining supported by the tubes, and outwardly pulling tension devices acting on the tubes at opposite sides of the lower part of the chamber near the bight portions of the tubes.

18. A direct fired fluid heater having walls forming a combustion chamber, means for burning fuel in suspension in said combustion chamber, a pair of headers respectively arranged adjacent opposite vertical walls of said combustion chamber, U-shaped radiant heat absorbing fluid heating tubes having their ends connected to and supported by said headers, means for supporting said headers, and means engaging said tubes adjacent their bent portions for limiting expansion movements thereof.

19. In a separately fired superheater of the class described, a combustion chamber, a flue leading therefrom, a counterflow superheater section including a bank of tubes located in said flue with means to admit vapor to be heated thereto, a connection from the lower portion of said tubes leading to the lower portion of an intermediate parallel flow superheater section located in a lower part of said flue, a connection from the upper portion of the intermediate superheater

section to an adjacent header of a superheater section subject to the radiant heat of said combustion chamber and having a pair of headers connected by U-shaped tubes defining opposite sides and the bottom of said combustion chamber, and an outlet connection from said radiant heat superheater section, whereby vapor being heated flows successively through said counterflow, intermediate, and radiant heat superheater sections.

20. A direct fired fluid heater having a combustion chamber, means for burning fuel in suspension in said combustion chamber, a series of suspended U-shaped radiant heat absorbing fluid heating tubes, each having substantially vertical leg portions extending along opposite sides of said combustion chamber and connected at their lower ends by a curved intermediate portion, and positioning means connected to each of said curved intermediate portions at opposite sides of said combustion chamber for minimizing deformation of said tubes.

21. A direct fired fluid heater having vertical side walls and a curved bottom wall extending between opposite side walls and forming a combustion chamber having a top heating gas outlet, means in a side wall for burning fuel in suspension in said combustion chamber, a pair of headers respectively arranged adjacent said opposite side walls of said combustion chamber, a row of U-shaped radiant heat absorbing fluid heating tubes having their ends connected to and supported by said headers, said tubes having their vertical portions extending adjacent said opposite side walls and their looped portions arranged side-by-side adjacent to and slightly spaced from said curved bottom wall, refractory material closing the spaces between the looped portions of said tubes, and means for supporting said headers.

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