March 28, 1944. W. C. HENSEL ET AL 2,345,257

TUBE SUPPORT

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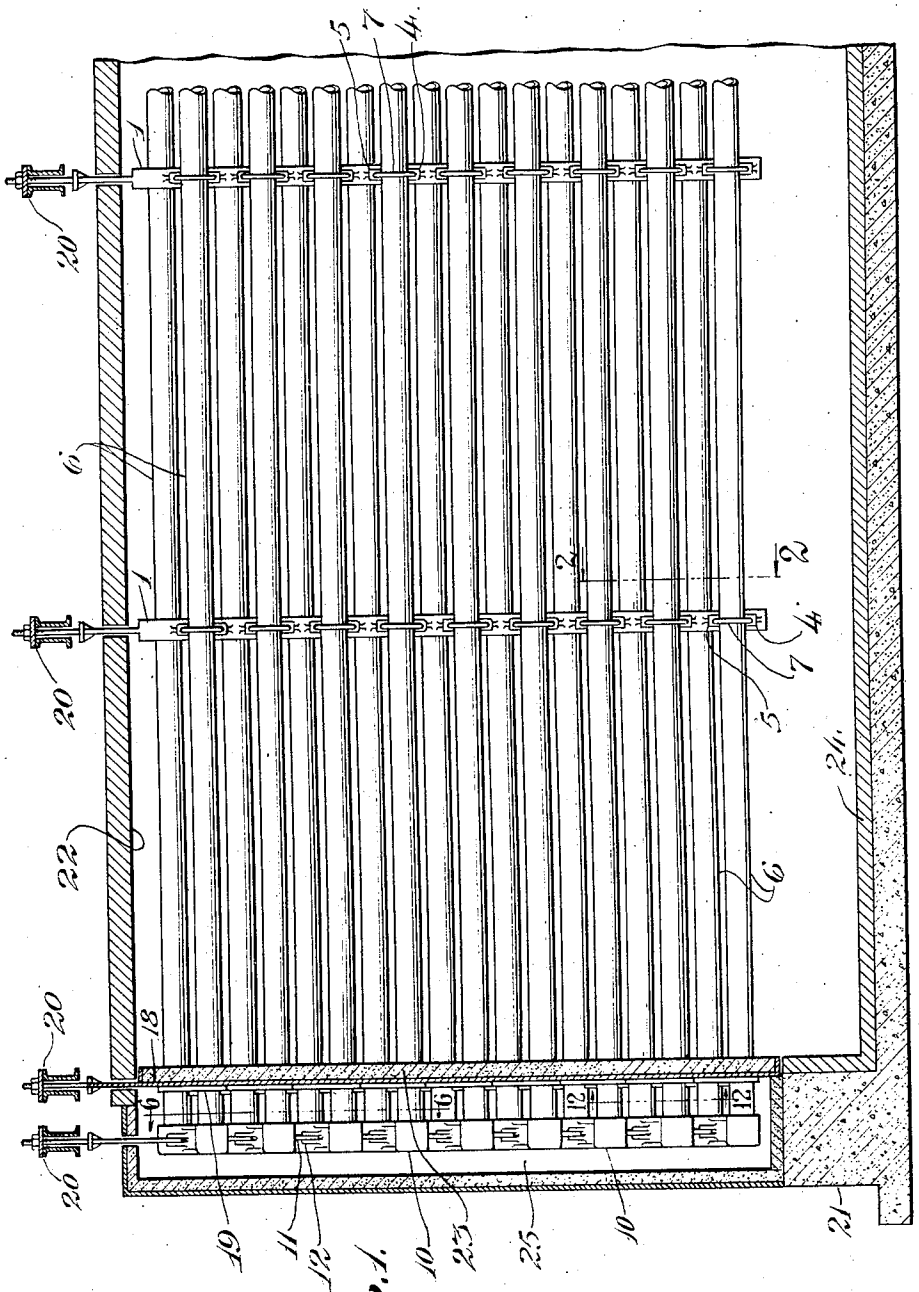


Fig. 1.

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Fig. 2.

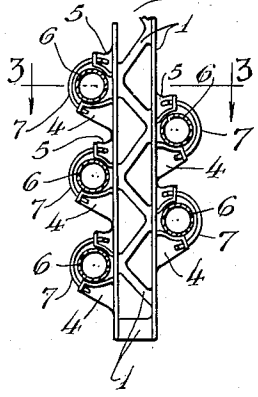


Fig. 3.

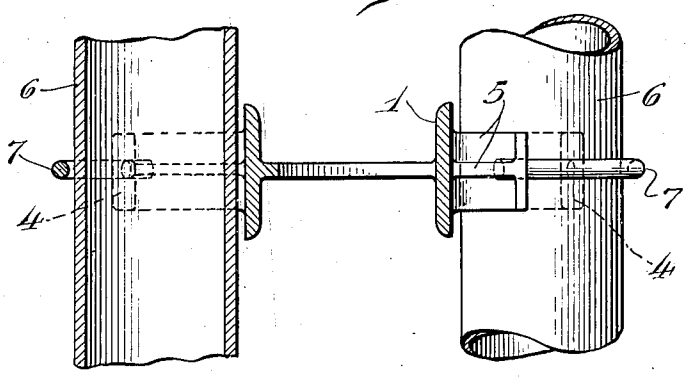


Fig. 4.

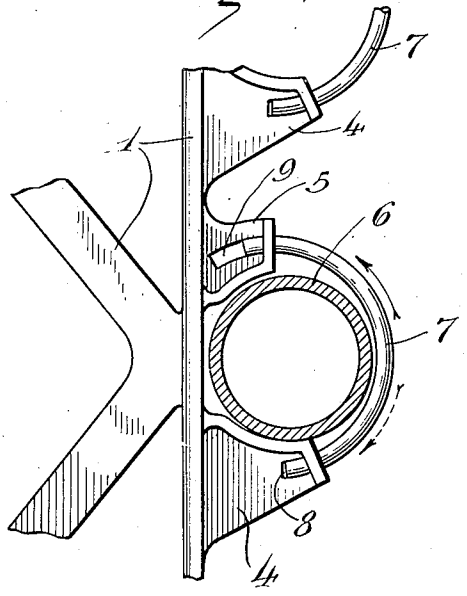
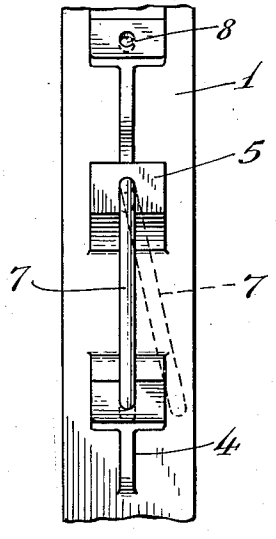


Fig. 5.



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Fig. 6.

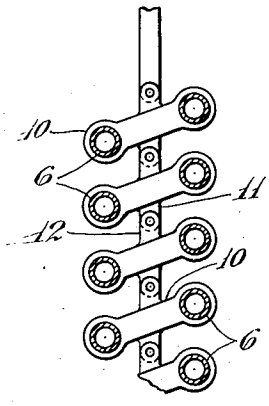


Fig. 7.

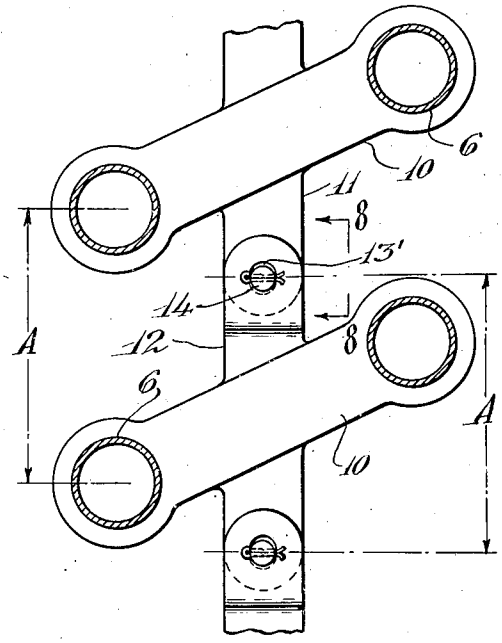


Fig. 8.

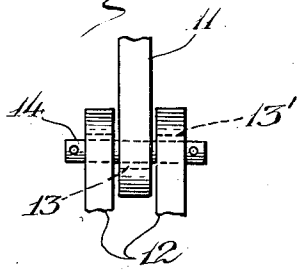
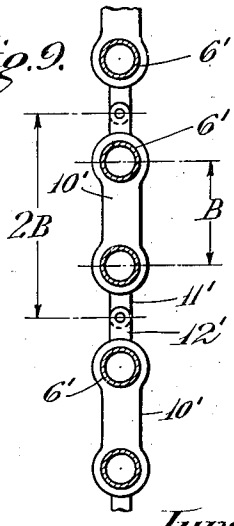


Fig. 9.



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Fig. 10.

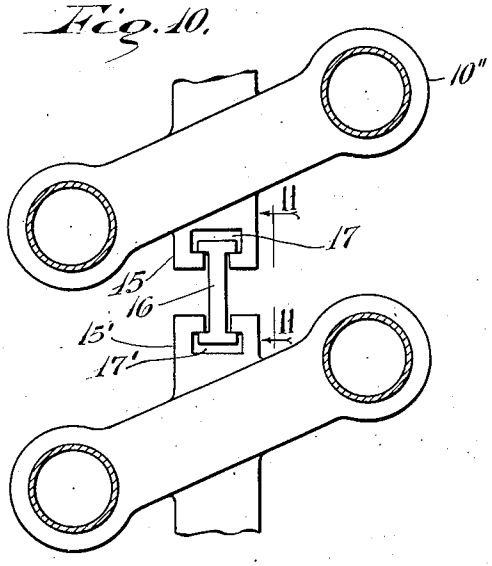


Fig. 11.

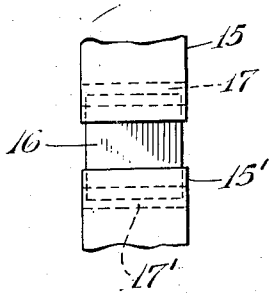


Fig. 12.

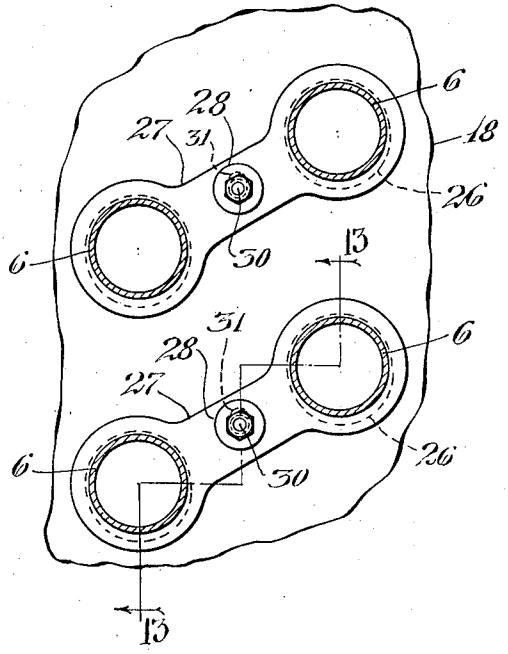
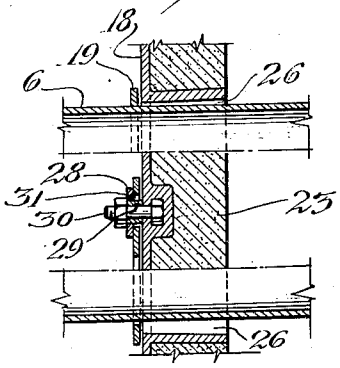


Fig. 13.



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UNITED STATES PATENT OFFICE

2,345,257

TUBE SUPPORT

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Application November 29, 1941, Serial No. 421,019

12 Claims. (Cl. 122—510)

The invention relates to supporting means for a substantially vertical bank of horizontally disposed heating tubes. The features of the improved type of supporting means provided by the invention are particularly advantageous as applied to the tubular fluid conduits of oil heaters, boilers and the like, which tubes are subjected to high furnace temperatures and are of sufficient length in the heating zone to require one or more supports intermediate their ends.

The invention provides both intermediate and end supporting means for a tube bank of the nature above mentioned, as well as means for sealing the tube header compartment of the furnace from the heating zone thereof in which the intermediate tube supports are disposed.

In supporting a vertical bank of horizontally disposed tubes which traverse a high temperature heating zone in a furnace and are of sufficient length to require intermediate supports disposed within said heating zone, it is convenient to construct the intermediate supports of metal or metallic alloy which retains good strength at the temperatures employed in the heating zone and is otherwise capable of withstanding oxidizing conditions and the like which may be encountered, so that the supports may be left bare or uninsulated and are exposed on all sides to the temperature conditions prevailing in the heating zone. The end tube supports, on the other hand, conventionally comprise tube sheets which serve as a partition between the heating zone and the unheated compartments of the furnace in which the tube headers or return bends are disposed. The end tube supports are, therefore, subjected to the high temperature conditions prevailing in the heating zone on only one side or, in some instances, are insulated on the heating zone side in order that they may be constructed of less expensive material than the bare intermediate supports and to prevent excessive heat loss therethrough. In service such an arrangement brings about differential expansion and contraction upon heating and cooling between the intermediate supports and the end supports. As the furnace is brought up to temperature, the intermediate supports, being subjected to a higher temperature than the end supports, expand a greater amount and become longer than the end supports. If the tube bank is suspended, (i. e., with the supporting means fixed at the top and free to expand in a downward direction) the members of the intermediate supports upon which the tubes rest when the latter are cold will, when heated, expand away from the tubes and leave them unsupported. If the tube bank is supported from the bottom (i. e., the supporting means fixed at the bottom and free to expand in an upward direction) the more rapid expansion of the intermediate supports will lift the tubes from the end supports or, if they are not free to move on the latter, will bow the tubes upward between the end supports.

The obvious method of avoiding the difficulties above outlined is to carry the entire weight of the tube bank on the intermediate supports, employing the tube sheets or plates at opposite ends of the heating zone only as a means of sealing the heating compartment from the header compartments and allowing the tube to float in the end tube sheets by providing the latter with elongated tube openings. However, such an arrangement brings about another undesirable condition due to the lack of supporting means at at the end of the tubes and the weight of the return bends or headers, the unsupported ends of the tubes and the headers being carried by the intermediate supports nearest the tube sheets and giving a cantilever action which tends to bow the tubes upward between the end-most intermediate supports. This may bring about permanent distortion to the tubes and render them difficult to clean, as well as setting up undesirable stresses in the tube walls. This also renders any intermediate supports, other than those nearest the tube sheets, of little or no utility during normal operation of the heater so that the two end-most tube supports must be sufficiently strong to carry substantially the entire weight of the tube bank.

The improved supporting means provided by the invention obviates all of the difficulties above mentioned. We utilize bare or uninsulated intermediate tube supports of suitable high-temperature-resistant metal or alloy and of special construction which prevents springing of the tubes from the intermediate supports, but permits the tubes to be lifted onto and from the intermediate supports in assembling the tube bank and in replacing worn out or damaged tubes. We also employ tube sheets between the header compartments and the heating zone which are preferably insulated on the heating zone side and are provided with elongated tube ports which permit free upward and downward movement of the tubes at the tube sheets, the latter functioning as partitions which separate the heating zone from the header compartments. We utilize the headers or return bends, which connect the adjacent tubes of the bank at their opposite ends,

as a portion of the end-supporting structure, the adjacent headers or return bends being interconnected by links which are relatively loose or slack when the tube bank is cold and which are tightened by expansion of the intermediate supports upon heating so that the assembly of headers and links at each end of the tube banks functions as an articulated unit to support the tubes at their ends when heated.

The features of the invention are illustrated in the accompanying diagrammatic drawings.

In the drawings,

Figure 1 is a sectional elevation of a portion of a heater showing one end and an intermediate portion of a tube bank supported as provided by the invention.

Figure 2 is a view taken along line 2—2 in Figure 1, showing some of the lowermost tubes of the bank in cross section and showing a front elevation of the lower end of one of the intermediate tube supports.

Figure 3 is a view of a portion of the tube bank at an intermediate support and is taken along line 3—3 in Figure 2.

Figure 4 is an enlarged detail showing, in front elevation, a portion of the intermediate support illustrated in Figures 1, 2 and 3.

Figure 5 is a side elevation of that portion of the support illustrated in Figure 4, with the tube 6 omitted.

Figure 6 is a sectional elevation illustrating return bends such as provided by the invention for use in a bank comprising adjacent vertical rows of staggered tubes with the adjacent tubes in opposite rows connected in series. This section is taken along a plane which cuts through the tubes adjacent the return bends, as indicated by the line 6—6 in Figure 1.

Figure 7 shows an enlarged detail of one specific form of linkage means joining two adjacent return bends such as provided by the invention.

Figure 8 is a view taken from the plane indicated by the line 8—8 in Figure 7.

Figure 9 is a sectional elevation similar to that of Figure 6 but illustrating return bends such as provided by the invention as used for connecting adjacent, superimposed, horizontal tubes in a vertical row. This section is taken, as in Figure 6, along a plane which cuts through the tubes adjacent the return bends.

Figure 10 shows an enlarged detail of an alternate form of linkage means between two adjacent return bends.

Figure 11 represents a view taken from the plane indicated by the line 11—11 in Figure 10.

Figure 12 is a sectional view of a portion of the tube sheet at one end of the heater. The section being taken along a plane which cuts through the tubes adjacent the return bends as indicated by the line 12—12 in Figure 1.

Figure 13 is a sectional view taken along line 13—13 in Figure 12.

Referring to Figure 1, the tubular fluid conduits 6 are supported at spaced points within the heating zone of the furnace structure by intermediate supports 1. When the furnace is fired, the linkage members 11 and 12 attached to the return bends 10 take up the support of the opposite ends of the tubes. The intermediate supports and the return bends as well as the tube sheet 18 are suspended from suitable supporting members 20 as shown. The heating zone of the structure is enclosed by refractory side walls, not shown in this view, a refractory roof 22, a refractory floor 24 and tube sheets, such as shown at 18, which are insulated in the heating zone, as indicated at 23, and separate the latter from the header compartments 25. The entire furnace structure is supported on a suitable foundation 21. The heater may be fired in any desired manner. The firing means do not comprise a novel part of the invention, and is not illustrated.

Referring particularly to Figures 2 to 5 inclusive, the intermediate tube support 1, as here illustrated, comprises a substantially I-shaped member which forms the main body of the support, having opposite flanges joined by an openwork web. Along the outer face of each of the flanges, brackets 4 and 5 are provided at spaced intervals along the length of the flanges. The vertical distance between corresponding portions of adjacent brackets 4 on the same flange corresponds to the vertical center to center distance between the vertically aligned, horizontally disposed tubes 6 in each row thereof disposed on opposite sides of the support, as illustrated. The vertical distance between corresponding portions of the adjacent brackets 4 on the opposite flanges, corresponds to half the vertical center to center distance between the adjacent tubes in each row. The same applies to the distance between the corresponding portions of brackets 5. The adjacent brackets 4 and 5 on the same flange are complementary, the tubes 6 resting upon the upper curved surface of brackets 4, and brackets 5 serving as anchors for the upper ends of the substantially semicircular members 7, the lower ends of which are anchored in the supporting brackets 4.

Members 7, which serve to prevent tube 6 from springing from the supporting structure due to any tendency of the tubes to bow when heated, may be tubes or solid rods of circular cross-section curved to a diameter somewhat larger than the outside diameter of tube 6. The members 7 each define slightly more than half a circle so that when their opposite ends are inserted in the openings 8 and 9 of the respective brackets 4 and 5, they cannot be forced therefrom by the lateral thrust of tubes 6 when the latter tend to bow outward from the support. However, the form of the brackets and members 7 make the latter readily detachable from the brackets when it is desired to place a tube on or remove it from the supporting structure. This is accomplished by rotating member 7 in the direction indicated by the arrow shown with the solid line in Figure 4, forcing its upper end farther into opening 9 of barcket 5 and releasing its lower end from the opening 8 in bracket 4. Then, by turning member 7 to the approximate position indicated by the dotted lines in Figure 5 so that its lower end clears bracket 4, it may be rotated in the opposite direction, indicated by the dotted arrow in Figure 4 until its upper end is free of opening 9 in bracket 5, thus releasing member 7 from the brackets and permitting tube 6 to be lifted upward and outward from the support, the distance between the outer ends of adjacent brackets 4 and 5 being somewhat greater than the outside diameter of the tube.

Referring now to Figures 6, 7 and 8 of the drawings, the tubes 6 terminate in the return bends 10. Angularly attached to one side of the return bend is a single lug 11 and to the opposite side of the return bend a forked lug or two parallel lugs 12 are attached and so arranged that the single lug on the adjacent return bend is received between the lugs or forks 12. Vertically elongated holes 13 and 13' are provided through lugs 11 and 12 respectively to receive a pin 14

which is of substantially smaller diameter than the length of said holes and is retained in position by cotter keys or by any other desired means. The vertical center to center distance between the holes in the lugs on opposite sides of the return bend is equal to the center to center distance between the vertically aligned horizontally disposed tubes 6, as indicated by the dimension A in Figure 7. The difference in the diameters of the pin 14 and the vertical dimension of holes 13 and 13' substantially corresponds to the expansion which will occur between tube centers in the intermediate tube supports, when heated, so that when the intermediate tube supports expand during heating, this difference is taken up, thereby causing the tube return bends 10 to assume the support of their respective tubes and all return bends and tubes disposed therebelow. By thus supporting the tube ends when they are in a heated state, the possibility of their becoming warped or bowed is minimized, and stresses within the tube walls due to bending are thus obviated. This also helps to decrease permanent distortion of the tubes and thereby lengthens their useful life and facilitates the removal of carbonaceous or calcarious deposits therefrom.

Figure 9 shows a linkage arrangement similar to that shown in Figure 6 except that the return bends 10' of Figure 9 connect adjacent horizontally disposed tubes 6' in a vertical row thereof. The lugs 11' and 12' are disposed at opposite ends of return bends 10' and the center to center distance between holes in the lugs on each return bend is equal to twice the center to center distance between the adjacent tubes of the vertical row thereof, as indicated by the dimensions B and 2B in this figure. With this arrangement, as in that shown Figure 7, the pins which connect the lugs on the return bends are smaller than the openings provided for the pins.

Figures 10 and 11 show an alternative form of linkage means wherein the I-shaped member 16 engages the slots 17 and 17' in the return bend extensions or lugs 15 and 15' respectively on the return bends 10'' when the intermediate tube supports expand. The members 16 and slots 17 and 17' are of such relative size that the return bends are loosely connected when the tube bank is cold, the slack being taken up when the intermediate tube supports expand so that the return bends act as end supports for the tubes. This form of linkage arrangement may also be substituted, when desired, for that shown in the return bend arrangement of Figure 9.

Referring to Figures 12 and 13, the tubes 6 extend through the vertically elongated openings 26 in the tube sheet 18. Adjacent the outer surface of the tube sheet the tubes are encompassed by the closure plates 27 which are retained in slidably movable relationship to the tube sheet by washers 28, the tubular spacing members 29 and the bolts 30 which engage the tube sheet and pass through the vertically elongated central openings 31 in plate 27. The tubes and closure plates are thus free to move up and down within the limits necessary to accommodate longitudinal expansion and contraction of the intermediate supports, and the tubes are free to expand and contract longitudinally through the tube openings in the tube sheets and closure plates without moving the latter from its position of sliding engagement with the tube sheet. Using this feature of the invention, it is possible to allow for the longitudinal expansion of both the intermediate supports and the tubes themselves and still maintain a substantial seal between the tube heater compartment and the heated portion of the furnace.

We claim as our invention:

1. In a heater for fluids having a bank of tubular fluid conduits disposed within a heated zone of the structure and provided at their ends with terminal fittings which connect adjacent tubes of the bank and are disposed outside said heated zone, means comprising bare metal members disposed within said heated zone for supporting said tubes intermediate their ends, means comprising metal tube sheets insulated from said heated zone for separating the latter from that zone of the structure in which said terminal fittings are disposed, and means loosely interconnecting said terminal fittings when the intermediate supports are cold and which tighten to support the tubes at their ends when the intermediate supports are hot.

2. In a heater for fluids having a bank of tubular fluid conduits disposed within a heated zone of the structure and provided at their ends with terminal fittings which connect adjacent tubes of the bank for the flow of fluid therethrough and are disposed outside said heated zone, means comprising bare metal members disposed in said heated zone and free at one end, for supporting the tubes intermediate their ends, means loosely interconnecting said terminal fittings when the intermediate supports are cold and which tighten to support the tubes at their ends when the intermediate supports are hot, and means comprising metal plates provided with openings through which the tubes extend and insulated from said heated zone, for separating the latter from that zone of the structure in which said terminal fittings are disposed.

3. The structure defined in claim 2 wherein said separating means and said end-supporting means are constructed and arranged to permit expansion and contraction of the tube bank and of said intermediate supporting members.

4. In a heater for fluids having a bank of super-imposed, horizontally disposed tubular fluid conduits extending through a heated zone of the structure and provided at their opposite ends with terminal fittings disposed outside said heated zone and connecting adjacent tubes of the bank for the flow of fluid therethrough, means comprising tube sheets provided with openings larger than the tubes and through which said tubes extend for separating said heated zone from that zone in which the terminal fittings are disposed, said tube sheets being insulated from the heated zone, means comprising bare metal members disposed within said heated zone and free at one end, for supporting the tubes intermediate their opposite ends, and means on said terminal fittings which loosely interconnect the same when the intermediate supports are cold and which tighten to support the tubes at their ends when the intermediate supports are hot.

5. The structure defined in claim 4 wherein the last named means include lugs on said terminal fittings and links connecting adjacent fittings at said lugs.

6. The structure defined in claim 4 wherein said intermediate tube-supporting means comprise elongated members having vertically spaced brackets between which the tubes are received and members spanning adjacent brackets and detachably secured thereto for restraining springing of the tubes from between said brackets.

7. The structure defined in claim 1 wherein the intermediate tube-supporting means comprises an elongated metal member, pairs of brackets on said member spaced apart to permit the passage of a tube therebetween, and an auxiliary member spanning the distance between each pair of said brackets and detachably secured thereto in such a manner as to prevent springing of the tubes from between the brackets when said auxiliary members are in place.

8. The structure defined in claim 1 wherein the intermediate tube-supporting means comprises an elongated metal member anchored at one end and free at its opposite end to permit longitudinal expansion and contraction thereof, supporting brackets for the tubes disposed on said member at spaced points along its length, auxiliary brackets disposed on said member between and spaced from said supporting brackets, and other auxiliary members spanning the distance between the supporting brackets and the adjacent auxiliary brackets and detachably secured thereto in such a manner as to restrain springing of the tubes from between said brackets.

9. In combination with a bank of substantially horizontal tubular fluid conduits disposed within a heating zone, means disposed within said heating zone for supporting said tubular elements, said means comprising an elongated substantially vertical metallic member fixed at one end and free at its opposite end to permit longitudinal expansion and contraction thereof, brackets disposed at spaced points along the length of said elongated member and adapted to receive and support said tubes, complementary brackets disposed between the adjacent supporting brackets on said elongated member, each pair of brackets being adapted to receive and retain the opposite ends of an elongated rigid member of curved contour spanning the distance between said pair of brackets, and detachably secured to the latter to retain one of said tubular members therebetween, the brackets being provided with openings therein of curved contour corresponding to that of the ends of said retaining member, said ends being adapted to fit within said openings and the shape, size and curved contour of said openings and retaining members being such that the latter resist outward bowing of the tubes but are detachable from the brackets by a combination of motions including partial rotation of the retaining members.

10. Supporting means for the ends of tubes in a bank of substantially horizontal tubular fluid conduits, said means comprising terminal fittings on said tubes interconnecting adjacent tubes of the bank for the flow of fluid therethrough, and means for detachably interengaging adjacent fittings comprising lugs on said fittings provided with registerable openings therethrough, and removable pins of smaller size than said openings and receivable therein for interengaging adjacent fittings at said lugs.

11. Supporting means for the ends of tubes in a bank of substantially horizontal tubular fluid conduits, said means comprising terminal fittings on said tubes interconnecting adjacent tubes of the bank for the flow of fluid therethrough, and means for detachably interengaging adjacent fittings comprising lugs on said fittings provided with slotted openings therein and links extending between and detachably engaged with the slotted openings in the lugs of adjacent fittings.

12. Supporting means for the ends of tubes in a bank of substantially horizontal tubular fluid conduits, said means comprising terminal fittings on said tubes interconnecting adjacent tubes of the bank for the flow of fluid therethrough, and means for detachably interengaging adjacent fittings comprising lugs on said fittings provided with slotted openings therein and links extending between and detachably engaged with the slotted openings in the lugs of adjacent fittings, said links and openings being of such form and relative size that the adjacent fittings are loosely engaged when the tube bank is cold and tightly engaged when the tube bank is hot.

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