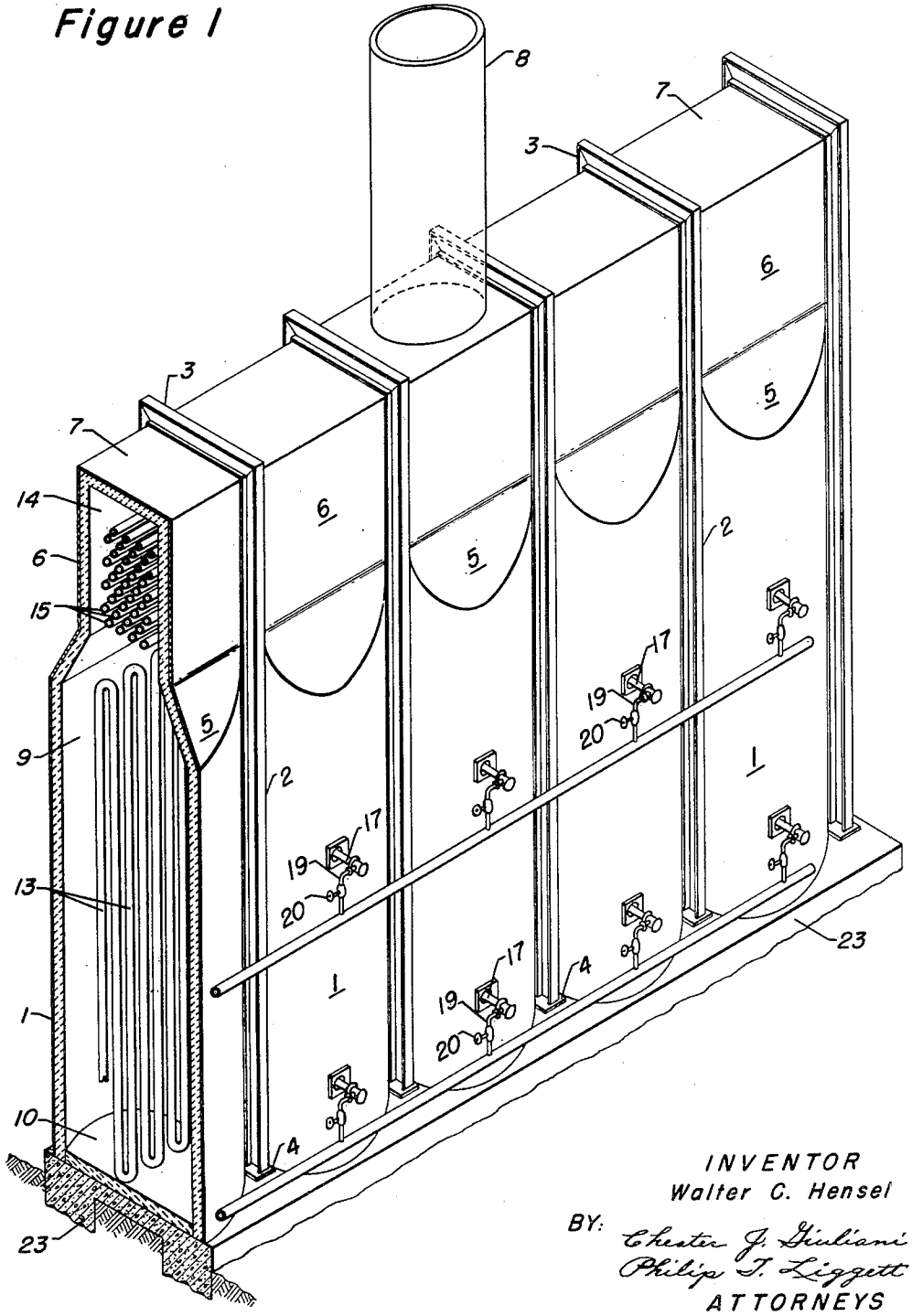
Dec. 4, 1962 W. C. HENSEL 3,066,656

FLUID HEATER

Filed May 3, 1960 2 Sheets-Sheet 1

Figure 1



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FLUID HEATER

Filed May 3, 1960 2 Sheets-Sheet 2

Figure 2

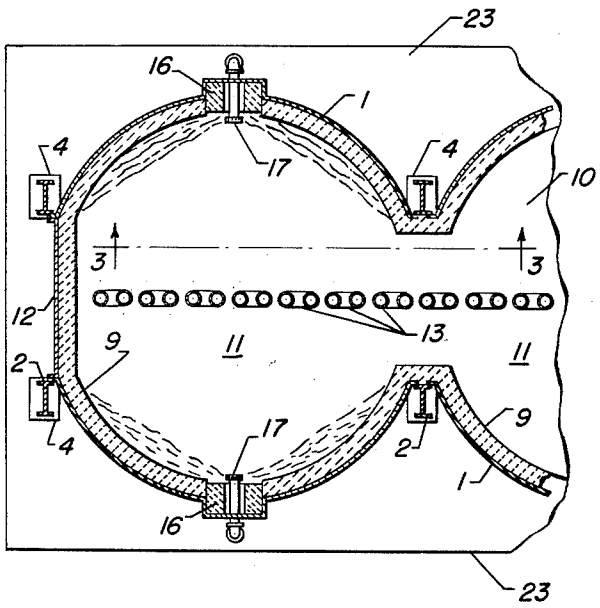
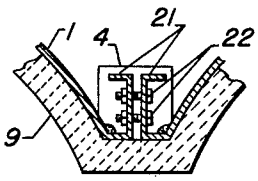


Figure 4



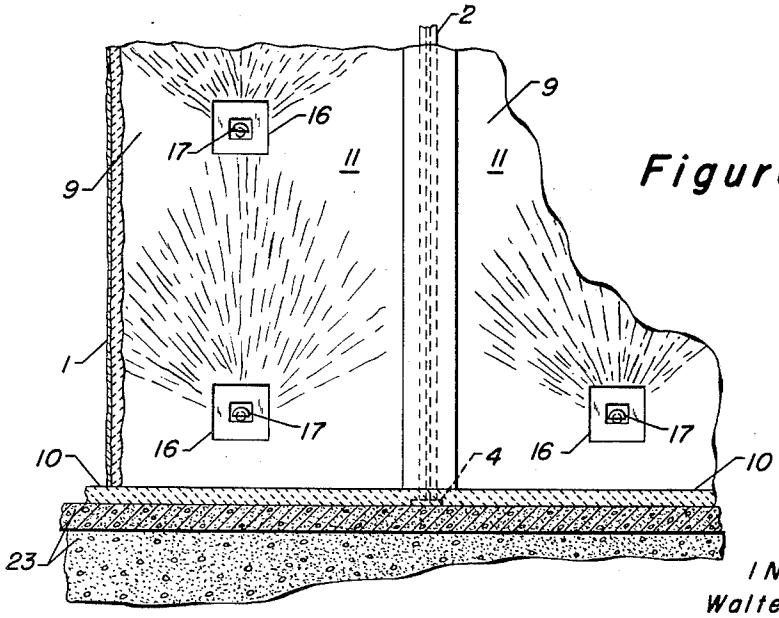


Figure 3

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FLUID HEATER

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3 Claims. (Cl. 122—240)

This invention relates to an improved apparatus for heating fluid streams passing through a plurality of conduits or tube banks. More specifically, the improved heater design and arrangement of this invention provides advantageous means for economically constructing and erecting a heating chamber, as well as advantageous means for effecting controlled radiant heating in selected designated portions of a unitary heater.

The usual heater construction requires a considerable amount of structural framing, including columns or buck stays, continuous bents or frames and intermediate cross bracing, even though prefabricated panels may be used to some degree in the erection of the heater structure. Also, in connection with usual heater designs, where it is desired to obtain different degrees of heating within different zones of the heating chamber for different sections of fluid conduits or tube banks, it is generally necessary to provide suitable dividing walls within the chamber to aid in effecting controlled heating within the different zones.

It is an object of the present invention to provide curved or arcuate shaped wall sections which, when erected, will provide rigid walled sections that obviate the necessity for the usual framing and bracing utilized in connection with heater constructions.

It is also an object of the invention to utilize a plurality of curved or arcuate shaped wall sections for a heater construction, which provide a plurality of adjacent communicating cylindrical-like heating zones which are in turn heated in a manner to provide internal curved heating surfaces that impart uniform radiant heating to centrally positioned conduits.

It may also be pointed out that the improved design provides a construction which eliminates the necessity of expansion joints which are usually necessary in heaters or other high temperature apparatus construction. Other objects and advantages of the improved construction and arrangement will be pointed out hereinafter.

Briefly, the improved heater construction of this invention provides in combination, an enclosed heating chamber having a lower radiant heating section and a narrow elongated straight-walled upper convection heating section above said lower section, the lower section having its side wall portions formed of a series of adjacent arcuate shaped sections providing, in turn, a series of adjacent vertically positioned cylindrical-like heating zones which communicate with one another and with the upper portions of the lower arcuate wall sections tapering inwardly and connecting with the straight wall portions of the upper convection heating section, banks of fluid heating conduits positioned within the central portions of said lower and upper heating sections, and burner means in spaced positions along the side walls of the lower section of the heater directing flame and hot combustion gases over spaced portions of the inside wall surfaces of the arcuate shaped sections whereby to provide radiant heating for the fluid conduits in the lower portion of the heating chamber and convection heating of the fluid conduits in the upper heating section.

The curved or arcuate shaped wall sections for the lower portion of the heating chamber may be constructed such that they have a constant radius and provide cylindrical segments or they may, if desired, for particular designs, be parabolic or hyperbolic, or of other curvature.

In other words, it is not intended to limit the present invention to any one cross-sectional shape for the curved sections.

Various types of interior surfaces or liner constructions may be used in connection with the wall sections of the heater inasmuch as there are available various types of insulating concretes and refractory materials. A material is, of course, used which provides a high temperature-resistant heat-reflecting wall effective for in turn providing the desired radiant heating to the tubes maintained within the central portion of the furnace chamber. Also, combinations of insulating material and high temperature-resistant refractory materials may be used in lining the interior of a curved sheeting or covering material in forming the wall sections, with the lighter, more porous insulating material being placed adjacent the outer covering. It is, however, a particular feature of the present invention to have the arcuate sections fabricated such that they may be easily erected in the field. The refractory liner may be pre-attached in a shop construction or it may be put in place in the field after the various segments have been made ready for erection, or even after they have been erected and attached in place to form a furnace chamber.

The general construction features and advantages on the present improved heater may be better described and explained with reference to the accompanying drawings and the following descriptions thereof.

FIGURE 1 of the drawing shows a diagrammatic perspective view of the improved heater with an end removed so as to show a portion of the interior of the heater construction.

FIGURE 2 of the drawing is a sectional plan view through a portion of the heater.

FIGURE 3 is a partial elevational view, showing a portion of the interior wall sections of the lower portion of the heating chamber.

FIGURE 4 is a sectional view through a juncture between curved sections, where specially formed edge portions are utilized to form stiffening means.

Referring now to the drawings, it will be noted that there are a plurality of curved wall sections 1 which oppose one another and which form the walls for a lower radiant heating section of the heating chamber. Edges or side portions of each of the curved sections 1 are provided with lips to in turn connect with and attach to a plurality of spaced structural column sections 2. As is best shown in FIGURE 1 of the drawing, each of the columns 2 connect with beams 3, which extend across the top of the heating chamber, such that there is provided a series of bents or frames to support the chamber. The frames are in turn supported on a suitable foundation 23 by means of base plates 4 or other suitable means for attachment to the foundation. The upper portions of curved sections 1 have an offset portion or taper provided by transitional pieces 5 to join with straight wall sections 6 which in turn form the side wall portions of the upper convection heating zone. Side wall sections 6 together with top sections 7 actually form the enclosure for the convection heating zone 14. The latter also serves as a collecting chamber for hot gases introduced into the lower radiant heating section by means of burners, whereby the hot gases may be discharged from the heating chamber by means of stack 8.

The wall portions 1 and 6, as well as the top sections 7, are indicated diagrammatically to have a suitable refractory liner 9, which, as previously pointed out, may comprise various of the heat-resistant refractory materials such as calcium aluminate in combination with refractory materials, etc. Similarly, a heat-resistant refractory material is provided along the bottom of the heating chamber to provide a floor 10. The latter may,

if desired, be formed by laying suitable refractory tile or brick over the foundation 23, in lieu of a refractory concrete type of material. The drawing shows a single relatively thick layer of refractory material 9 attached to a steel plating or other rigid type of outer covering sheets, however, as previously noted, more than one layer of liner material may be utilized, with perhaps one layer embodying a lighter weight insulating type of material more suitable for reducing heat transfer than the hard types of cementitious refractory materials.

As is best shown in FIGURE 2 of the drawing, the plurality of curved sections 1 provide in turn a plurality of somewhat separated radiant heating zones 11, which are connected only at restricted area junctures at the zones of the columns 2. Opposing columns 2 are, of course, spaced to suit the spacing between wall sections 6 which are in turn spaced to accommodate the size of the tube bank extending through the convection heating section. An end closure section 12 used at each end of the heater provide means for total enclosing of the end portions of the heating chamber. There is, of course, no limit to the number of curved sections 1 and resulting cylindrical-like heating sections 11 which may be erected to provide a total heating chamber. The size is determined by the amount of fluid heating to take place and spacing and arrangement of the fluid conduits which are to be positioned within the central portion of the heating zones.

The present drawings indicate diagrammatically a single row of vertically disposed tubular members 13 extending through the central portions of the connecting radiant heating zones 11. More than one row of tubes may be employed if desired and it is not intended to limit the present invention to any one tube arrangement within the radiant heating zones of the heater nor is it intended to limit the fluid flow and tube bank arrangement to the use of one extended coil in the radiant zones. A plurality of streams may be introduced into and withdrawn from the radiant heating zones by means of suitable inlet and outlet conduits through the heater to a plurality of adjacent tube banks, with tubes being positioned vertically or horizontally in the banks thereof. The present drawing indicates diagrammatically a plurality of horizontally disposed tubes extending throughout the convection heating zone 14 in a tube bank 15. Again, it should be noted that the present invention does not provide a design which limits the fluid heating to the use of any one type of fluid conduits or tube bank within the convection heating zone 14, inasmuch as any desired number of tubes or conduits may be placed in this zone and such tubes or conduits may be interconnected to form one or more tube banks to in turn accommodate one or more different fluid streams.

A particular feature of the present improved design and construction is the utilization of spaced burners mounted through the curved side-wall portions of the lower radiant heating zones. The present embodiment indicates diagrammatically a plurality of spaced burner blocks 16 which in turn accommodate the passage of a plurality of spaced burner means 17 that are adapted to impinge high temperature flames and hot gases against a surrounding surface of the liner 9 of wall sections 1. The blocks 16 and the burners 17 are shown spaced vertically along the center portions of each of the wall sections 1 at distances which correlate with the spread of flame from the nozzles of burners 17, such that the entire interior curved surface of each of the wall sections may be heated to a high temperature to in turn impart high temperature radiant heat to the tubular members 13 positioned along the central portions of the radiant heating zones 11. The burners 17 may be provided with suitable fuel by means of fuel supplying conduits connecting therewith exteriorly of the furnace chamber. It may be pointed out that this heater may be fired with either liquid or gaseous fuel, or both simultaneously, and its operation not limited to the use of gaseous fuels only. FIGURE 1 of the drawing shows diagrammatically fuel supply headers 18 each having a plurality of fuel supply lines 19 connecting with each of the burners 17. Adjustable valves 20 are positioned within each of the supply lines 19 in order that control may be provided for each of the individual burners 17, to in turn control, if desired, the degree of heating within each of the heating zones 11. As previously pointed out the present design, and arrangement provides inherently substantially separate heating zones 11 whereby varying controlled heating levels may be attained in adjacent heating zones and without the necessity of having to build special partitioning walls between heating zones as is required with present types of conventional furnace designs and construction.

In FIGURES 2 and 3 of the drawing, there is shown diagrammatically the impingement of high temperature flame and combustion gases on the interior curved surface of liner 9, over areas which are above and along the sides of each of the burners 17. In other words, the nozzle portion of each of the burners 17 is constructed and designed to direct flame substantially at right angles to the line of the axis of the burner whereby flame is directed only along the refractory wall surfaces alongside of and above the zone of each burner. No flame is directed toward the plurality of conduits 13. As a result, the entire interior curved wall surfaces are heated to a high temperature and there is provided the advantages of uniform radiant heat from a large heated wall area for the entire length and extent of the tube banks comprising conduits 13. It may be further pointed out that the curved or cylindrical-like design of the lower heating zones, together with centrally located burners providing lateral flow of flame and gases effects a desirable uniformity in the heating of the tubular conduits 13, particularly by virtue of the fact that the higher temperature flames and the greater heating of the wall surfaces will occur close to each of the burners and in the central area of each wall section 1, which in turn, is the greater distance from the tube members 13 as compared with the outer extremities of the wall sections 1. In other words, the edge portions of the curved walls, which are nearer the supporting column 2, will receive less heating effect from the plurality of burner 17, but on the other hand, these portions will be spaced closer to the opposing conduits 13 so that the resulting reflected radiant heating can be adjusted to be substantially the same in these areas as that received by the conduits opposing the central portions of the curved wall sections. Vertical spacings between burners may, of course, be adjusted to suit burner designs and the extent of the flame and heat projection from the burner nozzles. While it has been indicated that burner positioning is preferably along the central portion of each of the wall sections 1, it is not intended to limit the design and construction to such burner placement only. With large radius cylindrical segments forming the wall sections 1, it may be desirable to position more than one burner at any one level in each wall section 1 in order to properly be able to blanket the interior wall surface of each section 1 with high temperature flame and combustion gases to in turn accomplish the desired radiant effect therefrom for the fluid heating.

The present diagrammatic drawings do not show means for supporting or holding the tubular conduits in position, however, various conventional means may be provided for supporting the desired tube banks within each of the heating zones. A preferable construction provides means for hanging the tubes 13 from their top portions by means of cast alloy beams which extend across the top of the radiant heating zone between the wall sections. Alternatively, suitable supports or rests may be placed along the floor 10 of the furnace chamber to support the weight of the vertically positioned tubes 13 in the radiant heating zones and lateral supports may be extended through the walls

so that the tubes are held in suitable vertical alignment, but free to expand vertically upward from their lower supports or rests. Tubular members in bank 15 may be suitably supported by means of horizontal tube supports extending through the convection heating section 14 from supporting columns 2. Such tube support means being spaced along the length of the heater to correspond to the series of spaced frames formed by columns 2.

It will, of course, be understood that various modifications may be made in connection with the various minor details of the heater construction without deviating from the broad improvement provided by the cylinder-like substantially separate heating zones which are in turn formed by the use of curved wall sections. For example, it is not intended to limit the gas removal arrangement to a single centrally positioned stack, such as 8. If desired, stack means may be provided at one of the ends of the heating chamber, or if necessary, more than one stack may be embodied in the construction of a particularly long heating chamber.

Further, the preferred form of the heater provides curved wall sections 1 which are formed integrally with the sloped sections 5 and the upper straight-walled sections 6 whereby each total wall section may be prefabricted and shipped to the heater erection site to in turn provide for rapid and efficient construction of the heating chamber with a minimum of field labor. However, if, for reasons of fabrication or erection, it is desired to have joints between the various sections 1 and 5, or 5 and 6, then provision may be made to bolt, weld or otherwise effect a field connection between sections.

Further, as is shown diagrammatically in FIGURE 4 of the drawing, channel shaped members 21, placed back to back, may be welded or otherwise attached to the edges of the curved wall sections, in lieu of structural beam sections such as 2, and provide the desired stiffening and supporting members for the chamber. The channels 21 may be bolted together by bolts 22 to effect the erection of the curved sections. Structural channel members may be utilized to form sections 21, however, in an alternative fabrication, the channel shaped members 21 may be actually formed from extensions of the plate or sheeting forming the curved sections 1.

As previously pointed out, the individual sections 1 may be provided with refractory and insulating material prior to shipment to the field, in which case suitable temporary bracings or crating should be provided for the shipping operation in order that the refractory material is not readily broken or dislodged from its bonding with the outer casing plates of sections 1. A relatively light weight metal or sheet steel may be utilized to form the curved wall sections 1 and upper sections 5 and 6, however, in some instances, suitably stiff and rigid members may be formed of other materials such as of various types of plastics or fiberglass. Weather resistance and strength and rigidity, which will permit elimination of bracing, are, of course, necessary requisites in the present construction. The curvature of the lower arcuate shaped wall sections and the relatively close spacing of columns 2 provide a construction which is self supporting and self bracing. A further advantage, briefly set forth hereinbefore, is the furnishing of curved sections in the lower high temperature zone of the heater such that thermal expansion and contraction movement is accommodated in the flexure of the curved sections without the necessity of building special expansion joints.

I claim as my invention:

1. A heater for the radiant and convection heating of fluids comprising an enclosed heating chamber having a lower radiant heating section and a narrower elongated straight-walled upper convection heating section, said radiant heating section having spaced lower side wall portions formed of a first series and a second opposing series of adjacent rigid arcuate shaped sections extending through the major portion of the height of the radiant heating section, said arcuate wall sections being concave toward the central portion of the heating chamber and forming said radiant heating section as a linear series of vertically elongated cylindrical-like heating zones, the vertical edge portions of the arcuate sections of said first series being disposed opposite and spaced from the corresponding vertical edge portions of the arcuate sections of said second series and means connecting the vertical edge portions of adjacent arcuate sections to form vertically elongated restricted area junctures providing communication between said heating zones, inwardly tapering wall sections connecting said lower arcuate wall sections with the wall portions of said upper convection heating section, banks of fluid heating conduits positioned within the central portions of said lower and upper heating sections, and burner means positioned and spaced along said lower side wall portions of the radiant heating section and constructed and arranged to direct flame and hot combustion gases laterally and upwardly over the inside surfaces of said arcuate sections.

2. The heater of claim 1 further characterized in that each of said heating zones is provided with oppositely disposed burners projecting through the arcuate wall sections thereof.

3. The heater of claim 1 further characterized in that said burner means comprises vertically spaced burners projecting through each of said arcuate wall sections.

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