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2,745,388

MULTIPLE CELL CIRCULAR HEATER

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FIG. 2

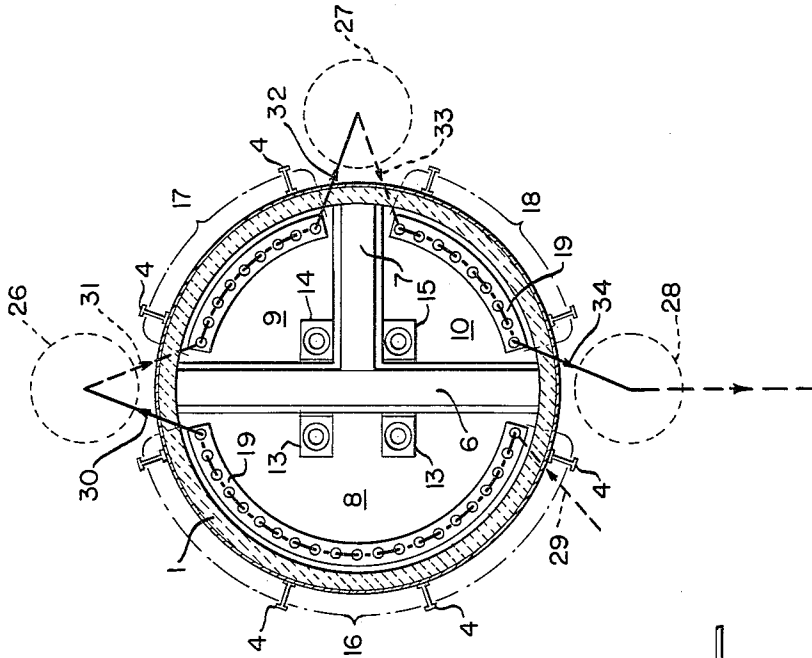
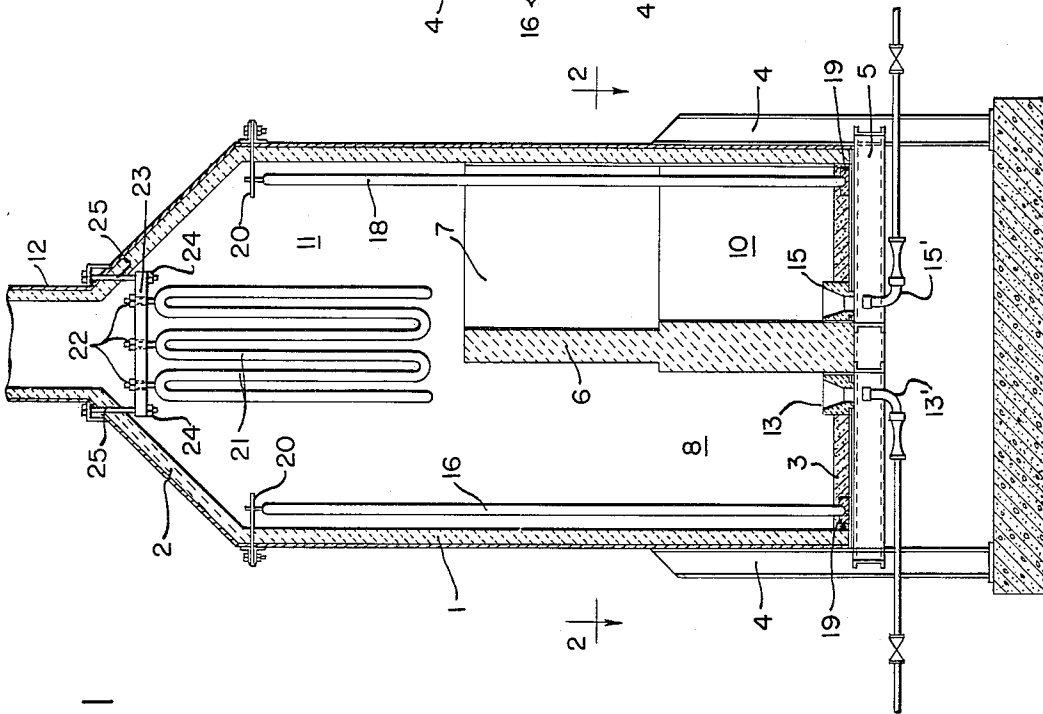


FIG. 1



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MULTIPLE CELL CIRCULAR HEATER

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6 Claims. (Cl. 122—240)

This invention relates to an improved type of multiple cell heater and more particularly to an updraft form of circular heater providing separately controlled radiant heating to a plurality of different tube banks and fluid streams.

It is desirable in connection with various types of chemical and petroleum processing operations to effect the controlled heating of a particular reactant stream as it progresses continuously from one reaction zone to another, or alternatively, it may be desirable to simultaneously heat different fluid streams used within a conversion process or in adjacent units to different temperature levels. Thus, the present improved type of heater provides independent controlled heating conditions within separate portions thereof and the advantages and usefulness of several different heating units within one structure.

A single structure and a compact arrangement, as provided by the present invention, is of further advantage economically when utilized in connection with effecting the re-heating of a single fluid stream passing in series flow through a plurality of reaction zones. In other words, a plurality of separate reaction chambers may be positioned around the periphery of the heater chamber and a minimum of piping is required to and from the tube banks maintained within the different cells of the heater. Also, the reactor chambers may be supported entirely, or in part, from the steel framework for the heater chamber, so that there is a resulting compact processing unit which saves ground area and construction costs.

The construction and arrangement of the heating and conversion apparatus of the present invention will be better understood and additional advantageous features noted in connection therewith by reference to the accompanying drawing and the following description thereof.

Figure 1 of the drawing is a sectional elevational view of one embodiment of the multiple cell circular heater.

Figure 2 of the drawing is a sectional plan view through the heater, as indicated by the line 2—2 in Figure 1 of the drawing.

The furnace chamber is preferably vertically disposed and has a cylindrical refractory side wall 1, a conically shaped top portion 2, and a bottom or floor portion 3. The refractory side wall 1, as well as the upper and lower end portions may be constructed of an insulating concrete, or of other suitable insulating or refractory materials adapted to withstand high temperature conditions. The present embodiment provides vertical columns or buckstays 4 and lower beam members 5 to support the furnace chamber, however, the floor or supporting means may be made directly on concrete or brickwork which in turn extend directly from a foundation.

In accordance with the present improved type of construction, the interior of the furnace chamber is provided with partitioning walls 6 and 7 which in turn divide the

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lower portion of the heating zone into separate segmental radiant heating zones 8, 9 and 10, as better indicated in Figure 2 of the drawing. The walls 6 and 7 terminate substantially below the upper end portion 2 of the furnace chamber and thus provide an open convection heating zone 11, while above the zone 11 and extending from the upper conical top portion 2 is a flue gas outlet or stack portion 12.

Located in the floor 3 of the furnace chamber are spaced burner blocks 13, 14 and 15, each accommodating a burner directly therebelow supplied with a suitable fuel. As indicated in Figure 1, burners 13' supply high temperature flame and combustion gases upwardly through the burner blocks 13 to one face of the dividing wall 6, while burner 15' supplies high temperature flame and hot combustion gases upwardly through burner block 15 to the corner zone of radiant heating zone 10, at the juncture between dividing walls 6 and 7. Although not shown, another burner supplies flame and high temperature combustion gases against the walls 6 and 7 within the segmental radiant heating zone 9. In each case, the burner blocks and burners are arranged so that the flames impinge against the dividing walls and provide high temperature heating of these walls which in turn provide reflected radiant heat across the various divided heating zones. It is a particular feature of the present invention to provide independently controlled heating means for each of the radiant heating zones, as may be provided by the illustrated arrangement providing separate burners and burner ports to each of the separate zones, however, it is not intended to limit the improved multiple cell circular heater to the use of any one particular type of burner means. For example, a single burner means may be provided in the cell 8 rather than the two burners and burner ports 13 now indicated, or alternatively, a plurality of reflecting cup type burners may be spaced vertically along the interior axial portions of each dividing wall and near the center of the furnace chamber, so that reflected radiant heat may be provided throughout substantially the full height of each section. The hot combustion gases from each separate segmental zone or cell of the heater commingle within the upper convection heating zone 11 and subsequently pass from the furnace chamber by way of the stack outlet 12.

Each of the separate segmental radiant heating sections are provided with separate banks or rows of tubular fluid conduits, so that in accordance with the advantages of the present heating apparatus, separate fluid streams may be subjected to different heating conditions. It is not intended to limit the circular furnace chamber to any number of cells or to the use of any set number of tubular members within each cell, for obviously the number of tubes or fluid conduits will vary to suit the heat input required for a particular type of processing operation. The present embodiment, as best shown in Figure 2 of the drawing, indicates that the furnace chamber has been divided into three radiantly heated cells, with cell 8 comprising substantially one-half of the cross sectional area and cells 9 and 10 utilizing one-fourth of the cross-sectional area, but of course, a greater number of cells may readily be provided and each of the cells may utilize any desired fractional portion of the cross-sectional area.

The individual tubular members within each segmental section may be placed horizontally or vertically, but preferably are disposed vertically so that each tubular member of the bank of tubes receives substantially the same radiant heat within each zone. Also, one or more vertical rows of tubes may be maintained within each heating zone, with the tubes of one row placed in a staggered formation with respect to those in a next row. However, within a small diameter circular furnace, a single row of tubular members is normally utilized

and the tubes are placed in an arcuate arrangement adjacent to or near the circular wall of the furnace chamber within each segmental zone. In this instance, a single row of conduits 16 is disposed in radiant heating section 8 while a lesser number of tubes 17 are arranged in a row within section 9 and another plurality of tubes 18 are in a row within section 10. In each case, the tubes are connected with suitable U-bends at their top and bottom extremities so that any desired fluid flow may be maintained through each tube bank. The present drawing again indicates that the tubes in each cell are connected in series, however, other heater arrangements may be provided to provide parallel flow or a plurality of parallel flows through each tube bank of the furnace chamber.

Individual tubular members of each tube bank within the separate radiant heating sections may be suspended from an upper portion thereof, and space provided therebelow to accommodate linear expansion of each tube under high temperature conditions. Alternatively, as shown in Figure 1, each of the tubular members may be supported from the lower extremities, at the U-bends connecting adjacent tubes by suitable cradle members such as 19, and the tubes of the various banks may be allowed to expand upwardly along the cylindrical wall of the furnace chamber. Suitable guide brackets 20 may be spaced around the inside of the furnace chamber at the upper ends of the tubular members so as to properly hold tubular members of each tube bank in vertical alignment.

In the upper convection heating zone 11 of the heating chamber, a plurality of vertically disposed conduits 21 provide still another tube bank which may accommodate one or more fluid streams that may be subjected to high temperature convection heating. In other words, the resulting hot gases passing upwardly through the upper portion of the furnace, from each of the lower segmental radiant heating sections, provide available heat which may well be utilized for the heating of one or more additional fluid streams or for the preheating of at least one of the streams passing to the radiant zones. It is not intended to limit the convection heating bank or banks to any set number of tubes or to any bank arrangement, but again the tube supporting means for the plurality of tubular members is constructed to accommodate the linear expansion of the tubular members and not cause undue stress on the individual members. The present embodiment provides that the tubular members 21 are suspended from their weld U-bends, or return bends, by means of hanger bolts or stud members 22, which in turn pass through holes or slotted openings within beam members 23. The beam members 23 are in turn supported on horizontal cross beam members 24 at each end thereof, and the latter are supported by suitable hanger rods or bolts 25 which connect at their upper ends with the top portion of the furnace head 2.

In the operation of the heaters, the heating of the fluid stream, or streams, within the convection bank tubes 21 is, of course, dependent upon the heat resulting from each of the radiant heating sections within the lower portion of the furnace chamber. However, it is a particular feature of the present multiple cell circular heater to provide means for supplying different regulated heating to each of the different segmental heating zones. This is accomplished by independently regulating the heat supplying means at the lower end of the furnace chamber so that different quantities of heat are supplied to the faces of the dividing walls within each radiant heating zone whereby resulting different heat intensities may be obtained from the reflected radiant heat in each zone. As set forth hereinbefore, a different number of tubes and different size segmental radiant heating sections may be provided to accommodate the heat requirements of the different fluid streams

of a given process unit. A further feature of the present construction and arrangement is the supplying of high temperature reflected radiant heat from the center portion of the circular furnace chamber, in other words, from the included angle formed by the junctures of adjacent partitioning walls, whereby resulting reflected radiant heat is emitted substantially from an axial center portion of the furnace structure to the arcuate rows of fluid conduits. By this arrangement, the individual tubes or conduits within any given segmental zone are subjected to substantially equivalent heat inputs.

Also, as mentioned hereinbefore, the present arrangement provides a furnace or heater for fluid streams which permits a compact arrangement with a plurality of adjacent reactor zones. For example, as indicated in Figure 2 of the drawing, a plurality of reaction zones such as the dotted circles 26, 27 and 28, may be located circumferentially around the furnace chamber so that there is a minimum of conduits or piping in effecting the initial heating and reheating of a fluid stream which is passing through the different reactors. More specifically, the charge stream may be introduced by way of an inlet line 29 to one end of the bank of conduits 16 and subjected to high temperature radiant heating so that the resulting stream at conversion temperature may be discharged by way of line 30 into the reactor 26. A reduced temperature stream from the reactor 26 may then pass by way of line 31 into one end of the bank of tubes 17, within radiant heating zone 9, and a reheated fluid stream passed by way of line 32 into reactor 27. In a similar manner, a cooled or reduced temperature stream from reactor 27 may pass by way of line 33 into one end of the bank of tubes 18, and radiant heating cell 10, and a resulting reheated stream passed from the other end of tube bank 18 by way of line 34 into the reactor 28. Thus, there is provided a continuous series flow through the different cells of the furnace chamber and through a plurality of separate reaction chambers, with reheating obtained between the different chambers. Of course, more than three reactor chambers may be utilized in any given arrangement and it is not necessary to limit the present heater to but three cells and its use with the three reactor chambers.

It is to be further noted that the present construction and arrangement of a multiple cell circular heater is such that the burners are below the bottom or floor 3 of the furnace chamber and there is an upflow of flame and hot combustion gases through the entire chamber, with the convection heating section being located in the upper portion of the chamber. The improved multiple cell circular furnace, providing vertical partitioning walls and reflected radiant heat to separate banks of fluid conduits in each cell or zone, may also be constructed in a down-draft arrangement. In other words, the upper portion of a vertical furnace may be segmentally divided by partitioning walls to accommodate different banks of radiantly heated tubes and suitable burner means may provide a downflow of flame and hot combustion gases along the walls with the result that hot combustion gases and flue gases pass to a convection heating section maintained within the undivided lower portion of the furnace chamber. In the latter arrangement, a flue gas outlet means is provided from the bottom of the structure and, of course, one or more banks of tubular conduits may be maintained within the lower portion of the furnace chamber to receive the benefit of convection heating from the downflowing hot gas stream.

I claim as my invention:

1. A heating apparatus comprising a vertical furnace chamber of circular cross-section having a refractory cylindrical wall, a vertical partitioning wall extending across an end portion of said chamber, a vertical partitioning wall extending angularly from the first-mentioned partitioning wall to said cylindrical wall, said partitioning walls dividing said end portion of the chamber into a

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plurality of segmental radiant heating sections, a bank of fluid heating conduits disposed within each of said sections adjacent said circular wall of the furnace chamber, and means for supplying heat to each of said sections adjacent the partitioning wall surfaces therein comprising burner means at the vertex of each of the angles formed by said partitioning walls.

2. A heating apparatus comprising a vertical furnace chamber of circular cross-section having a refractory cylindrical wall, a vertical partitioning wall extending across the lower portion of said chamber, a vertical partitioning wall extending angularly from the first-mentioned partitioning wall to said cylindrical wall, said partitioning walls terminating short of the top of the furnace chamber and dividing the lower portion thereof into a plurality of segmental radiant heating sections, a bank of fluid heating conduits disposed within each of said sections adjacent said circular wall of the furnace chamber, a bank of fluid heating conduits in the undivided upper portion of the chamber above said partitioning walls, means for passing flames and hot combustion gases upwardly along the partitioning wall surfaces in each of said segmental sections comprising burner means at the vertex of each of the angles formed by said partitioning walls and means for removing flue gases from said undivided upper portion of the chamber.

3. A heating apparatus comprising a vertical furnace chamber of circular cross-section having a refractory cylindrical wall, a vertical partitioning wall extending across an end portion of said chamber between diametrically opposed portions of said cylindrical wall, a vertical partitioning wall extending at a right angle from the first-mentioned partitioning wall to said cylindrical wall, said partitioning walls dividing said end portion of the chamber into a semi-cylindrical radiant heating section and a pair of smaller radiant heating sections, a bank of fluid heating conduits disposed within each of said sections adjacent said circular wall of the furnace chamber, means for supplying heat to the surface of the partitioning wall in said semi-cylindrical section, and burner means in each of said smaller sections at vertex of the right angle formed by said partitioning walls.

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4. A heating apparatus comprising a vertical furnace chamber of circular cross-section having a refractory cylindrical wall, a vertical partitioning wall extending diametrically across the lower portion of said chamber, a vertical partitioning wall extending at a right angle from the center of the first-mentioned partitioning wall to said cylindrical wall, said partitioning walls terminating short of the top of the chamber and dividing the lower portion thereof into a semi-cylindrical radiant heating section and a pair of smaller radiant heating sections, an arcuate row of fluid heating conduits disposed within each of said sections adjacent said circular wall of the furnace chamber, a bank of fluid heating conduits in the undivided upper portion of the chamber above said partitioning walls, burner means at the vertex of each of the right angles formed by said partitioning walls, burner means on the opposite side of the first-mentioned partitioning wall, and means for removing flue gases from said undivided upper portion of the chamber.

5. The heating apparatus of claim 1 further characterized in that each of said banks of fluid conduits within said radiant heating sections comprises a plurality of vertically disposed tubes, said tubes arranged in an arcuate row and connected with U-bends providing a series flow therethrough.

6. The apparatus of claim 2 further characterized in that said bank of conduits within the upper portion of said chamber comprises a plurality of vertically disposed tubular members connected at their ends with U-bends providing a series flow therethrough.

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