

Dec. 12, 1950

C. S. REED ET AL
MULTIPLE BLOCK BAFFLE CONSTRUCTION FOR
MULTIPLE TUBE FLUID HEATERS

2,534,208

Filed Jan. 16, 1948

2 Sheets-Sheet 1

Fig. 2.

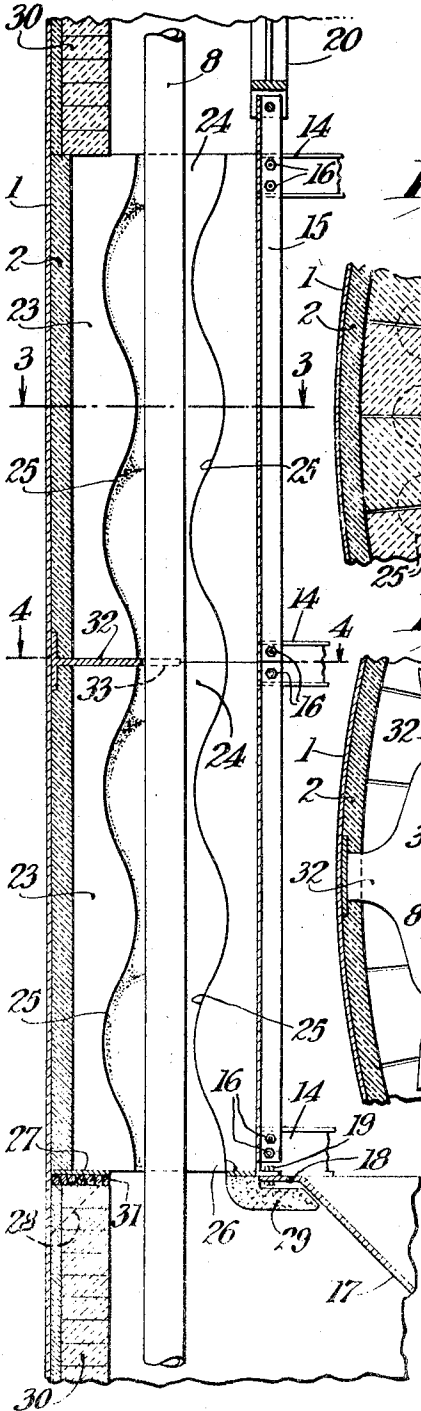


Fig. 1.

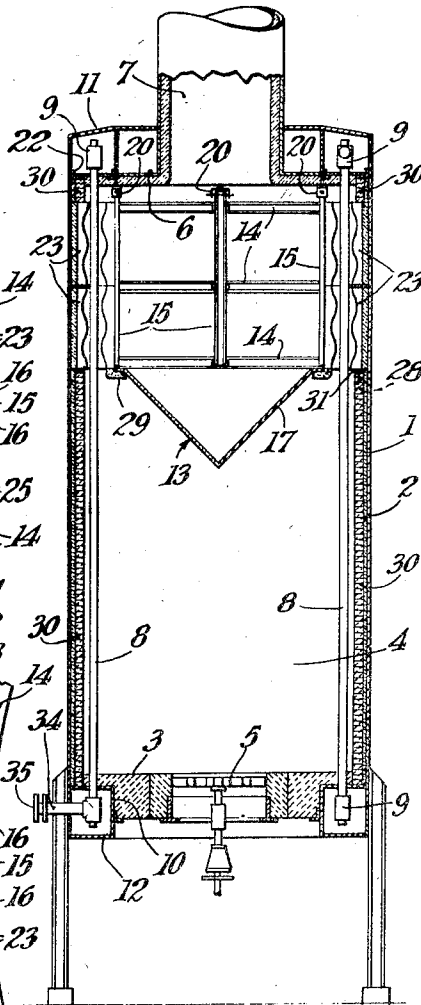


Fig. 3.

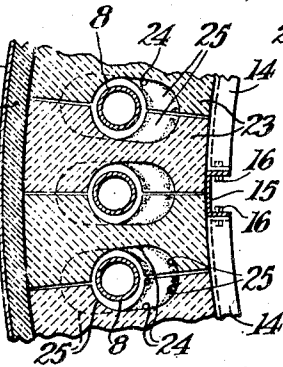
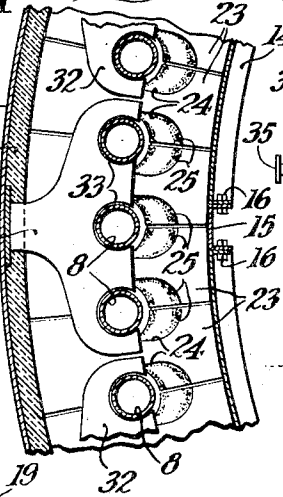


Fig. 4.



INVENTORS
Carl S. Reed and
BY *Otto C. Schauble*
Math and Co.
ATTORNEY

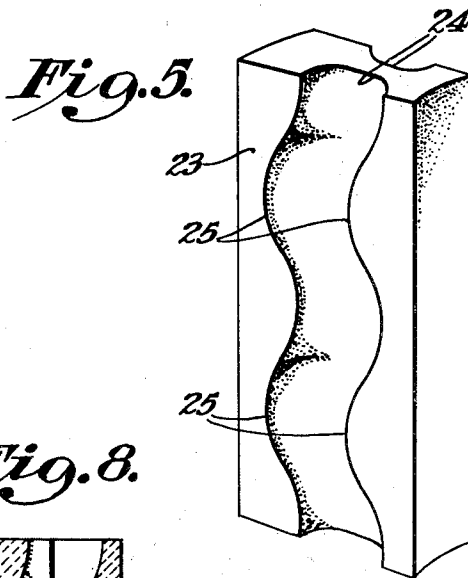
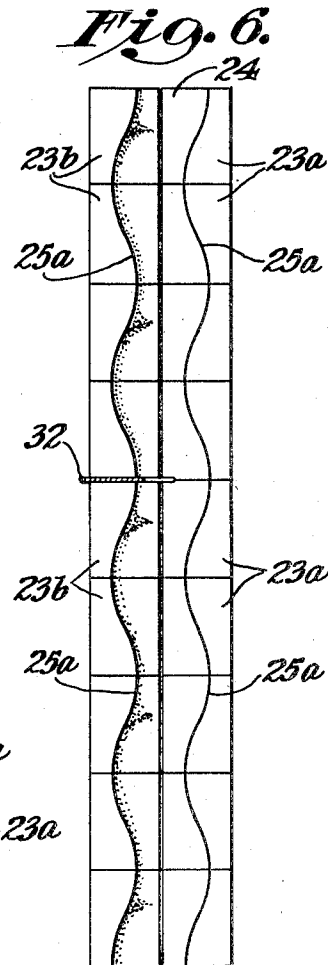
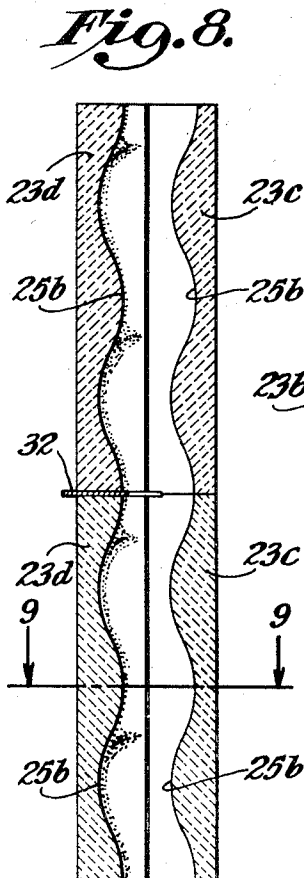
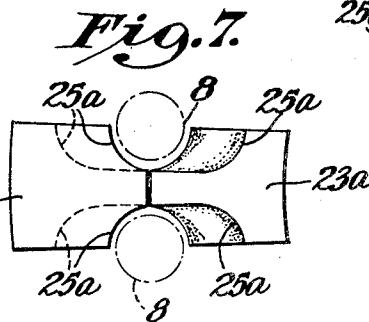
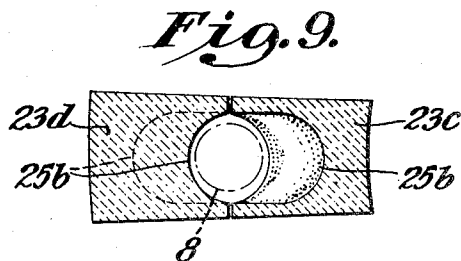
Dec. 12, 1950

C. S. REED ET AL
MULTIPLE BLOCK BAFFLE CONSTRUCTION FOR
MULTIPLE TUBE FLUID HEATERS

2,534,208

Filed Jan. 16, 1948

2 Sheets-Sheet 2



INVENTORS
Carl S. Reed and
Otto C. Schauble
BY *Nathaniel E. [Signature]*
ATTORNEY

UNITED STATES PATENT OFFICE

2,534,208

MULTIPLE BLOCK BAFFLE CONSTRUCTION
FOR MULTIPLE TUBE FLUID HEATERS

Carl S. Reed, New York, and Otto C. Schauble,
Mount Kisco, N. Y., assignors to The Lummus
Company, New York, N. Y., a corporation of
Delaware

Application January 16, 1948, Serial No. 2,665

11 Claims. (Cl. 110—98)

1

This invention relates to improvements in baffle structures for fluid heaters of a type including spaced parallel tubes through which a fluid to be heated is passed and means for passing a hot gas over the exterior of the tubes for convection heating thereof. More particularly, the invention relates to improved baffle means for a vertical heater of a type employed in the distillation or conversion of hydrocarbon fluids, for example. Such a heater commonly includes a vertical furnace chamber containing vertical tubes arranged in a circular series. Within a region surrounded by the lower portion of the tubes there is provision for conducting combustion to heat the adjacent length of the tubes predominantly by radiant heat. Along the upper portion of their length the tubes are heated by convection. For that purpose, a deflector is mounted within the region surrounded by the upper portion of the tubes to compel the hot gases from said combustion to flow in contact with the tubes to an outlet at the top of the furnace chamber. The present invention provides improved baffle means for the convection heating zone between the deflector and the surrounding wall of the furnace chamber. This baffle means is an improvement upon baffle means disclosed and claimed in a copending application of Carl S. Reed, Serial No. 605,612, filed July 17, 1945, and entitled "Heaters for Hydrocarbon Fluids." This copending application has matured into Patent No. 2,454,943 which issued November 30, 1948.

An important object of the invention is to provide a baffle structure devised to increase substantially the heat transfer efficiency in the convection heating zone.

A further object of the invention is to provide such a baffle structure formed of non-metallic refractory material, for heat resistance and durability.

A further object is to provide an improved baffle structure formed of courses of refractory tiles.

A still further object is to provide a tile of improved design for employment in the baffle structure.

Further objects and advantages of the invention will appear from the following description taken in connection with the accompanying drawings.

In the drawings:

Fig. 1 is a vertical sectional view of a heater embodying one form of the invention;

Fig. 2 is an enlarged vertical sectional view of an upper portion of the heater, containing the improved baffle structure;

2

Figs. 3 and 4 are horizontal sections on the lines 3—3 and 4—4, respectively, of Fig. 2;

Fig. 5 is a perspective view of one of the tiles forming the baffle structure;

Fig. 6 is an elevation of an assembly of tiles of another form;

Fig. 7 is an enlarged plan view of a pair of opposed tiles of the form shown in Fig. 6;

Fig. 8 is a vertical sectional view showing tiles of still another form; and

Fig. 9 is an enlarged horizontal section on the line 9—9 of Fig. 8.

According to the invention, in the embodiment illustrated, the baffle structure is formed of an assembly of refractory tile blocks. These are laid up in superimposed annular courses within the convection heating zone of a vertical heater, located within the annular space between a central gas deflector and the surrounding wall of the furnace chamber. The blocks are formed to define serpentine gas passages through which the hot gases ascending from a combustion zone within the lower portion of the heater are constrained to flow to an outlet at the top of the heater. The serpentine form of the passages causes a sinuous flow of the gases along and crosswise of the tubes for efficient convection heating of the tubes. The blocks are also formed to substantially fill the spaces between the tubes so as to prevent channeling of the gases and constrain them to pass in intimate contact with the tubes.

Fig. 1 of the drawings shows a vertical heater embodying the invention. The heater includes a cylindrical metal shell 1 vertically disposed and with its inner surface covered with suitable heat insulation 2. A lower wall 3, of refractory material forms the hearth of a furnace chamber 4 within the shell and has a burner 5 mounted within a central area thereof. A removable top wall 6, of metal lined with refractory material, has a central outlet flue 7 for the combustion gases. Vertical tubes 8, spaced in a circular series, extend through the furnace chamber and through holes in the bottom and top walls 3 and 6 to the exterior of the furnace. There, they are connected by return bends 9 for passage of a fluid to be heated through the tubes in series. The lower wall 3 is formed with a reentrant portion 10 which defines an annular recess to accommodate the lower series of return bends. Both the upper and lower return bends are covered by housings 11 and 12, respectively. The upper housing 11 and the wall 6 are supported for upward removal. A gas deflector 13 is disposed within the upper

3

portion of the chamber 4. As shown in Figs. 1 to 4 inclusive, the structure of the deflector includes a cylindrical frame coaxial with the shell of the heater and comprising three vertically spaced rings 14 of channel form and a number of circumferentially spaced vertical channel irons 15. The rings are formed in segments, and the elements 15 extend between the opposed ends of the segments and are bolted thereto, as at 16. An inverted cone 17, of heat-resistant metal, forms the lower end of the deflector and has a flange 18 bolted, as at 19, to the under side of the lowermost ring 14. The openings in the frame may be covered with sheets of heat-resistant material or, as shown, they may be covered solely by a portion of the baffle structure surrounding the frame. Suspension connections 20 between the wall 6 and the upper ends of the vertical elements 15 of the frame support the deflector in operative position. In turn, said wall 6 is supported by a ring 22 releasably secured within the shell 1. While a satisfactory deflector structure and supporting means therefor are shown it will be understood that same may be modified.

In the form shown in Figs. 1 to 5 inclusive, the baffle structure comprises annular courses of tiles or blocks, 23 of non-metallic refractory material. The material may be fired refractory or, it may be a suitable air-drying plastic material. In the present instance, there are two of the courses, one resting upon the other, and both surrounding the deflector and, in effect, forming a part thereof. The number of tiles in each course corresponds to the number of spaces between the circular series of tubes 8, and the tiles of both courses are of the same form. Each tile is of segmental shape in horizontal section and extends radially across substantially the entire space between the frame of the deflector and the insulating wall 2. Each tile has, in the opposite radial faces thereof, a trough-like channel 24 rounded in cross section and extending the entire depth of the tile. The opposite side surfaces 25 of said channel are of serpentine form in vertical section. In the present instance, each of said surfaces defines two complete sine curves, and the convexities of one surface are radially opposed to the concavities of the opposite surface. The convexities of the opposed surfaces are radially spaced a distance substantially exceeding the outside diameter of the tubes 8, and the transverse depth of the channel substantially exceeds one-half of said diameter.

When the tiles are assembled each channel 24 thereof registers sidewise with a corresponding channel of an adjacent tile in the same course and registers endwise with a channel of a tile in the other course. Thereby, companion tiles in the same course and in both courses form substantially tubular channels extending from the under side of the lower course to the top side of the upper source. One of the tubes 8 extends through each of said tubular channels and the walls of the channels are all laterally spaced from the tubes. A gas passage is thus formed along each tube and around the entire periphery of the tube.

The tile assembly is supported at its under side by concentric flat rings 26 and 27. Ring 26 is formed on or welded to the lowermost ring 14 of the deflector and forms a supporting ledge underlying the inner margin of the tile assembly. Ring 27 is secured to the shell 1 and braced by gussets 28 and forms a supporting ledge un-

4

derlying the outer margin of the assembly. A ring 29 of refractory material is detachably secured to the under side of ring 26 to form a facing therefor and also form a cover for the connection between the deflector cone and the ring 14. Above and below the baffle tile assembly the chamber 4 is lined with refractory brick 30 and between the ring 27 and the brick 30 therebeneath there is compressible packing 31. Between the upper and lower courses of the baffle tiles there is a circular series of flat tube-supporting brackets 32 secured to the shell 1 and each having notches 33 at its inner edge. The tubes extend through said notches and the latter include sufficient cross section of the tubes to hold the tubes against displacement into contact with the walls of the tile channels.

In the erection of the heater, the tiles of the lower course are inserted downwardly into position upon the supporting rings 26 and 27, the tube-supporting brackets 32 are secured in place and the tiles of the upper course are downwardly inserted to rest upon the lower course. The tiles of both courses are backed by the three rings 14 and held against inward displacement. After assembly of the baffle structure the tubes are inserted endwise, the brick lining 30 above the baffle structure is erected and the top wall 6 and the housing 11 are placed in position. The tiles are formed to afford a slight clearance therebetween in their respective courses and also slight clearance between the deflector and the surrounding wall 2, for ease in assembly and for expansion.

In the operation of the heater, a fluid charge to be heated is admitted through a nozzle 34, passed through the tubes 8 in series and discharged through a nozzle 35. Combustion at the burner 5 causes heating of the length of the tubes below the deflector 13 predominantly by radiant heat. Hot gases from the combustion ascend past the deflector and are constrained by the baffle structure to flow through the channels defined thereby along the upper length of the tubes and in close contact therewith. At the same time, the serpentine baffle surfaces 25 at opposite sides of the tubes cause a sinuous flow of the gases and a desired turbulence, for efficient heat transfer. Thereby, a highly efficient convection heating zone is provided. Since the tiles fill the intertube spaces, substantially the entire volume of the gases is constrained to flow in close contact with the tubes.

In the modification shown in Fig. 6 a greater number of smaller tiles are employed in the assembly. There are two opposed stacks of superimposed concentric courses of tiles at opposite sides of the tubes. Each tile 23a of one stack is directly opposed to a companion tile 23b of the other stack. As shown in Fig. 7, the opposed companion tiles together have a cross section similar to that of a single tile in the form of the invention first described. The tiles are also of materially reduced depth so that the baffle surface 25a of each tile defines only one-half of a sine curve. The tiles of the two stacks together define continuous serpentine passages, as before, to conduct the hot gases along the tubes. Owing to the small size of the tiles, they may be placed in position by passing them outwardly through the openings in the frame of the deflector. An additional advantage in this construction is that it enables withdrawal of the tiles supported by the ring 26 along with the deflector.

Figs. 8 and 9 also show a split tile construc-

tion in which the serpentine gas passage is formed by opposed companion tiles 23c and 23d. Here, the channels 24a defining said passage are formed in the radially opposed side faces of the companion tiles instead of in the radially arranged side faces thereof. Together, the opposed companion tiles, with their serpentine baffle surfaces 25b, form a tubular serpentine channel, as before, to conduct the gases along a tube within the channel. In this modification also, the inner tiles immediately surrounding the deflector, may be withdrawn with the deflector. In both modifications, the form of the tiles is such as to close the intertube spaces and constrain the gases to flow along the tubes.

It is of course to be understood that the present disclosure of our invention is merely illustrative and in nowise limiting, and that the invention comprehends such modifications as will come within the scope of the claims.

We claim:

1. Baffle structure for an updraft fluid heater of a type including an upright furnace chamber, an annular series of spaced substantially vertical fluid-heating tubes within said chamber and surrounded by a wall of the chamber, means to conduct combustion within a region surrounded by a lower portion of said tubes, and a deflector within a region surrounded by an upper portion of the tubes to direct ascending combustion gases between the deflector and said chamber wall, said baffle structure comprising an annular assembly of tiles having opposed baffle surfaces arranged at opposite sides of said upper portion of the tubes and formed in vertical section to cause therebetween sinuous flow of the combustion gases upwardly along and crosswise of the tubes between the deflector and the chamber wall, for convection heating of the tubes.

2. Baffle structure as claimed in claim 1, wherein the said opposed baffle surfaces are serpentine in vertical section and spaced from the tubes and each surface has its convexities horizontally opposed to the concavities of the opposed surface.

3. Baffle structure as claimed in claim 1, wherein the tiles are arranged in superimposed annular courses.

4. Baffle structure as claimed in claim 1, wherein the tiles extend between the tubes and obstruct flow of the gases through the intertube spaces.

5. Baffle structure as claimed in claim 1, wherein the tiles extend between the tubes to obstruct flow of the gases through the intertube spaces, substantially surround the individual tubes and are spaced therefrom and form serpentine gas passages individual to the tubes.

6. Baffle structure as claimed in claim 1, wherein the tiles extend between the tubes to obstruct flow of gases through the intertube spaces, and each tile has in a face thereof a channel cooperating with an opposed channel in an adjacent tile of the assembly to form a single channel whose walls substantially surround one of the tubes and form a passage for combustion gases along the tube.

7. Baffle structure as claimed in claim 1, wherein the assembly includes tiles arranged in an annular course, each tile in said course has opposite radial side faces each formed with a channel extending lengthwise of the tubes and cooperating with a similar opposed channel in the next adjacent tile of the course to form a single channel whose walls substantially surround the cross section of one of the tubes and form a passage for combustion gases along the tubes, and portions of

said channel walls at opposite sides of the tube are serpentine to cause sinuous flow of the gases along the tube.

8. Baffle structure as claimed in claim 1, wherein the tile assembly includes a plurality of superimposed annular inner courses of tiles and a plurality of superimposed annular outer courses of tiles concentric with said inner courses and radially opposed thereto.

9. Baffle structure for a fluid heater of a type including a series of substantially parallel spaced fluid-heating tubes and means for passing a heating gas over the exterior of the tubes, said baffle structure comprising an assembly of blocks extending along said tube series, portions of said blocks substantially surrounding the cross section of the individual tubes in spaced relation thereto and extending into the spaces between the tubes to obstruct flow of the gas through said spaces, said block portions forming gas passages individual to the tubes and extending therealong and having opposed baffle surfaces at opposite sides of the tubes and serpentine in section longitudinally of the tubes to cause serpentine flow of the gas along and crosswise of the tubes, for convection heating thereof.

10. Baffle structure for a fluid heater of a type including a series of substantially straight parallel spaced fluid-heating tubes and means for passing a heating gas over the exterior of the tubes, said baffle structure comprising a course of side-by-side blocks arranged along said tube series, said blocks extending into the spaces between the tubes and each block having in each of two opposite side faces thereof a channel extending lengthwise of the tubes and cooperating with a similar opposed channel in the next adjacent tile of the course to form a single channel whose walls substantially surround the cross section of one of the tubes and form a passage for combustion gases along the tube, portions of said channel walls at opposite sides of the tube being serpentine longitudinally of the tube and substantially parallel to cause sinuous flow of the gases along the tube.

11. Baffle structure for a fluid heater of a type including a series of substantially parallel spaced fluid-heating tubes and means for passing a heating gas over the exterior of the tubes, said baffle structure comprising an assembly of blocks arranged in courses disposed in succession along the tubes and each course extending along said tube series, portions of said blocks substantially surrounding the cross section of the individual tubes in spaced relation thereto and extending into the spaces between the tubes to obstruct flow of the gas through said spaces, said block portions of the combined courses forming gas passages individual to the tubes and extending therealong to cause flow of the gas along the tubes, for convection heating thereof.

CARL S. REED.
OTTO C. SCHAUBLE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
634,978	Boss	Oct. 17, 1899
1,920,122	Chavanne	July 25, 1933
2,152,269	Nelson	Mar. 28, 1939
2,340,287	Throckmorton	Feb. 1, 1946