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3,492,973

TUBE HEATER

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FIG. 1

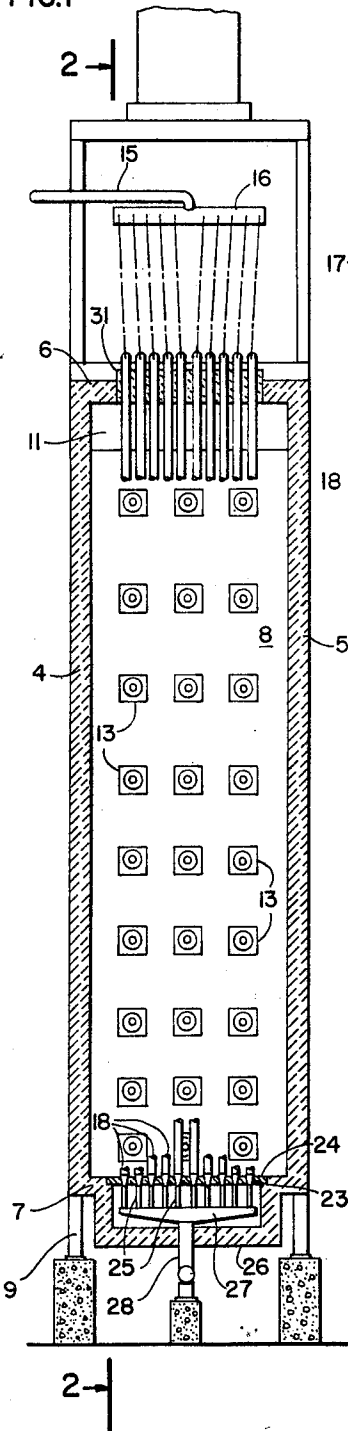


FIG. 2

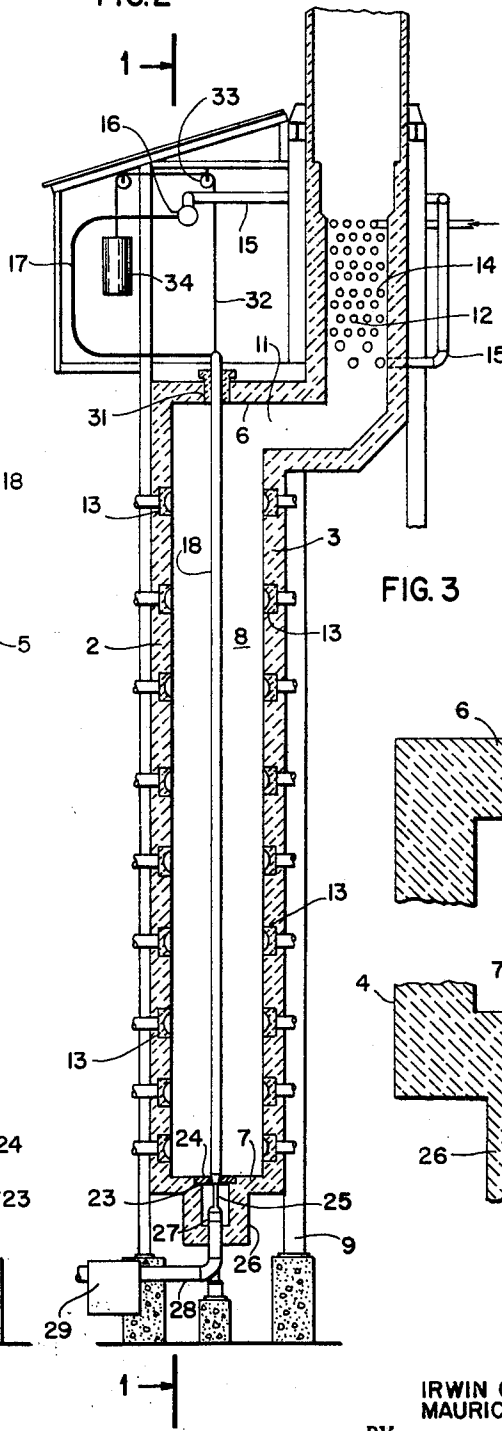
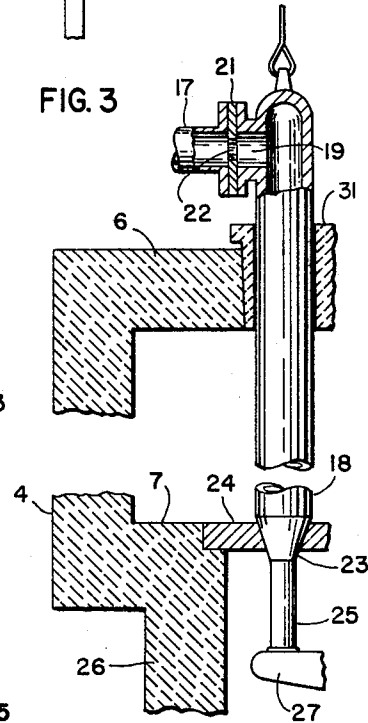


FIG. 3



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TUBE HEATER

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Int. Cl. F22b 37/20, 37/64

U.S. Cl. 122—510

7 Claims

ABSTRACT OF THE DISCLOSURE

The invention relates to a tube heater for hydrocarbon pyrolysis in which the fluid to be treated is heated as it flows in a single pass through a plurality of parallel tubes. Means is provided to insure substantially equal flow through each tube and to speed up the flow of the heated fluid from the tubes to a quench.

This application is a continuation of application Ser. No. 724,798 filed Apr. 29, 1968.

SUMMARY OF THE INVENTION

The present invention relates to tube heating furnaces, and more particularly to such heaters in which the fluid being heated flows through a single, vertical tube length.

In modern hydrocarbon pyrolysis the emphasis has been on higher temperature and shorter residence times in the effort to obtain greater cracking and better product distribution. Heaters are working near the mechanical limits of materials that are presently available, and it becomes necessary to refine the designs to permit the increases safely to be achieved.

It is an object of the invention to provide a tube heater in which the temperature of the tubes can be kept uniform throughout their entire length.

It is a further object of the invention to provide a tube heater in which a single row of vertical tubes is used with provision to insure substantially the same amount of fluid flow through each tube in a minimum time with a minimum pressure drop in the tube, and that the heated fluid is passed in a minimum of time to a quench.

The various features of novelty which characterize our invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which we have illustrated and described a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a section through a heater on 1—1 of FIG. 2, FIG. 2 is a section taken on line 2—2 of FIG. 1, and FIG. 3 is an enlarged view showing a tube, the manner in which it is supported, and the connections thereto.

DETAILED DESCRIPTION

In the drawings there is shown furnace structure that can be built in accordance with ordinary furnace practice including side walls 2 and 3, end walls 4 and 5, a roof 6, and a floor 7 which form a radiant chamber or section 8 of the furnace. This structure is supported upon structural steel members 9 in a conventional manner. The upper portion of the furnace is provided with an exhaust passage 11 through which the products of combustion flow to and through a convection section 12, to a suitable stack. Each of the side walls 2 and 3 is provided with a plurality of horizontal rows of burners 13 which are preferably of the well known radiant cup type. It will be noted from FIG. 1 that the rows of burners are spaced

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increasing distances apart toward the upper portion of the furnace chamber.

Fluid to be heated is introduced into a convection coil 14 where it is preheated by the exhaust products of combustion flowing through section 12 and passes from this preheating coil through a transfer line 15 to a manifold 16 located above radiant chamber 8. This manifold is connected by flexible supply tubes 17 to radiant heating tubes 18 that are located in the radiant chamber 8. Tubes 18 extend vertically in a row substantially midway between the walls 2 and 3 so that heat supplied by the burners will be applied with equal intensity around the tubes. Each of the tubes has at its upper end an intake 19 which is connected to the discharge of a connecting tube 17, with an orifice plate 21 having an orifice 22 therein located immediately at the entrance of the tube. The lower ends of the tubes 18 are formed with conical sections 23 which rest in openings that are provided in a plate 24. The conical section 23 connects each tube 18 with a reduced extension 25 on its lower end. This extension extends into a depression or compartment 26 that is formed in the floor 7 of the furnace below plate 24. Also located in this depression is a manifold 27 which is connected to the lower ends of all of the extensions 25. It will be noted in FIG. 1 that the manifold increases in area toward its center as additional tubes discharge into the manifold. The center of the manifold is connected by means of a pipe 28 with a quench 29 or other suitable apparatus located immediately outside of the furnace chamber.

The tubes 18 in many cases are thirty or more feet in length and, as a result, will expand several inches as they are heated to operating temperature. For this reason the upper ends of the tubes extend through the roof of the furnace and through a guide 31 that is located in the roof. The openings in the guide for the tubes are snug enough so that the tubes can expand but will prevent passage of any appreciable amount of exhaust gases through the openings around the tubes. Each of the tubes is provided with a means to bias its upper end upwardly so that the tube will not have a tendency to bend as it increases in length due to heating. As shown herein, each tube has attached to its upper end a cable 32 which passes over suitable pulleys 33 in the frame of the furnace to a counterweight 34. This weight generally will be equal to at least half the weight of the tubes.

In the operation of the furnace the burners 13 are ignited and are adjusted in horizontal rows so that the temperature of the tube will be substantially the same from top to bottom. Since the exhaust gases from the burners rise to the top of the tubes, these gases will have a convection heating effect in addition to the radiant heating effect of the burners. The upper rows of burners are spaced further apart than are the lower rows to take this effect into account when adjusting the rows of burners to obtain a uniform tube temperature.

In furnaces of this type the hydrocarbons steam mixture which is being heated moves vertically in the single pass through the tubes to the point of discharge. Because of the high velocity of the fluid and the low pressure drop in the tubes, it is important to provide a means which will insure substantially uniform distribution of the fluid being treated through the various tubes of the heater. For this reason there is provided immediately in front of the entrance 19 to each of the tubes 18 the restriction or orifice 22 that will cause a substantial pressure drop, thereby evening out the flow of fluid through the tubes. If, for example, tubes 18 have an internal diameter of about 3" and the flexible tubes 17 have an internal diameter of about 2", orifice 22 would be about 1" in diameter. For throughput of a gas oil-stream mixture of 600 pounds per hour, an orifice of this type would give a pressure

drop of approximately 25 p.s.i. During the time that the fluid being treated is in the tubes it is heated to cracking temperature, and after this temperature has been reached it is desirable, if not necessary, for the material to go to the quench in the least possible time, a small fraction of a second. The restricted extensions 25 reduce the area through which the heated fluid flows and thereby increase the velocity in order to speed up transfer of the heated material from the tubes to quench 29. It will be noted that manifold 28 is shaped so that it will offer substantially no restriction to the flow of the heated fluid from the tubes discharged into it.

In the drawing and the above description the tubes have been shown as being supplied from the top. It will be obvious, however, that from an operational point of view the direction of flow of the fluid being heated is immaterial. It is within the scope of the invention therefore to reverse the position of the tubes in the furnace so that reduced extensions 25 and manifold 27 are at the top and inlets 19 and orifices 21 are at the bottom of the furnace. In this case the tubes would be fastened at the top and expand downwardly, and counterweights 34 would not be needed.

While in accordance with the provisions of the statutes we have illustrated and described the best form of embodiment of our invention now known to us, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit and scope of the invention set forth in the appended claims, and that in some cases certain features of our invention may be used to advantage without a corresponding use of other features.

What is claimed is:

1. In a tube heater, structure including side walls, end walls, a roof and a floor forming a vertically elongated chamber, a plurality of rows of burners in said side walls to heat said chamber, a plurality of vertically extending tubes in said chamber forming a row substantially midway between said side walls, means to support one end of said tubes in a fixed position, means to supply a fluid to be heated to one end of said tubes including a first manifold, a flexible connection between said first manifold and each of said tubes, a flow restricting device between each connection and tube, each tube being provided on its other end with an extension smaller in diameter than the tube, a second manifold connected to the outlet end of each of said extensions, and an outlet for said second manifold, said second manifold increasing in area toward

its outlet as said extensions of said tubes are connected thereto.

2. The heater of claim 1 in which said flow restricting devices comprise orifice plates having an orifice smaller in diameter than the internal diameter of said connections or said tubes.

3. The heater of claim 1 in which the lower ends of said tubes are fixed adjacent to said floor and said second manifold is received in a depression in said floor below the point at which said tubes are fixed.

4. The heater of claim 3 in which said means to support said tubes comprises means through which the lower ends of said tubes extend, and means to support said last mentioned means across said depression in said floor.

5. The heater of claim 2 in which the upper ends of said tubes extend through said roof and including means to guide the upper ends of said tubes for sliding movement in said roof as said tubes expand and contract.

6. The heater of claim 1 in which said rows of burners extend horizontally in said side walls and in which said rows of burners are spaced further apart as the height of the rows increase in the side walls.

7. In a tube heater, structure including side walls, end walls, a roof and a floor forming a vertically elongated chamber, a plurality of rows of burners in said side walls to heat said chamber, a plurality of vertically extending tubes in said chamber forming a row substantially midway between said side walls, means to support one end of said tubes in a fixed position, means to supply a fluid to be heated to one end of said tubes including a first manifold, a flexible connection between said first manifold and each of said tubes, a flow restricting device between each connection and tube, a second manifold means to connect the outlet end of each tube to said second manifold, means to support one end of each of said tubes rigidly in position in said chamber, means in one of said roof and floor through which the other end of said tubes can move as said tubes expand and contract, and an outlet directly connected to said second manifold.

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KENNETH W. SPRAGUE, Primary Examiner