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FURNACE TUBE ARRANGEMENT

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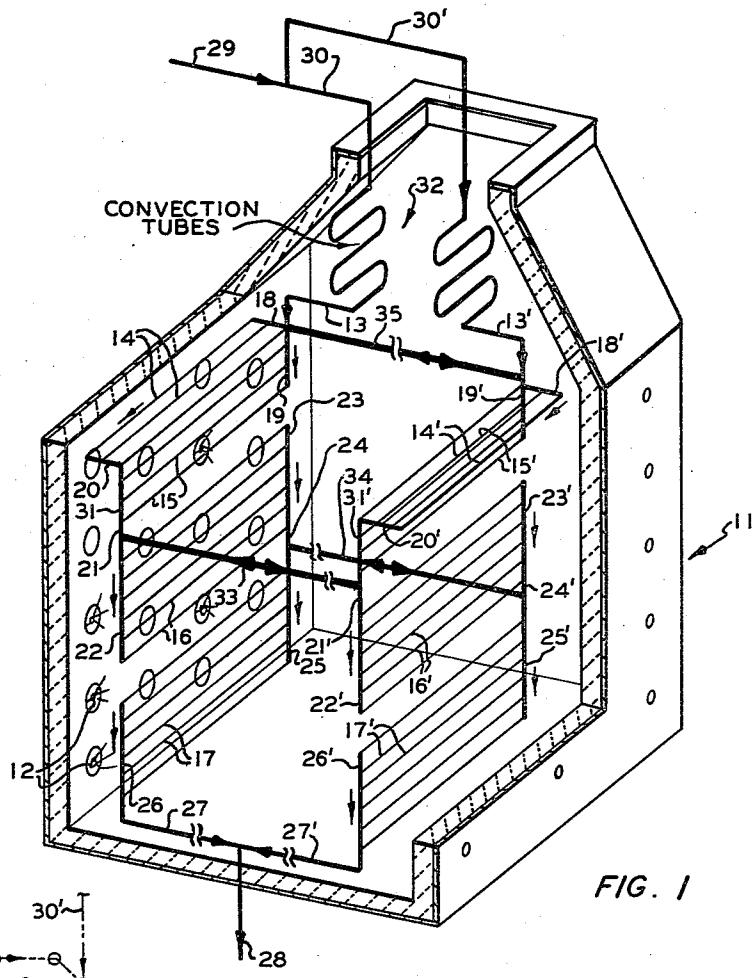


FIG. 1

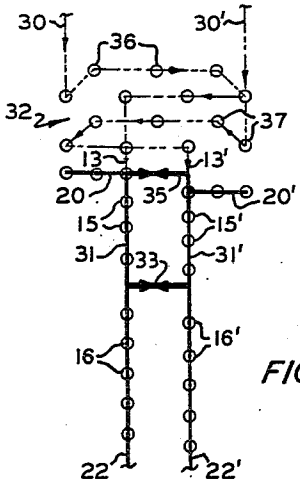


FIG. 2

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FURNACE TUBE ARRANGEMENT

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This invention relates to an improved furnace used for heating petroleum products and other fluids. In one aspect it relates to an improved furnace for heating liquids, and for heating fluids from a temperature at or near their bubble points at furnace pressure to a higher temperature such that the furnace effluent is part vapor and without cracking.

An object of this invention is to provide a tube furnace of a type suitable for heating of liquid materials. Another object is to provide a tube furnace having a unique arrangement of heating tubes for heating a liquid from a temperature at or near its bubble point to a higher temperature without cracking. Yet another object is to provide such a furnace for heating a liquid from a temperature at or near its bubble point to a higher temperature with partial vaporization and without cracking. Still another object of this invention is to provide a tube furnace having a particular arrangement of tubes so as to allow partial vaporization without localized overheating or extensive pressure drop. Yet other objects and advantages of this invention will be realized upon reading the following description which, taken with the attached drawing, forms a part of this specification.

I achieve these and other objects by providing a pair of multiple, parallel coil passes, with multiple passes of each pair being in series and with by-passes from one multiple pass to its counterpart in the other of the pair of multiple coil passes. By such coil arrangement I am able to heat liquids with or without partial vaporization and without localized overheating or extensive pressure drop through the various segments of the flow path of the fluid.

FIGURE 1 illustrates, in diagrammatic form, an arrangement of apparatus parts for carrying out this invention. FIGURE 2 illustrates, in diagrammatic form, an arrangement of tubular elements of this invention.

Reference numeral 11 identifies the walls of a furnace in which the tubular heating elements of this invention are positioned. The side walls of this furnace are provided with openings into which burners 12 are positioned for providing heat. The heating tubes in this furnace can be noted by following the flow of fluid from entry into the furnace through a feed line or inlet pipe 29 through the furnace. From inlet conduit 29 the feed divides into two portions, one portion flowing through pipe 30 and the other through pipe 30'. That portion flowing through pipe 30 passes through its portion of convection section heating tubes in convection section 32 and thence through pipe 13 into the radiant heating section of the furnace. From pipe 13 oil or fluid flows through headers 18 and 19 and thence, respectively, through pipes 14 and 15 to headers 20 and 31. Fluid from header 20 passes through header 31 and fluid flowing through pipes 15 collects in header 31 and this combined fluid passes on through a connecting pipe 21 to a header 22. From header 22 the fluid flows through several parallel heater tubes 16 toward header 23. From header 23 the fluid flows through a connecting pipe 24 to a header 25. From this latter header the fluid flows through parallel heating pipes 17 to a header 26 from which the heated material flows through a pipe 27 and from a furnace through a pipe 28.

On the opposite side of this heater, fluid from inlet pipe 30' flows through its convection tubes in convection section 32 and thence through pipe 13' to this parallel

portion to heating tubes. From pipe 13' fluid flows through header 18' and header 19' and thence through parallel tubes 14' and 15' to headers 31' and 20' Fluid from header 20' flows though header 31' and the combined material in header 31' flows through a connecting pipe 21' to a header 22'. From this header fluid flows in parallel flow paths through heating tubes 16' to a header 23'. From this header the fluid flows through a connecting pipe 24' to a header 25' from which fluid flows through the parallel heating tubes 17' to a header 26'. From this header the heated material flows on through a pipe 27' and joins material from pipe 27 for passage from the furnace through conduit 28.

A cross pipe 35 connects the two flow channels of fluid at about the points illustrated in FIGURE 1. Another cross pipe 33 is connected with the connecting pipes 21 and 21' while a third cross pipe 34 is connected to the connecting pipes 24 and 24'.

These several cross pipes 33, 34 and 35 are provided for allowing flow either in one direction or the other dependent upon which main flow channel through the furnace is at a lower pressure than the other.

The convection section 32 of this furnace is provided with tubes 36 and 37 positioned as illustrated in the upper portion of FIGURE 2. While only two banks of convention heating tubes are shown, the furnace actually contains more than two of such banks. Alternate banks of tubes in this convention section are connected together for equal heating of the two flows of materials to be heated. For example, a material flowing through conduit or pipe 30 flows through tubes 36 in the direction indicated and from the final tube of this bank of tubes the material flows through pipe 13 to the radiant section of the furnace described hereinabove. In like manner, the material flowing through pipe 30' flows through the lower of the two illustrated banks of convection tubes 37 and this material finally exits from the final tube and flows through pipe 13' to the right-hand portion of tubes in the radiant section of the furnace.

While the number and arrangement of heating tubes in the left-hand side of the radiant portion of the furnace is exactly as the number and arrangement of tubes in the right-hand side, the two tubes positioned in the vertical planes are staggered with respect to each other so that radiant heat from the left-hand wall of the furnace will contact all of the tubes of the furnace. That is, the right-hand tubes 15', 16' and 17' are not in the shadow of tubes 15, 16 and 17 respectively. In like manner, by this arrangement of tubes the tubes 15, 16 and 17 are not in the respective shadows of the tubes 15', 16' and 17' from the right-hand set of burners.

Tubes 14 and tubes 14' in the upper banks of radiant heating tubes are positioned in a horizontal plane merely for convenience and this particular positioning plays no specific part in the invention.

By employing multiple, parallel flow passages such as illustrated by the banks of tubes 15, 16 and 17, pressure drop through the heating tubes is maintained at a minimum. Furthermore, since such a furnace as herein described is employed as a debutanizer column reboiler heater and since vaporization of the debutanizer bottoms takes place in these tubes, pressure drop through the heating tubes is at a minimum. Any restriction in flow through tubes 15 is offset by passage of fluid through cross pipe 35 to headers 18' and 19' and thence through the heating tubes 14'. Likewise, the cross pipes 33 and 34 maintain flow through the heating coils of the furnace at a minimum pressure drop through the coils. As mentioned above, any restriction in flow through tubes 16 which would cause an increased pressure drop is

offset by flow of fluid through connecting pipe 33 from left to right with the result that the flow through pipe 16' is increased somewhat. In like manner, any variation in flow through tube 17 or tube 17' is corrected by flow through cross pipe 34 in one direction or the other.

The metal of which the tubes of this invention are made is selected from the metal ordinarily used for such heating tubes.

While the tube arrangement of this invention allows flow of fluid therethrough with a minimum pressure drop, the apparatus is applicable to all liquid heating which does not involve cracking or carbon deposition. Partial vaporization can occur in the tubes or no vaporization at all.

The particular furnace of this invention has been used as a debutanizer reboiler heater very successfully. Since the pressure drop through this heater is maintained at a minimum, pumping costs for cycling the reboiler fluid is a minimum.

While certain embodiments of the invention have been described for illustrative purposes, the invention is not limited thereto.

That which is claimed is:

1. A tube arrangement for a tube heater comprising, in operable combination, a pair of like and parallel tube arrangements, each tube arrangement comprising a plurality of banks of horizontally positioned parallel tubes, said plurality comprising at least first, second and third banks of tubes arranged serially and in a vertical plane, a first header communicating with the ends of the tubes of said first bank at one end thereof, a second header communicating the ends of said second bank of tubes corresponding to said one end of said first bank of tubes, a first connecting tube connecting adjacent ends of said first and second headers, a third header connecting the ends of the tubes of said second bank opposite said second header, a fourth header connecting the tube ends of said third bank of tubes adjacent said third header, a second connecting tube connecting adjacent ends of said third and fourth headers, a fifth header connecting the tube ends of said third bank of tubes opposite said fourth header, an outlet tube connected with the end of said fifth header opposite said second header for passage of heated material from said tube arrangement, a first by-pass tube communicating the first connecting tube of one tube arrangement with the corresponding connecting tube of the other tube arrangement, a second by-pass tube communicating the second connecting tube of one tube arrangement with the corresponding connecting tube of the other tube arrangement, each first bank of tubes having an inlet header communicating with the tube ends thereof adjacent said third header, a third by-pass tube communicating the inlet headers with each other, one of said tube arrangements being positioned at an elevation above the other tube arrangement about half the vertical distance between centers of adjacent tubes in such a manner that all tubes of both tube arrangements are exposed for radiant heating.

2. A tube arrangement for a tube heater comprising, in operable combination, a pair of like and parallel tube arrangements, each tube arrangement comprising a plurality of banks of horizontally positioned parallel tubes, said plurality comprising at least first and second banks of tubes arranged serially and in a vertical plane, a first header communicating with the ends of the tubes of said first bank at one end thereof, a second header communicating the ends of said second bank of tubes corresponding to said one end of said first bank of tubes, a first connecting tube connecting adjacent ends of said first and second headers, a third header connecting the ends of the tubes of said second bank opposite said second header, an outlet tube connected with the end of said third header opposite said first bank for passage of heated material from said tube arrangement, a first bypass tube connecting the first connecting tube of one tube arrangement with the corresponding connecting tube of the other tube arrangement, each first bank of tubes having an inlet header communicating with the tube ends thereof adjacent said third header, a second bypass tube communicating the inlet headers with each other, one of said tube arrangements being positioned at an elevation above the other tube arrangement about half the vertical distance between centers of adjacent tubes in such a manner that all tubes of both tube arrangements are exposed for radiant heating.

3. A tube arrangement for a tube heater comprising, in operable combination, a pair of like and parallel tube arrangements, each tube arrangement comprising a plurality of banks of horizontally positioned parallel tubes, said plurality comprising at least first and second banks of tubes arranged serially, a first header communicating with the ends of the tubes of said first bank at one end thereof, a second header communicating the ends of second bank of tubes corresponding to said one end of said first bank of tubes, a first connecting tube connecting adjacent ends of said first and second headers, a third header connecting the ends of the tubes of said second bank opposite said second header, an outlet tube connected with the end of said third header opposite said first bank for passage of heated material from said tube arrangement, a first bypass tube connecting the first connecting tube of one tube arrangement with the corresponding connecting tube of the other tube arrangement, each first bank of tubes having an inlet header communicating with the tube ends thereof adjacent said third header, a second bypass tube communicating the inlet headers with each other, one of said tube arrangements being positioned at an elevation above the other tube arrangement about half the vertical distance between centers of adjacent tubes in such a manner that all tubes of both tube arrangements are exposed for radiant heating.

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