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HEATING UNIT FOR HEAT TRANSFER LIQUID

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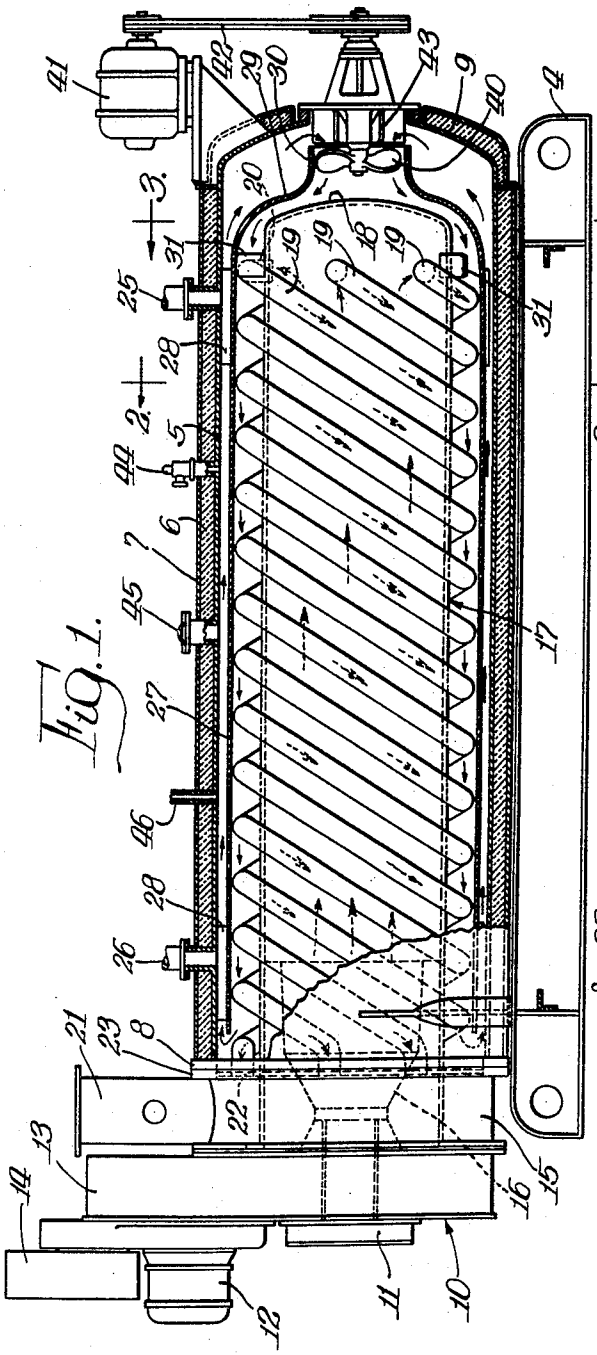


Fig. 1.

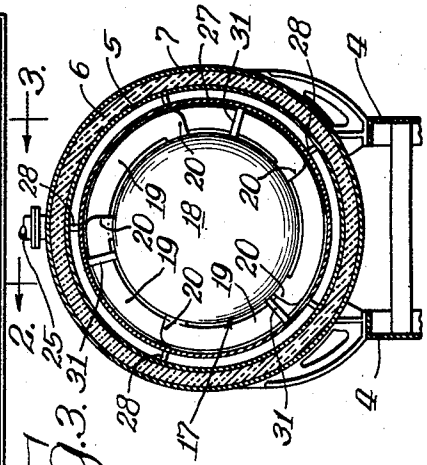


Fig. 3.

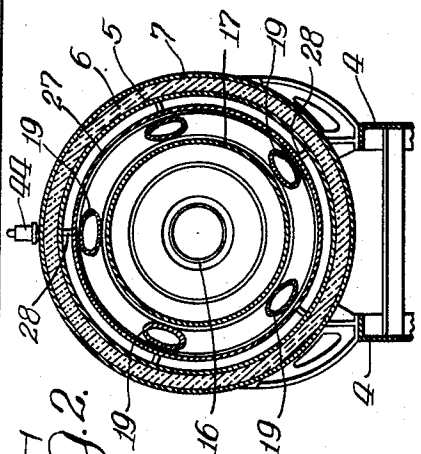


Fig. 2.

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# HEATING UNIT FOR HEAT TRANSFER LIQUID

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3 Claims. (Cl. 122—149)

This invention relates to a heating unit and more particularly to a unit for heating a heat transfer liquid in a closed circuit used to heat a desired product.

Viscous bituminous and petroleum products are often heated in order to lower the viscosity for pumping and other handling operations. This may be accomplished by heating a heat transfer liquid, ordinarily a high flash point oil and pumping this liquid through coils and lines in out-of-contact heat exchange with the product. It is ordinarily desirable to employ as little heat input as possible to the transfer liquid to effect a desired heating of the product. Time is also usually a governing factor as ordinarily the heating should be accomplished quickly in order to avoid unnecessary delays.

The present invention is concerned with an improved heating unit for raising the temperature of a heat transfer liquid and circulating it into and out of the heater in a closed circuit. The present unit has several advantages which have not been present in existing units for the same purposes. The structure is so arranged that all of the heating surfaces of the furnace have the transfer liquid pumped thereover at a uniform high velocity maintaining a minimum differential between the temperatures of the heated surfaces and the transfer liquid. Difficulties of expansion and contraction of the furnace parts are avoided since, in effect, the furnace structure is full floating and at the same time permitting ready removal of the furnace for cleaning.

A further advantage of the new structure is that it permits a minimum quantity of liquid in the heater thus reducing the cost.

It is, therefore, the principal object of this invention to provide a new and improved heating unit of the character described.

Another object is to provide a heating unit for heat transfer liquid in which the liquid may be passed at high uniform velocity in contact with substantially all of the heated surfaces of the unit.

A further object is to provide a heating unit of particularly high efficiency coupled with a low operating cost.

Other features, advantages and objects of the present invention will be apparent from the following description of a preferred embodiment illustrated in the accompanying drawings in which:

Figure 1 is a side elevational view, partly in section, of the improved heating unit of this invention;

Figure 2 is a vertical sectional view taken through the heating unit substantially along line 2—2 in Figure 1; and

Figure 3 is a vertical sectional view taken through the heating unit substantially along line 3—3 in Figure 1.

While this invention is susceptible of embodiments in many different forms, there is shown in the drawings and is herein described in detail one specific embodiment, with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention



to the embodiment illustrated. The scope of the invention will be pointed out in the appended claims.

The present invention, in general, provides a heating unit to which a coil and suitable lines will be attached to form, with the liquid space in the heater, a closed circuit for circulation of heat transfer liquid. The present invention is concerned with the heating unit, its structure and mode of operation. In the past, boiler type constructions, in which a number of fire tubes secured at opposite ends in tube sheets, have been used within a shell for the passage of combustion products which heat the transfer liquid in an out-of-contact heat exchange relation. Difficulties have been encountered since the transfer liquid did not come in contact with all of the heated surfaces in a uniform manner, thus permitting parts of the furnace to be at much higher temperatures than other parts. Some parts of the furnace were stressed to such a degree that an actual pulling loose of the parts sometimes occurred.

In the present structure, the furnace extends into the shell of the heater in a manner allowing expansion and contraction of the furnace without danger of the breakage of any of the parts. At the same time, the structure is so arranged that the heating liquid is pumped over the furnace structure at a very high velocity compared with what has been possible in the past. This results in a very small differential in temperature between the heated surfaces and the liquid. Uniformity in the expansion and contraction of the furnace parts is also achieved by this structure.

The unit is intended for use in the field so that it is ordinarily mounted on skids 4 forming the base for supporting the shell 5 about which an insulating layer of material 6 is placed and covered by a retaining sheet metal cover 7. The heater ordinarily operates at atmospheric pressure and an expansion tank or space is provided to maintain the pressure at atmospheric pressure. The shell is provided with a flange 8 at one end and a dome-shaped or spherical end 9 opposite the flange. The front of the unit mounts a burner structure generally indicated 10 which includes the burner 11, and a motor 12 for operating a blower inside an air plenum chamber 13 having an air intake at 14. The burner structure 10 is generally the same as disclosed in the application of Cleaver et al., Serial No. 403,286 filed January 11, 1954, now Patent No. 2,835,230.

This burner structure is mounted on a door which is hinged to a combustion products gas chamber 15 directly secured to the flange 8 on the shell. The products of combustion formed in the burner 11 are discharged into a burner section 16 so that the flame may travel down the main fire tube 17 of the furnace toward the spherical end 18 thereof. At the end of the main fire tube 17, the combustion products enter one or an other of a plurality of return flues 19, each of which has an end portion 20 communicating through an opening with the interior of the main fire tube. The return flues are each helically wound about the fire tube and communicate at the burner end with the chamber 15 and stack 21. For instance, the particular return flue connecting with the fire tube on the near side of the same, as illustrated in Figure 1, has its exit into the combustion products chamber at 22. The return flues are generally wound in parallel lines so that in a sense the five flues are in the form of a compound thread. For the particular size of fire tube and flues illustrated, each flue makes about two and three-quarters turns about the fire tube.

The particular form of the furnace or heating element is advantageous in that it permits expansion and contraction of the fire tubes and flues without the danger of breaking any of the connections. The products chamber 15, fire tubes and flues are all supported by a heavy flange

23 secured to the flange 8 of the shell and are extended thereby in a cantilever fashion into the shell. This permits ready removal for cleaning which must be done from time to time as the formation of coke is dependent upon a time-temperature relationship.

The heat transfer liquid is conducted into and out of the shell through an inlet 25 and an outlet 26. The space within the shell about the furnace forms a part of a closed circuit with a coil of pipelines which may be connected with the inlet and outlet. Ordinarily, a circulating pump is connected to the outlet 26 for forcing the heated oil or other liquid through heat transfer equipment such as storage tanks, heating coils or other heat exchangers.

The form of the present heater employs a shroud 27 of generally cylindrical form placed in the shell and about the fire tube and flues concentrically. Spacers 28 serve to hold the shroud in position. The end of the shroud adjacent the stack 21 is open while the other end has a partially spherical end 29 with a neck portion 30 forming a central opening. The shroud thus divides the interior of the shell into a return passage between itself and the shell and a heating passage between the shroud and the fire tube. The transfer liquid is heated passing over the furnace surface after which is passes around the end of the shroud to the outlet 26. Cold liquid is drawn back into the shell through the inlet 25 while at the same time some oil may be by-passed around the outside of the shroud to again pass to the heating zone. Spacer members 31 are also employed to space the shroud around the fire tube.

One of the important features of the present invention is the structure by which the transfer liquid is forced over the heated surfaces at a uniform high velocity. This maintains the heated surfaces at a lower temperature than otherwise would be possible. In the present invention, a propeller 40 is mounted on a shaft in the end of the shell so that it rests within the reduced portion 30 of the shroud and is positioned between the passages mentioned. A suitable motor 41 is provided with a belt 42 for driving the propeller. Cold oil may pass from the inlet through louvers 43 to the blades of the propeller 40 and is then forced longitudinally over the fire tube and return flues. The propeller turns in the direction of the winding of the flues so that the oil may follow a path slightly helical in nature rather than strictly longitudinally of the shell. This structure contributes to a very low head loss which has been experienced with the unit.

The primary benefit of the pumping arrangement just described is the maintenance of a relatively high velocity of flow of the transfer liquid over the heated surfaces. It has been found that velocities of the order of seven to eight feet per second may be maintained without requiring especially large driving motors for the propeller. At such velocities, a temperature differential between the heated surfaces and the liquid of not substantially more than 70° F. have been achieved. The shroud is placed quite close to the return flues so that a generally uniform, relatively thin passage is provided for the liquid over the heated surfaces. There is practically no obstruction in the path of the liquid through this uniform size channel. The fact that there may be more space between the shroud and the fire tube in between the flues does not interfere with the uniform flow. Thus, the shroud is placed quite close to the flues so that the flow area is at a minimum and only a small amount of liquid is needed in the heater permitting use of a smaller pump. The high flow rate and low metal surface temperatures minimizes the amount of coking that occurs, particularly since temperature differentials are kept quite low.

Several heat transfer liquids are suitable for use in the unit. Generally, all of the high flash point oils as well as some of the commercially available products of petroleum and chemical companies for heat transfer purposes are entirely satisfactory. One of the results achieved by the present structure is the rapid transferral of heat from the heated surfaces of the furnace to the transfer liquid. Gas temperatures in the inlets to the return flues have been found in the range of 1500° to 1850° F. whereas the metal temperatures close to the same locations would be under 500° and in some cases below 400° F. The gas in the stack would generally run no more than 200° F. higher than the metal temperatures. It was found that when the propeller pump 40 was stopped the heated surfaces would rise in temperature quite rapidly and would accordingly as rapidly be brought down in temperature once the pump was returned to use. The structure of the present invention is intended for long service of a very efficient nature. It may be easily serviced since the furnace may be removed from the shell quite readily.

Safety features are employed by the use of a pop-off pressure valve 44 and a blow-out plug 45. To accommodate any expansion in the heated transfer fluid, a line 46 communicating with the space within the shell may be connected to an expansion tank.

I claim:

1. A heating unit for heat transfer liquid subject to decomposition by application of heat, comprising: an elongated shell; a heating element secured only to one end of the shell and having a generally cylindrical fire tube and return flues cantilevered into the shell, said return flues being generally helical and wound about the fire tube; an open-ended shroud closely spaced about the fire tube and flues forming a narrow liquid passage over the fire tube and flue surfaces; a circulating pump impeller mounted in the other end of the shell and arranged to force liquid through said liquid passage at generally uniform velocity over all the heated surfaces of the fire tube and return flues, said pump impeller forcing the transfer liquid in the direction of the helical path of the return flues so as to minimize head loss in the liquid passage; and a transfer liquid inlet in the shell adjacent the pump and an outlet in the shell spaced from said inlet.

2. A heating unit for heat transfer liquid subject to decomposition by application of heat, comprising: an elongated shell; a heating element secured only to one end of the shell and having a fire tube and return flues cantilevered into the shell; an open-ended shroud sufficiently closely spaced about the fire tube and flues to form a narrow liquid passage bounded by the shroud fire tube and flue surfaces; a circulating pump impeller mounted in the other end of the shell and arranged to force liquid through said liquid passage at generally uniform velocity over all the heated surfaces of the fire tube and return flues; and a transfer liquid inlet in the shell adjacent the pump and an outlet in the shell spaced from said inlet.

3. A heating unit for heat transfer oil to be circulated through coils, lines and the like, comprising: a base; a heating shell mounted upon the base and having a transfer oil inlet and an outlet therein; a heating element secured to one end of the shell and having a portion extending into said heating shell in cantilever fashion, said heating unit including an inwardly extending fire tube and a plurality of return flues arranged about the fire tube in helical pattern for conducting flue gases out of the shell; an open-ended shroud surrounding the helical flues in sufficiently closely spaced relation thereto as to form helical passages therewith, said shroud being spaced from the shell and having a portion of diminished size about the free end of the furnace, said transfer oil inlet and outlet communicating with a space within the shell about the shroud; and a circulating pump impeller mounted in said diminished size portion of the shroud for forcing transfer oil from the space outside the shroud over the length of the furnace in the direction of the helical passages, said shroud having a portion about the flues forming an annular elongated passage for the liquid substantially unobstructed permitting relatively uniform high velocity flow over the tube and flue surfaces.

(References on following page)

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 974,166 | Maxim | Nov. 1, 1910 |
| 1,331,373 | Prache | Feb. 17, 1920 |
| 1,765,886 | Schwarz | June 24, 1930 |
| 1,791,622 | Howard | Feb. 10, 1931 |
| 1,980,424 | Morgan | Nov. 13, 1934 |
| 2,006,449 | Gallagher | July 2, 1935 |
| 2,216,809 | Derby | Oct. 8, 1940 |
| 2,263,534 | Aldridge | Nov. 18, 1941 |
| 2,291,872 | Brantly | Aug. 4, 1942 |
| 2,577,856 | Nelson | Dec. 11, 1951 |
| 2,625,915 | Glasgow et al. | Jan. 20, 1953 |
| 2,656,821 | Ray | Oct. 27, 1953 |
| 2,703,565 | Lustig | Mar. 8, 1955 |
| 2,800,307 | Putney | July 23, 1957 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 153,509 | Germany | July 26, 1904 |
| 382,971 | Great Britain | Nov. 10, 1932 |