Aug. 18, 1964 L. K. SMITH 3,144,854

LIQUID HEATER

Filed May 26, 1961

FIG. 1.

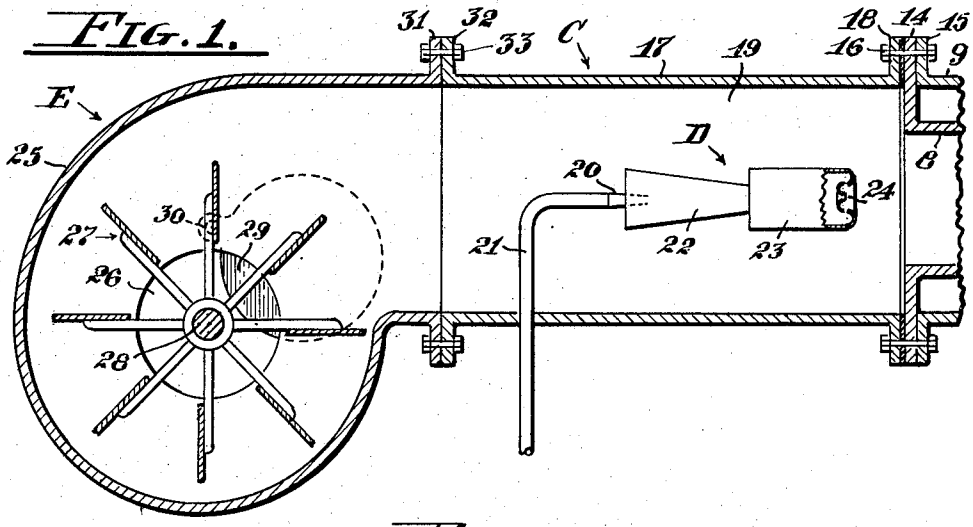


FIG. 2.

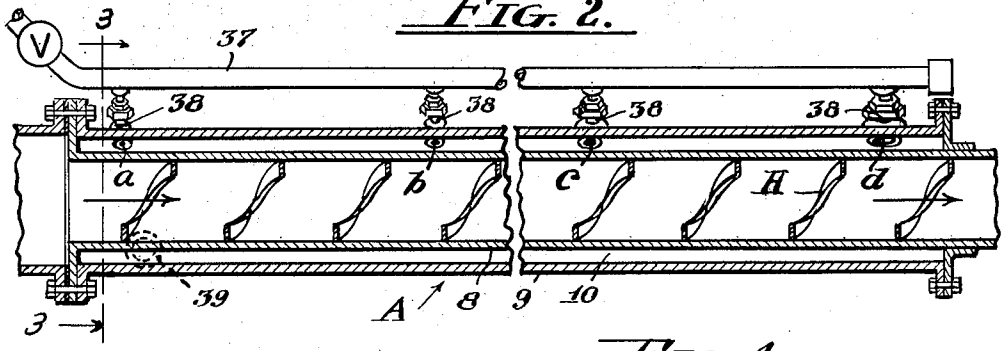


FIG. 3.

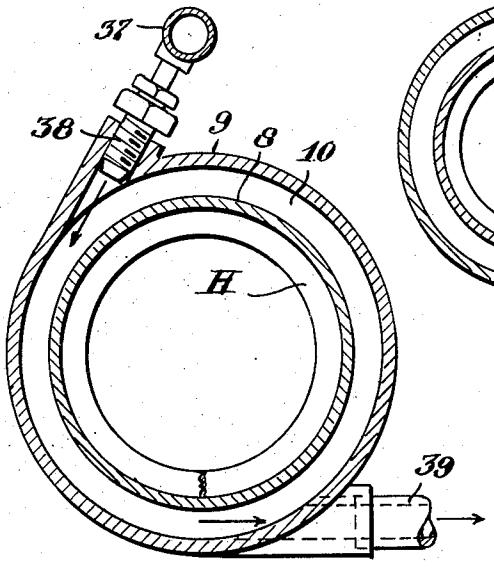
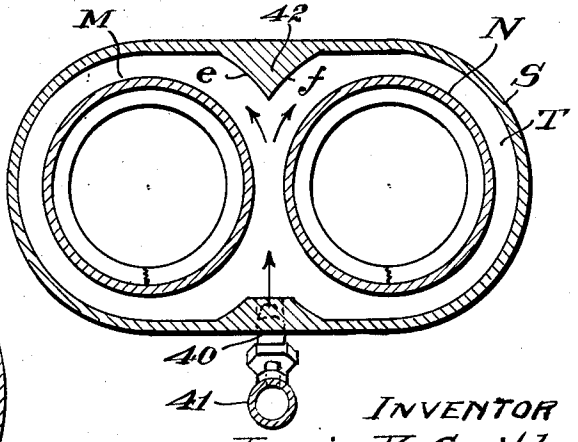


FIG. 4.



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LIQUID HEATER

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This invention relates to a liquid heater of the fire tube type in which hot gases are directed through a metallic tube to heat the latter and thereby convect heating into a flowing body of liquid surrounding the tube.

The primary object of the invention is to provide a liquid heater wherein a fire tube extends longitudinally through and is encompassed by a tubular shell through which liquid to be heated is directed along the length of the fire tube in contact with the surface thereof and wherein the shell surrounds the fire tube in spaced but close proximity thereto whereby the body of liquid flowing between the walls of the fire tube and shell may be extremely shallow, for example of a depth of one inch or less, so that the transfer of heat from the fire tube to and its absorption by the body of liquid may be rapidly accomplished.

Another object is to provide a highly effective means for creating turbulence in the body of liquid as it flows in contact with the fire tube to thereby augment heat transfer and consequently increase the efficiency of the heater, and also to provide a construction in such means as to direct the flow of the liquid in a spiral path around the perimeter of the fire tube and thereby maintain the liquid in turbulent contact with a given length of fire tube for a greater period than where caused to flow parallel with the fire tube, and further to adapt such construction to serve in conjunction with the fire tube to increase the radiation of heat therefrom.

A further object is to provide a means whereby hot gases flowing through the fire tube may be caused to move at least in part along a spiral path thereby prolonging the period of contact of such gases with the wall of the fire tube a given length, and wherein such means will serve to amplify convection of heat through the fire tube wall.

Another object is to provide a heater of the above character which is compact, highly efficient and economical in operation and maintenance, and which is of simple conctruction and thereby subject to being readily manufactured.

Another object is to provide a liquid heater which is particularly applicable for use in heating pumped liquids as in the case of heating water delivered to swimming pools, baths and the like, and in heating liquid employed in industry in the production of various products and in the generation of steam.

Another object is to provide a liquid heater embodying one or more sections or units which may be readily assembled to produce a multiple of the units of any desired number in a single heater and thereby produce a heater of a desired capacity by so doing; the capacity of the heater being varied by the employment of one or more of the units as well as in varying the size or capacity thereof.

With the foregoing objects and advantages in view together with such other objects and advantages as may subsequently appear, the invention resides in the parts and in the combination, construction and arrangement of parts set forth in the accompanying drawings and described in the following specification and called for in the annexed claim.

In the drawings:

FIG. 1 is a diagram in section showing the construction and arrangement of a blower and an associated hot gas generating element constituting a forced draft arrangement;

FIG. 2 is a view in longitudinal section of a modified form of the heat transfer element as detached;

FIG. 3 is an enlarged section as seen on the line 5—5 of FIG. 2; and

FIG. 4 is a detail in cross section illustrating the invention as applied to a multiple fire tube heater.

Referring to the drawings A indicates generally a cylindrical liquid heating unit embodying an open ended fire tube 8 encompassed by a cylindrical shell 9 disposed in spaced concentric but proximate relation thereto forming a liquid receiving chamber 10 between the tube and shell.

The ends of the fire tube 8 and shell 9 are connected together by a flange 14 on the end of the fire tube 8 overlapping the outer face of an end flange 15 on the shell 9; the flanges 14 and 15 being fastened together by bolts 16 in a usual manner. The flange 14 affords a closure for the contiguous end of the liquid conveying space 10.

In carrying out the invention one end of the unit A embodying the flange 14 is connected to the discharge end of a combustion unit C which embodies a cylindrical housing 17 having an end flange 18 connected to the assembled flanges 14–15 by the bolts 16.

The interior of the housing 17 constitutes a pressurized combustion chamber 19 in which is arranged a conventional burner D here shown as embodying a nozzle 20 on the outer end of a gas supply conduit 21 which nozzle discharges into a venturi-like intake 22 of an ordinary gas burner 23 having burner orifices 24 presented to the inner open end of the fire tube 8 as particularly shown in FIG. 3.

The outer end of the combustion chamber 19 opens to the discharge end of a blower E of conventional construction and embodying the usual housing 25 having a side air inlet 26 and enclosing a power driven rotary fan 27 fixed on a shaft 28 rotated from any suitable source of power. The air inlet 26 is fitted with an adjustable damper 29 adapted to vary the area of the inlet, which damper is here shown as comprising a plate pivoted at 30 for swinging movement across the inlet 26 in a usual manner. The discharge end of the blower housing has a marginal flange 31 which abuts a flange 32 on the outer end of the combustion unit C and is connected thereto by bolts 33. The end of the second unit A bearing the flanges 14 and 15 is connected to the lower end of an exhaust stack F with which the discharge end of the fire tube 8 communicates.

As a means for affording a high convective rate of heat transfer from the fire tube 8 the latter is equipped interiorly thereof with a continuous spiral heat conductive rib H which abuts the inner periphery of the tube and extends throughout the length thereof, the leading convolution of the rib H projecting into the path of the portion of the hot gases entering the leading end of the fire tube from the combustion chamber 19 contiguous the inner periphery of the fire tube and flowing longitudinally thereof. The spiral rib H may be of any desired width and accordingly may project from the inner surface of the fire tube to any suitable extent.

In the operation of the above described structure hot gases generated by the burner D and directed into the fire tube 8 are caused to flow therethrough by the blower E thus heating the fire tube 8 and spiral rib H. Highly efficient convection of heat from the hot gases flowing through the fire tube to the liquid flowing through the space 10 is effected by reason of the spiral rib H in the fire tube acting to divert such gases from their direction of flow longitudinally of the fire tube and to direct them along a spiral course over the inner cylindrical surface

of the fire tube as they advance lengthwise thereof, the rib H absorbing a portion of the heat from the hot gases flowing through the tube and transmitting such absorbed heat to the wall of the tube, which with the increased length of exposure of the fire tube to the hot gases afforded by the spiral movements thereof around the interior of the fire tube greatly augments heating of the liquid surrounding the fire tube.

Liquid is delivered to the space **10** from a supply pipe **37** through a series of nozzles **38** leading through the shell **9** at intervals along the length thereof, with the nozzles arranged to discharge tangentially into the cylindrical space **10** surrounding the fire tube **8**, whereby the liquid will be supplied to the space **10** in a multiple of spaced jets and will be caused to flow circumferentially of the fire tube and will also flow longitudinally thereof toward a discharge outlet **39** located adjacent the intake end of the unit; the liquid thus traversing a general spiral path around the fire tube in a state of turbulence and thereby being subject to rapid absorption of heat eminating from the fire tube.

The several nozzles **38** have their discharge outlets varying in size and progressively increasing from the nozzle of smallest dimension located adjacent the leading or intake end of the unit as indicated at *a*, *b*, *c* and *d* in FIG. 2, whereby the volumetric flow of liquid from the several nozzles will be substantially equal.

The fire tube **8** may be equipped with a spiral rib H as described with reference to the construction shown in FIG. 2.

The invention is applicable to a multiple fire tube arrangement as illustrated for example in FIG. 4 wherein a pair of fire tubes M–N corresponding to the fire tube **8** is shown as arranged in a single tubular shell S and surrounded by a liquid conveying space T in the manner described with reference to the construction shown in FIG. 2. In this instance a plurality of nozzles **40** is arranged (one of which is shown) along the length of the shell S on one side thereof with adjacent nozzles spaced at suitable distances apart; the nozzles being disposed to discharge streams of liquid from a supply conduit **41** and direct the streams between the fire tubes M–N against a deflecting rib **42** on the inner side of the shell S opposite the nozzles **40** and extending longitudinally of the shell. The rib **42** has diverging side faces *e–f* adapted to divide the stream of liquid directed thereagainst and to direct the divided streams circumferentially of the fire tubes M–N whereby the liquid will be caused to flow around the fire tubes M–N and also flow lengthwise thereof to an outlet (not shown) leading from the shell S at a suitable point adjacent an end thereof in the manner described in connection with the single fire tube arrangement shown in FIG. 2.

The inner ends of the fire tubes M–N lead from a combustion unit C and connect at their outer ends with an exhaust stack in a conventional manner.

In the operation of the invention hot gases are generated in the pressurized combustion chamber **19** by the burner D and are immediately directed into the intake end of the fire tube and force longitudinally therethrough by the blower E under velocity flow controlled by varying the speed of rotation of the fan **27** and regulating the air intake of the blower by adjusting the damper **29**. Heat from the hot gases flowing through the fire tube is transmitted through the walls of the fire tube to liquid being flowed through the narrow space surrounding the tube in the manner previously described; the liquid to be heated being flowed both circumferentially and longitudinally of the exterior of the fire tube in a shallow stream and in a state of turbulence by directing the flow of the liquid tangentially into the cylindrical space between the fire tube and its encompassing shell by the nozzles as shown in FIGS. 3 and 4.

The liquid is thus caused to traverse an extended path relative to the length of the fire tube whereby more time is allowed for absorption of heat by the liquid from the fire tube.

By the employment of the spiral or helical rib H in the fire tube the path of travel of a portion of the hot gases along the wall of the fire tube will be extended relative to the length of the fire tube whereby more time is allowed for convection of heat to the liquid traversing the fire tube than in the absence of the helical rib the presence of which thus increases the efficiency of the heater. However, in some instances the use of the rib H is not essential as in a small capacity heater, in which case the rib H may be dispensed with.

A feature of the invention resides in the provision of the heater unit A embodying assembled concentric lengths of the fire tube and its encompassing shell with the narrow liquid conducting space therebetween, with the units adapted to be assembled in multiple end to end to produce heaters of varying capacities and further resides in the provision of means for imparting turbulence to the liquid flowing through the conducting space whereby the efficiency of a heater of given capacity is materially increased.

Furthermore by the construction set forth, heaters of desired capacity may be economically constructed and by reason on conservation of heat may be economically operated.

I claim:

A liquid heater comprising an elongate cylindrical fire tube, a cylindrical shell encompassing said fire tube in concentrically spaced but proximate relation thereto forming a shallow cylindrical liquid conveying space between said fire tube and shell, said shell having a discharge outlet adjacent one end thereof, a series of liquid discharge nozzles opening through said shell to said cylindrical space tangentially thereof and arranged at spaced intervals along the length of said cylinder such as to direct a multiple of jets spirally along said space toward said outlet, and a supply pipe connected to said series of nozzles; said supply pipe having an intake end adjacent the end of said shell having the discharge outlet, and the several nozzles of the series thereof having discharge outlets progressively increasing in size from the nozzle of smallest dimension which is located adjacent the intake end of said supply pipe, whereby the volumetric flow of liquid from the several nozzles will be substantially equal.

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