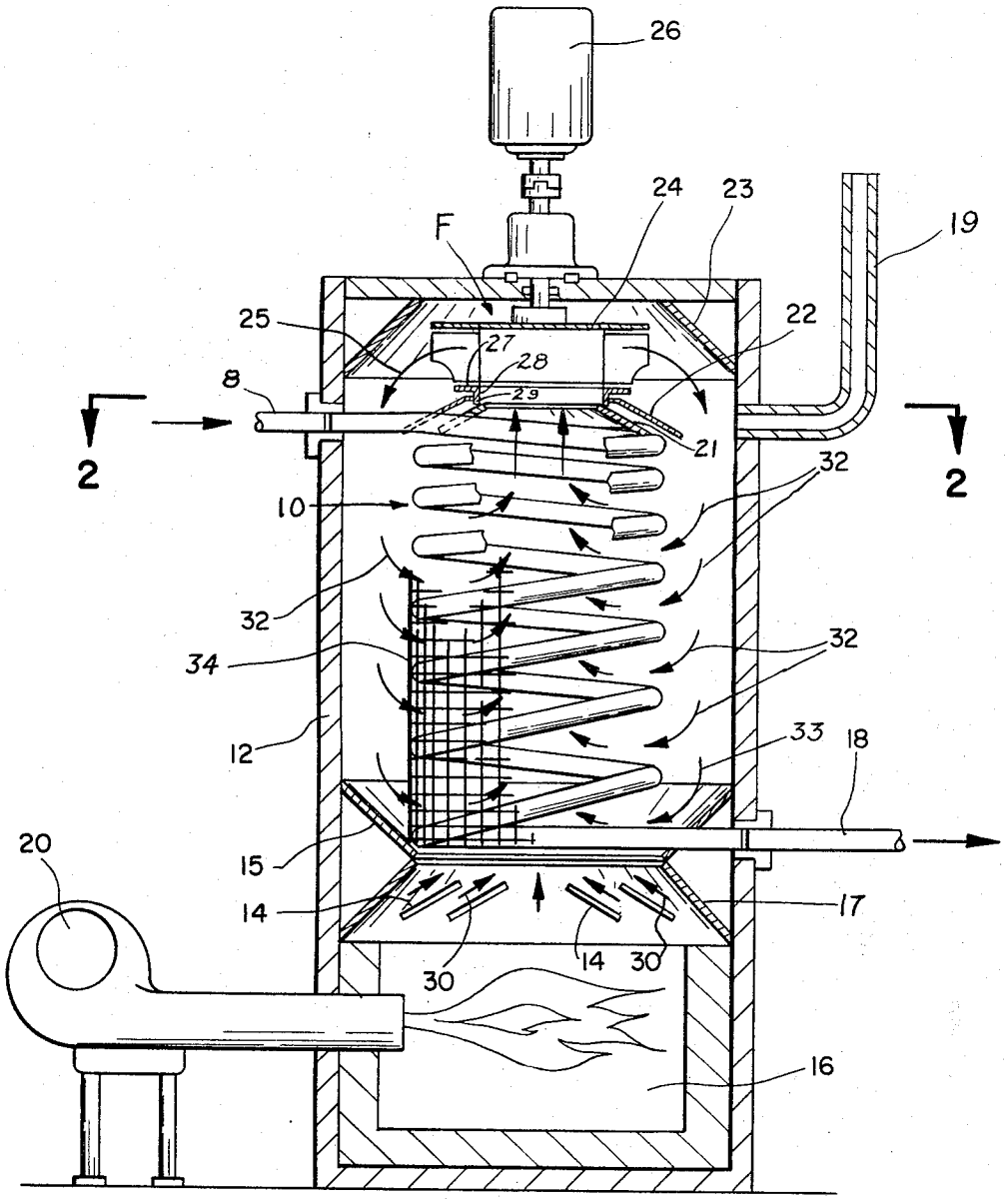
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HEATER

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INVENTOR

HENRY F. HOPE

BY Louis Mechs

ATTORNEY

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HEATER

Henry F. Hope, 195 Welsh Road,
Huntingdon Valley, Pa. 19006

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ABSTRACT OF THE DISCLOSURE

A liquid heater characterized by high speed recirculation of the combustion gases in opposite directions along the inside and outside of a coil with means for limiting the withdrawal of combustion gases to an amount substantially equal to the input of combustion gases.

This invention relates to a heater of the type used for heating water or other liquid.

One object of this invention is to produce an improved heater of the type set forth.

A heater of the type set forth includes a coil through which the liquid to be heated is passed and which is brought into contact with the hot products of combustion. In the following specification; "coil" will be used to mean a tube or other container; "water" will be used to exemplify any liquid to be heated; and "heating medium" will be used to mean products of combustion, steam, or any other source of heat.

It is well known that the rate of heat exchange varies with the temperature differential between the heating medium and the liquid to be heated; with the length of time during which the heat exchange may take place and with the velocity with which the heated gases are moved over the surface of the coil. Heat absorption is also affected by the presence, or absence, of any insulating material such as soot, or dust, on the coil, and by the phenomenon known as the Boundary Layer.

In a convection type heater, in which the only pressure used is only that needed to atomize the fuel and to supply the required combustion air, the gases move relatively slowly past the coil with the result that soot, which is a good heat insulator settles on the coil; with the result that the rate of heat transfer is reduced; with the result that the boundary layer remains undisturbed; and with the result that the gases move past the coil once only. Also, because of the absence of sufficient pressure, a relatively large flow capacity exhaust stack is needed. Experience has shown that, in such installations, the stack temperature is relatively high. High stack temperature indicates inefficient heat transfer and corresponding waste.

In order to prolong contact with the gases, it has been proposed to dispose the coil in sinuous, or zig-zag, passages, or to increase the length of the coil. There is a practical limit as to how long a coil can be made, be it sinuous or linear, and, if it is long enough for the purpose, the resistance to the flow of gases generates a back pressure which so increases the power needed to propel the gases, as to render the operation uneconomic, or nearly so. Furthermore, the back pressure slows down the flow of gases past the coil and the problem of soot deposit and of the boundary layer and of the reduced heat transfer will remain unsolved.

It is therefore a further object of the invention to produce an improved heater wherein the gases are recirculated repeatedly, over a relatively short coil, and at high velocity by a relatively small fan, and under substantially atmospheric pressure.

A still further object of the invention is to produce a construction wherein the gases being recirculated are confined within the casing which houses the coil, the fan, and the burner; wherein the exhaust stack is relatively small and is located on the pressure side of the fan; wherein the quantity of gases exhausted at any moment in time, is substantially equal to the quantity of combustion air and fuel admitted at said moment; wherein the quantity of gases exhausted at any moment in time is a very small fraction of the gases being re-circulated within the casing at said moment in time, and whereby the number of times the gases are re-circulated will be a function of the ratio of the amount exhausted to the volumetric capacity of the fan.

A still further object is to provide an improved arrangement which is compact and which is adapted to be used in heaters of various types and sizes.

The full nature of the invention will be understood from the specification and the accompanying drawing in which the single drawing is a view partly in section and partly in elevation, of a heater embodying the invention.

As can be seen from the drawing, the water to be heated is admitted through upper inlet end **8** of a coil **10** which is located within casing **12** above baffles **14** which separate the coil from the combustion chamber **16**. Adjacent baffles **14** is a conical baffle **17** which coacts with the baffles to direct the gases toward the open center of the coil as shown by arrows **30**. The heated water is conducted through lower outlet end **18** of coil **10** to the point of use. In combustion chamber **16** is a suitable source of heat, such as a gas or oil flame, to which combustion air is supplied by a motor blower **20**. Above the coil I provide spaced lower and upper baffles **21** and **22** and above these baffles I provide a suction fan F which is driven by motor **26**. Leading from the upper portion of casing **12**, preferably in the vicinity of baffles **21** and **22**, is an exhaust pipe or stack **19**.

As can be seen from FIG. 1, fan F includes a top cover or deflecting plate **24**, a bottom ring **27** having a central opening **28** and a pendent flange **29** which closes the space between the inner peripheries of the baffles **21** and **22**. Near the top of the casing is a deflector **23** which directs the gases sucked up by the fan through opening **28** downward in the direction of arrows **25**. Near the lower end of the coil is a baffle **15** which deflects the downwardly moving gases toward the center of the coil as shown by arrows **33**.

Surrounding, and preferably contacting, the coil is a heavy mesh screen **34** which extracts heat from the gases and transfers it to the coil.

The operation is as follows:

The rotation of the fan creates a negative pressure in the space defined by the coil and the air reaching the fan is thrown radially against baffle **23** which deflects the air downwardly as per arrows **25**. Baffles **21** and **22** protect the air leaving the fan from the high suction prevailing at that point so that, instead of re-entering the fan immediately, the air propelled by the fan will travel downwardly a substantial distance before it is sucked in as per arrows **32**. The flow capacity of stack **19** is such that the gases exhausted at any moment in time will be about equal to the combustion air and fuel admitted into combustion chamber **16**, whereby a substantially uniform equilibrium is maintained.

Because the fan merely draws air through the unobstructed space defined by the coil and blows it into the the unobstructed space between the coil and the casing, it can be propelled at high speed with very little power.

A working prototype has been built and successfully operated in which the volumetric capacity of the casing, exclusive of the combustion chamber was about 6 cu. ft.; the volumetric capacity of the coil was about 2.5 gal.; the fan rotated at 1850 r.p.m.; the motor was a ⅛ h.p.; the velocity of the air was about 25 ft. per minute; the volume of air circulated was about 2400 cu. ft. per minute; the apparatus was operated outdoors; the weather was cloudy,

and the temperature was 55° F. In this installation, the inlet end of the coil was connected to a source of water at about 55° F., and the outlet end of the coil was open so that the water was runnnig out continuously.

Because the gas exhausted through the stack is only such as to permit the admission of the needed combustion air, the bulk of the gas in the casing at any moment in time may be said to be re-circulated and reheated. In other words, the only heat lost is that fraction carried off by the gas escaping through the stack which, due to the repeated and rapid re-circulation, is at the relatively low temperature of about 300° F.

As above set forth, the location of the fan relative to the coil and the location of the stack and its flow capacity relative to the combustion air input and relative to the volumetric capacity of the casing are, in my opinion, responsible for the radically improved performance.

What I claim is:

1. A liquid heater including:

a casing,

an open spiral coil mounted within said casing for conducting the liquid to be heated through said casing,

the helices of said coil defining an unobstructed inner space and being spaced from, and coacting with, the wall of said casing to provide an outer space,

the helices of said coil being spaced apart to provide passages inter-connecting said inner and outer spaces,

a source of heat disposed adjacent one end of said coil for generating heated gases, and

a suction fan registering with said inner space at the other end of said coil,

whereby said heated gases are sucked by said fan through said inner space and are propelled into said outer space.

2. The liquid heater defined in claim 1 wherein said coil is vertical and the source of heat is below, and the fan is above, said coil.

3. The liquid heater defined in claim 2 and a baffle between the upper end of said coil and the suction end of said fan for isolating the suction side of said fan from the upper portion of said outer space.

4. The liquid heater defined in claim 3, and a stack connected to said casing in the vicinity of said baffle.

5. The apparatus recited in claim 3 and means for delivering combustion air at a constant rate and wherein the flow capacity of the stack is such that the gases are exhausted at said rate to maintain the pressure in said casing at substantially atmospheric level, whereby the power needed to operate said fan is reduced to that needed to overcome the inertia and friction factors.

6. The liquid heater defined in claim 3 and a screen surrounding said coil.

7. The liquid heater defined in claim 2 and a baffle obstructing the lower end of said outer space to direct downwardly flowing gases to the lower end of said inner space.

8. The liquid heater defined in claim 1 and a baffle adjacent the pressure side of the fan for directing the gases propelled by the fan downwardly in said outer space.

9. The liquid heater defined in claim 4 wherein the full capacity of the stack is a small fraction of the gases circulated in said casing.

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JAMES W. WESTHAVER, *Primary Examiner.*