May 9, 1933. E. J. HORTON 1,908,149

STORAGE TYPE FLUID HEATER

Filed Jan. 24, 1931 2 Sheets-Sheet 1

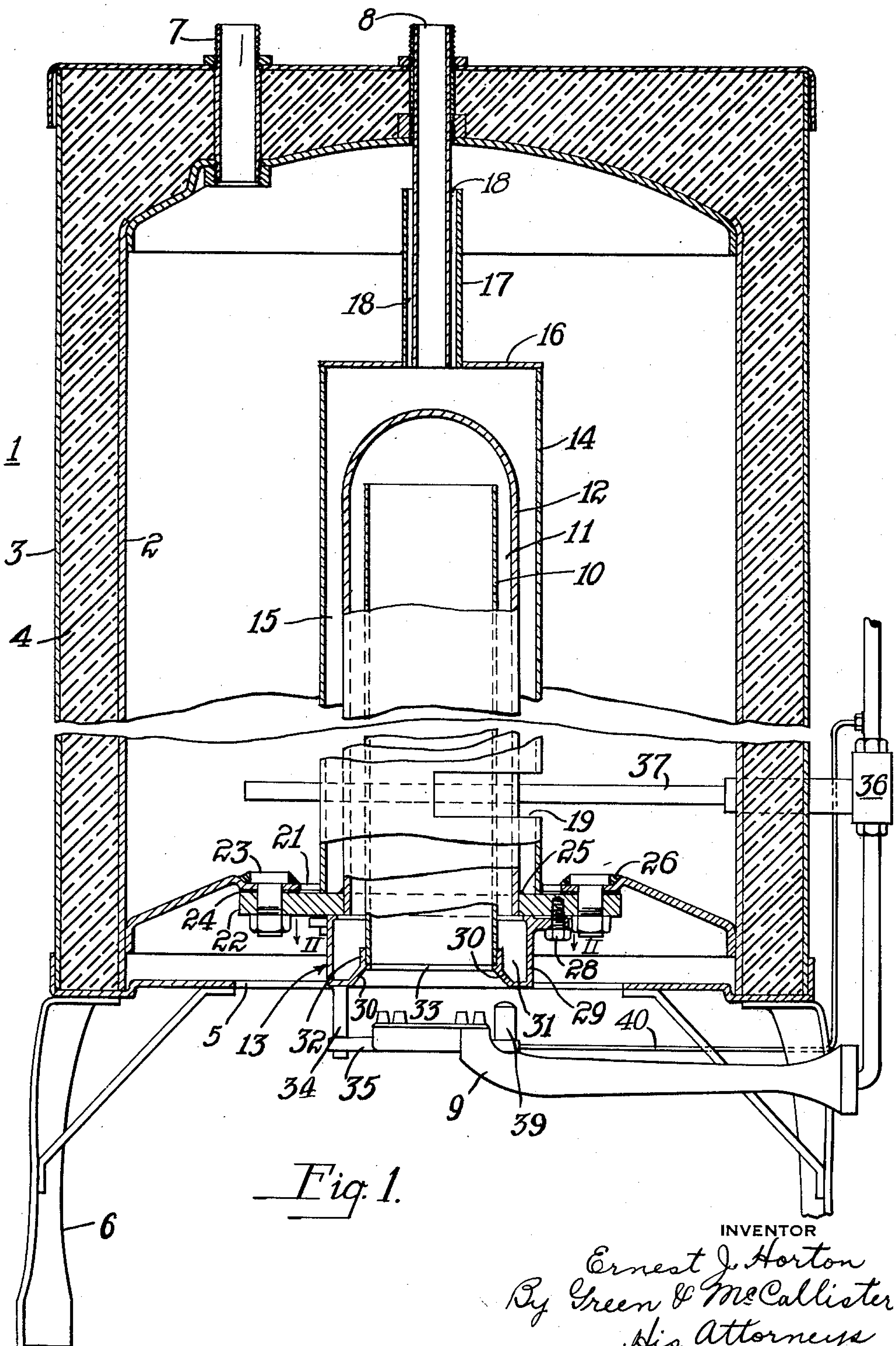

Fig. 1.

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2 Sheets-Sheet 2

Fig. 2.

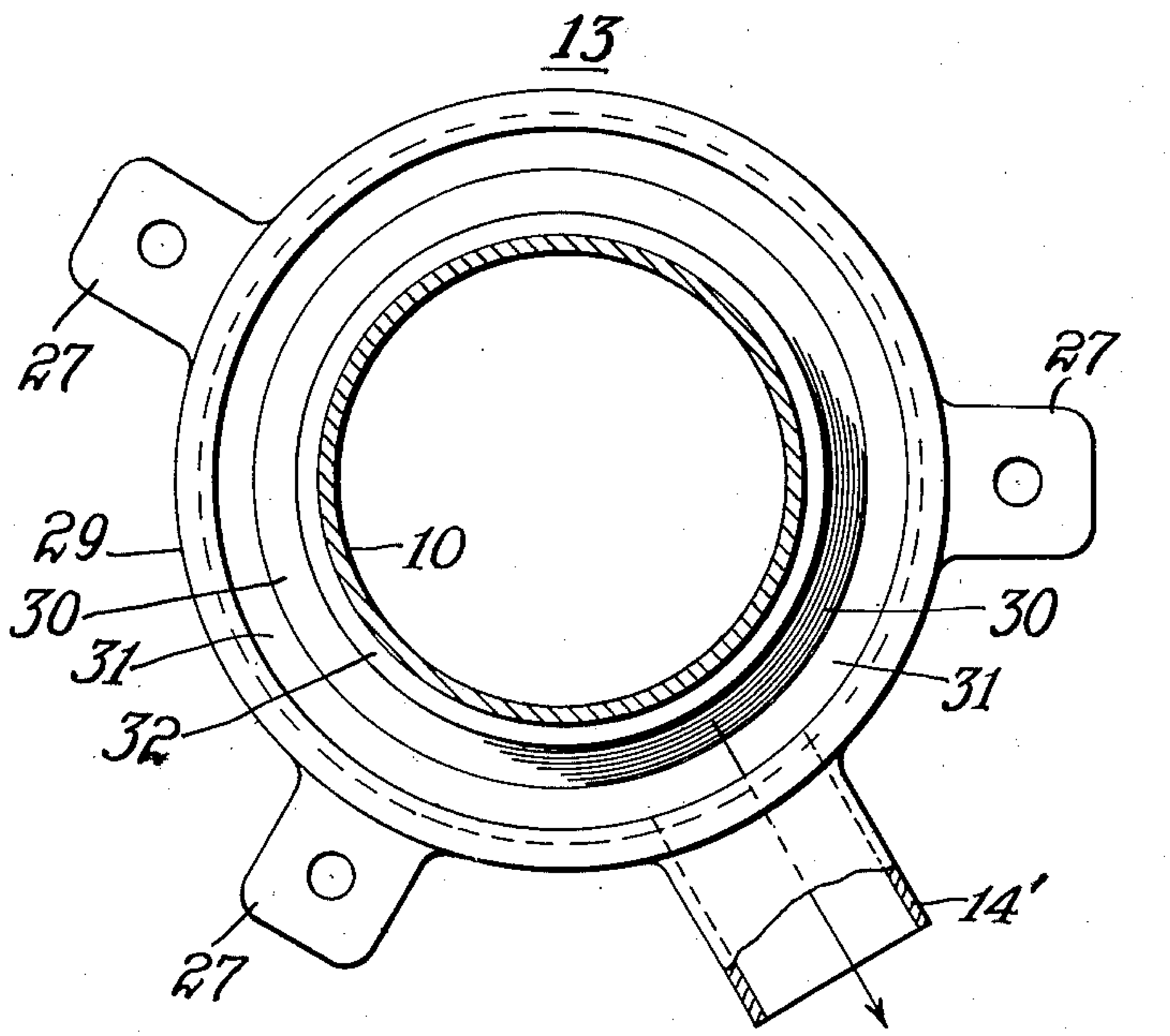
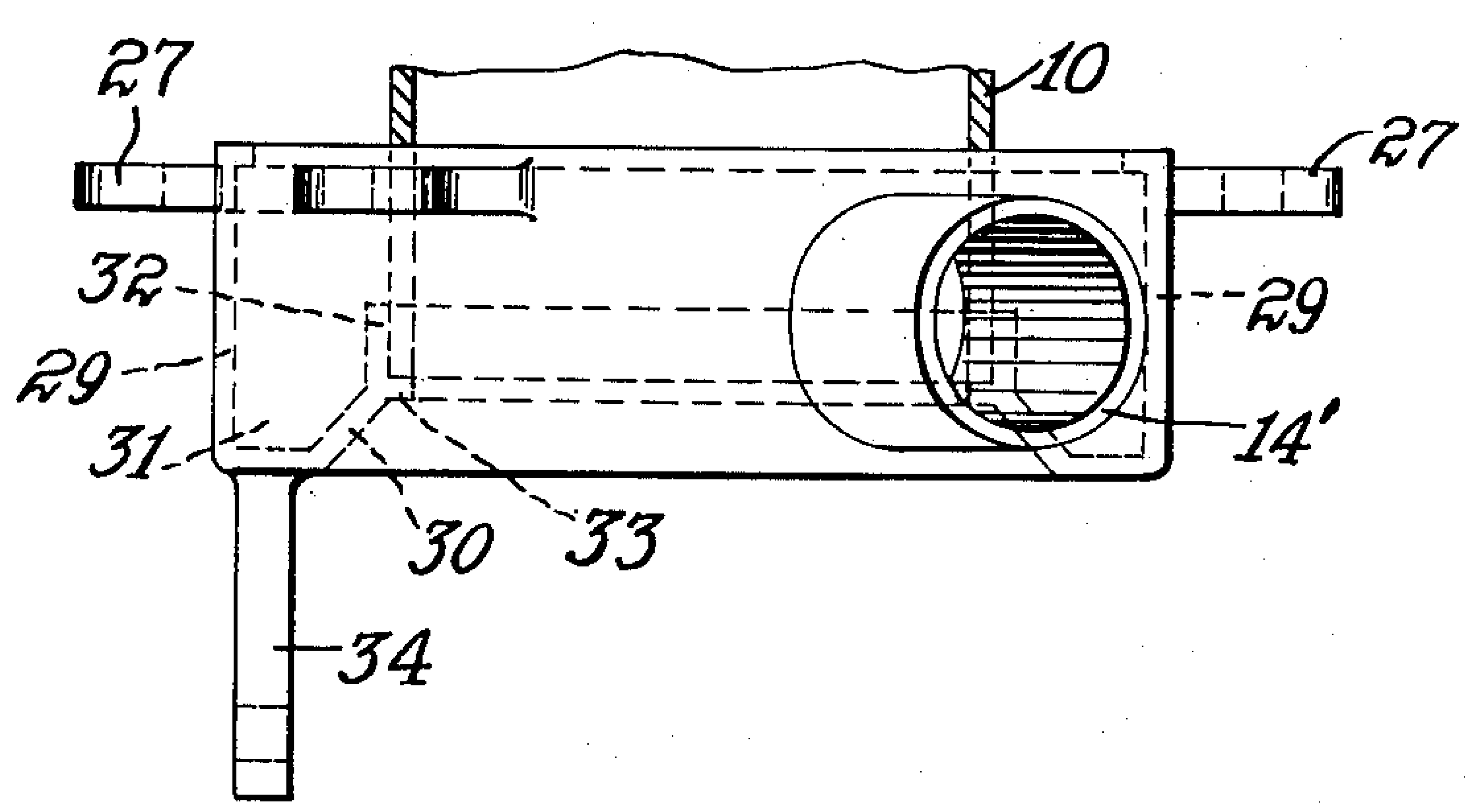


Fig. 3.



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UNITED STATES PATENT OFFICE

ERNEST J. HORTON, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO RUUD MANUFACTURING COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF NEW JERSEY

STORAGE TYPE FLUID HEATER

Application filed January 24, 1931. Serial No. 511,069.

This invention relates to heaters of fluid, water for example, and more particularly to heaters of the storage-tank type.

An object of this invention is to provide a heater of the storage-tank type that shall be simple in construction and efficient in operation.

Another object of the invention is to provide an improved arrangement for the transfer of heat to the body of fluid, water for example, to be heated.

A further object of the invention is the provision of a new method of transferring heat to a body of liquid.

A still further object of the invention is to provide for establishing a reversible cycle of heat transfer to the body of water or fluid being heated so that when hot water or fluid is being drawn from the tank, the cold water, which enters to replace the water drawn off, flows in the same direction as the flow of thermal energy utilized to heat the water or fluid; and when no water is being drawn from the tank, the water, as it becomes heated, is caused to flow in a direction opposite to that in which the thermal energy flows.

Another object of the invention is to confine a portion of the body of water or fluid to be heated within a well defined space; to provide for the admission of cold water to be heated at the top of said space and for its discharge at the bottom thereof into the body of water in the tank, when water is drawn from the hot water region of the tank; and to provide for controlling the temperature of the body of water by and in accordance with changes in the temperature of the water or fluid at the point where the cold water is discharged from said space.

Further objects of the invention will, in part, be apparent and will, in part, be obvious from the following description taken in conjunction with the accompanying drawings in which:

Figure 1 is a view in section of a heater arranged and constructed in accordance with an embodiment of the invention;

Fig. 2 is a view in section taken along line II—II of Fig. 1; and

Fig. 3 is a view in side elevation, partly in section, of the detail shown in Fig. 2.

Throughout the drawings and specification like reference characters indicate like parts.

In Fig. 1 of the drawings a water heater, designated generally by the reference character 1, is shown that comprises a tank 2 enclosed within a shell 3 between which thermal insulation 4 is confined. The tank and shell may be mounted on a platform 5 supported by legs 6.

The tank of a heater, of the type herein disclosed, when in use, is filled with water and the water or fluid as it is heated rises to the top into the hot water region thereof. Hot water is drawn from this region of the tank through an outlet pipe 7. As hot water is drawn off cold water enters the tank to replace that which has been drawn off through pipe 7. In the present case cold water enters through a pipe 8 extending through the top of the tank.

The heater shown in the drawings is of the type in which a flame, preferably a gas flame, is used to heat the water and for this purpose a burner 9 is provided. When burner 9 is lighted, hot gases rise upwardly through a flue or tube 10 and then downwardly through a space 11 in heat exchanging relation with a heat transferring element 12 through which the thermal energy of the gases is given up to the water or fluid in which element 12 is immersed. The gases flowing downwardly through space 11 may be collected in a box 13 and discharged therefrom through a tubular member 14′ formed as an integral part of the box. The tubular portion 14′ may be connected to a flue (not shown) whereby the gases may be conveyed to a stack or chimney (not shown).

As illustrated in Fig. 1, heat transferring element 12 is of tubular form, closed at its upper end and open at its lower end. The shape and construction of element 12 may take various forms, several modifications thereof being shown and described in my copending application for United States Letters Patent, Serial No. 483,428, filed September 22, 1930, and assigned to Ruud Manufacturing Company, a corporation of New Jersey.

In order that a portion of the body of water or fluid in tank 2 may be segregated and confined within a well defined space about the heat transferring element 12, a sleeve 14 is provided. Sleeve 14 is preferably co-axial with member 12 and the flue 10, so as to provide a uniform space or passageway 15 entirely surrounding the heat transferring member 12. The top of sleeve or cylinder 14 is closed as at 16. Closure 16 is apertured to receive a sleeve or tube 17 co-axial with inlet pipe 8 and through which pipe 8 passes, the sleeve and tube having a space 18 therebetween. Sleeve or tube 17 may be of such length that its upper end terminates near to the top of the tank. As shown in Fig. 1, the discharge end of inlet pipe 8 is located at the upper end of sleeve 14, and at the lowermost end of sleeve 17.

In order that water or liquid may flow in either direction through space 15 between heat transferring element 12 and sleeve 14, an opening or port 19 is provided in the sleeve near its lower end and within the cold water or cold liquid region of the tank.

To provide for the removal of flue 10, the heat transferring element 12 and the sleeve 14 through the bottom of the tank, an opening 21 is formed in the tank bottom. A plate 22 of larger diameter than opening 21 may be secured to the tank bottom by means of bolts 23, packing 24 being interposed between the tank bottom and the plate to provide a fluid-tight joint. Plate 22 may be provided with an opening large enough to accommodate the open end of heat transferring element 12, the plate and element 12 being welded as at 25 so as to form an integral structure and also to provide a fluid-tight joint therebetween. In practice the heads of bolts 23 may be welded to the tank bottom as at 26.

Plate 22 carries sleeve 14, heat transferring element 12 and flue 10.

As illustrated in Fig. 1, box 13 is of ring-like shape or construction and is provided with ears or lugs 27, screws 28 passing through the ears or lugs and having screw thread engagement with the plate, the plate 22 being tapped to accommodate the screws, may be employed to secure the box to plate 22.

Box 13 is illustrated more fully in Figs. 2 and 3 of the drawings. The box comprises an outer wall 29 and an inner wall 30 spaced therefrom to form an annular trough 31 therebetween. Trough 31, as shown in Fig. 1, is closed at the bottom and open at the top. Inner wall 30 has an upstanding annular flange 32, for accommodating the lower end of flue 10 and an annular ledge 33 upon which the lower end of the flue is supported. When the flue is mounted in place, as shown in Fig. 1, the hot gases flowing downwardly through space 11 are collected in trough 31 and discharged through tube 14′.

In order that the burner 9 may be supported under flue 10, box 13 is provided with a depending bracket 34 upon which a finger 35 of burner 9 may rest.

Economy in the consumption of fuel utilized to heat the water or fluid in tank 2 may be effected by employing a thermostatically operated valve 36 for turning on and shutting off the supply of gas or fuel to burner 9 in accordance with predetermined variations in temperature in the water or fluid. As illustrated, a thermal element 37, associated with valve 36, extends through the tank and into the body of water or fluid therein. The thermal element is preferably located near the lower end of the tank at a point or level adjacent to opening or port 19 in sleeve 14, and adjusted to control valve 36 in such a manner that the water at the top of the tank will be regulated or controlled at some predetermined value. To insure that burner 9 will be lighted each time the gas or fuel is turned on, a pilot burner 39 may be employed, gas being supplied through a pipe 40 connected to the fuel supply line at a point ahead of valve 36.

In the operation of the heater shown in Fig. 1, the pipe 8 is connected to the usual water service line and the tank filled with water. Burner 9 is then lighted. If no water is drawn from the hot water region of the tank through pipe 7, the temperature of the body of the water in the tank will be raised until the thermostatic valve 36 operates to shut off the fuel or gas to burner 9.

When no water is being drawn from the hot water region of the tank and burner 9 is burning, the hot gases developed rise upwardly through flue 10 to the closed upper end of heat transferring element 12. The gases while moving upwardly through flue 10 are out of thermal communication with the water in space 15 between sleeve 14 and heat transferring element 12. When the gases reach the upper closed end of heat transferring member 12, they are directed into space 11 between flue 10 and element 12 and are caused to flow downwardly in this space into trough 31 of box 12. As the hot gases flow downwardly through space 11, the thermal energy contained therein is transferred or conducted through element 12 into the water or fluid filling space 15. The water, as it is heated, rises within sleeve 14, flows through the space 18 between pipe 8 and tube 17 and is discharged into the hot water region of the tank. The water or fluid which rises into the hot water region of the tank from space 15, is replaced by water flowing, from the body of the water in the tank, through opening or port 19 near the lower end of sleeve 14.

It will be apparent from the above, that when no water is being drawn from the hot water region of the tank through pipe 7, the water in space 15 as it becomes heated flows upwardly in the opposite direction to that in which the hot gases are flowing in space 11 between flue 10 and heat transferring element 12. Therefore the hottest water in space 15 is in thermal communication with the hottest gases and the coolest water in this space is in thermal communication with the coolest gases. A maximum transfer of the thermal energy, in the gases, to the water or fluid in space 15 is therefore assured. When the body of water in the tank has been heated to a temperature of a predetermined value, thermal element 37 responds and operates to close valve 36 thereby shutting off the supply of fuel or gas to burner 9. When the body of water in the tank has cooled to a predetermined temperature, the thermal element 37 operates to open valve 36 and thereby turn on the fuel or gas at the burner 9.

When hot water is drawn from the tank through pipe 7 cold water enters through pipe 8 to replace the quantity of water drawn off. The water entering through pipe 8 is discharged into the upper end of sleeve 14 forcing the hot water in space 15 downwardly and out through opening or port 19 into the body of water in the tank. If at the time hot water is drawn from the tank through pipe 7, the gas or fuel has been shut off to burner 9, valve 36 will remain closed until all of the hot water in space 15 has been discharged through port 19. However, as soon as all of the water in space 15 has been discharged into the body of water in the tank, cold water or relatively cool water will be discharged through port 19 thereby quickly cooling thermal element 37 and causing it to open valve 36 to turn on the fuel or gas to burner 9. Therefore, it will be apparent that all of the heat stored in heat transferring member or element 12 will be given up to the cold water flowing downwardly in space 15 before the thermal element 37 operates to open the valve and turn on the fuel or gas at burner 9.

If, however, hot water is being drawn from the tank through pipe 7, while burner 9 is burning, the thermal energy of the gases developed at the burner will be transferred through element 12 into the water in space 15, as aforesaid. However, the water which is being heated, like the cold water entering through the pipe 8, flows downwardly in the same direction through the space 15. Therefore, the water which is being heated, while hot water is being drawn from the hot water region of the tank, through pipe 7, will be discharged into the body of the water in the tank through port 19 in sleeve 14. As soon as the demand for hot water ceases, the flow of cold water into the tank ceases also. The direction in which the heated water circulates therefore reverses. In this case when no water is flowing into the tank through pipe 8, but while burner 9 is burning, the water as it becomes heated will rise upwardly through space 15 and the space or port 18 between pipe 8 and tube 17 and be discharged into the hot water region of the tank. The cooler water to be heated enters through port 19 into the space 15. As soon as the body of the water in the tank reaches a predetermined temperature, the valve 36 is closed and the fuel supply to burner 9 is shut off.

Valve 36 will remain closed to shut off the supply of fuel to burner 9 either until the entire body of water in the tank has cooled to a temperature at which thermal element 37 responds to open valve 36, or, in case hot water is drawn from the hot water region of the tank, until cold water flowing downwardly through space 15 is being discharged through port 19 so as to produce a rapid cooling effect upon thermal element 37.

From the aforesaid, it will be apparent that the thermal energy contained in the gases rising from burner 9 are transferred to element 12 to heat it. Because of the direction of flow of the hot gases along element 12, the temperature of this element will be the hottest where the water is hottest and the coolest where the water is coolest. Therefore, a relatively high temperature differential is maintained between element 12 and the water surrounding it throughout its entire length so that a maximum of thermal energy is transferred into the water.

It will also be apparent from the aforesaid, that while no water is being drawn from the hot water region of the tank, the water being heated in space 15 will flow in the opposite direction to that in which the hot gases are flowing in space 11. Since the water is caused to circulate in this manner, when no water is being drawn from the tank, thermal element 37 will respond to shut off the supply of fuel to the burner, when the body of water in the tank has been heated to a predetermined temperature. Choosing the proper temperature at which valve 36 is to be closed, the temperature of the water in the hot water region of the tank may be limited to a value below the boiling point of water thereby precluding the formation of steam in the tank.

It will also be apparent from the aforesaid that, when hot water is being drawn from the hot water region of the tank, the cold water entering through pipe 8 will flow downwardly through space 15 and along heat transferring element 12 thereby forcing out all of the hot water in space 15 through port 19 into the body of water in the tank. The thermal element 37 will, therefore, be maintained at a relatively high temperature, thereby precluding the opening of valve 36 until all of the available hot water in space 15 has been utilized. By causing the entering cold water to flow downwardly into space 15, forcing the hot water ahead of it through port 19, all of the stored thermal energy in element 12 will be given up to the entering cold water before thermal element 37 is cooled to a value at which it operates to open valve 36. As stated hereinbefore, thermal element 37 will operate to open valve 36 as soon as cold water from space 15 is being discharged through port 19. When cold water is being discharged through port 19, thermal element 37 is cooled quickly thereby causing valve 36 to open and turn on the supply of fuel to the burner.

With the above form of construction it is possible to obtain the maximum thermal efficiency, which is a factor of quite importance in regard to water heaters of the storage tank type. It is, therefore, possible to utilize a small burner, that is one which consumes a relatively small amount of fuel per hour or per unit of time.

An important result obtained by the type of heater herein disclosed, is attributable to the flushing action that takes place when cold water enters sleeve 14 and is caused to flow downwardly through space 15. The flushing action prevents or deters the formation of deposits, such as mud and compounds of calcium, magnesium, etc., upon the heating surface of element 12 over which the water or liquid flows. The heater is therefore operable at a high efficiency over a longer period of time than would be the case if the flushing action was not available during normal operation of the heater.

While various modifications and changes may be made in the heater arrangement herein shown and described, without departing from the spirit and the scope of the invention, it is to be understood that only such limitations shall be placed on the invention as are imposed by the prior art and the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In combination, a tank having an outlet for heated liquid and an inlet for liquid to be heated, a heat transferring member in said tank, and means having a liquid space for causing incoming liquid to flow in one direction over said member, when liquid is being drawn off at the outlet, and for causing liquid from the body of liquid in the liquid space to flow through said space and over said heat transferring member in the opposite direction when no liquid is being drawn off at the outlet.

2. In combination, a tank having hot and cold liquid regions, a heat transferring element immersed in said tank and extending from the cold liquid region into the hot liquid region therein, means providing a space between the surface of said element and the body of liquid in the tank, said space having communication with the hot and cold liquid regions, and means for causing incoming liquid to said tank to flow downwardly through said space.

3. In combination, a tank having hot and cold liquid regions, a heat transferring element immersed in said tank and extending from the cold liquid region into the hot liquid region therein, means providing a space between the surface of said element and the body of liquid in the tank, said space having communication with the hot and cold liquid regions, means for causing the incoming liquid to said tank to flow downwardly through said space, means for heating the heat transferring element, and means responsive to the temperature of the liquid, at the point where the space about said heat transferring element communicates with the cold liquid region of the tank, for controlling the source of heat.

4. In combination, a tank having hot and cold liquid regions, a heat transferring element immersed in said tank and extending from the cold liquid region into the hot liquid region therein, a sleeve disposed about said element, said sleeve having communication with the hot and cold liquid regions, and means for causing the incoming liquid to the tank to flow downwardly through said sleeve and over said element.

5. In combination, a tank having hot and cold liquid regions, a heat transferring element immersed in said tank, said element extending from the cold liquid region into the hot liquid region therein, a sleeve disposed about said element and having communication with the hot and cold liquid regions, means for causing the incoming liquid to the tank to flow downwardly through said sleeve and over said element, means for heating the heat transferring element, and means responsive to the temperature of the liquid at the point in said tank where the incoming liquid is discharged from the sleeve into the body of liquid, for controlling the source of heat.

6. In combination, a tank having hot and cold water regions, a heat transferring element extending upwardly into the tank from bottom thereof, means for passing hot gases over said element at the top thereof and downwardly therealong in heat exchanging relation therewith, a sleeve surrounding said heat transfer element, said sleeve having a discharge pipe at its top of a diameter smaller than said sleeve and a discharge opening near its bottom, said discharge pipe terminating in the hot water region, and a cold water inlet pipe extending into said tank and downwardly through the discharge pipe in spaced relation therethrough and terminating at the top of said sleeve.

7. In combination, a tank having hot and

cold water regions, a heat transferring element extending upwardly into the tank from bottom thereof, means for delivering hot gases to the top of said element and directing the same downwardly thereover in heat exchanging relation therewith, a sleeve surrounding said heat transfer element, said sleeve having a discharge pipe at its top and a discharge opening near its bottom, said pipe terminating in the hot water region of the tank, a cold water inlet pipe extending into said tank and downwardly through the discharge pipe at said top of said sleeve and terminating at the top of the sleeve, and a thermostat having its thermal element extending into the tank and located near the bottom discharge opening of said sleeve for controlling the flow of hot gases.

8. In combination, a tank, a heat transferring member extending upwardly into the tank from its bottom, a sleeve surrounding said heat transferring element and having a discharge opening at the top and a discharge opening near the bottom thereof, and means for causing cold water to flow downwardly through said sleeve in contact with said heat transferring element and through said bottom opening when hot water is withdrawn from the tank.

9. In combination, a tank having hot and cold liquid regions, a heat transferring element extending upwardly into the tank, a sleeve surrounding said element, said sleeve having discharge openings in the hot and cold water regions respectively of the tank, and a cold water pipe entering through the top of the tank and discharging into said sleeve at the top thereof.

10. In combination, a tank having hot and cold liquid regions, a heat transferring element extending upwardly into the tank, a sleeve surrounding said element, said sleeve having discharge openings in the hot and cold water regions of the tank, a cold water pipe entering through the top of the tank and discharging into said sleeve at the top thereof, a source of heat for heating said heat transferring element, and a thermostatic element located in the cold water region of the tank for controlling said source of heat.

11. A heater comprising a tank having an opening in the bottom thereof, a plate secured to the tank bottom and partially closing said tank bottom opening, said plate having an opening therein, a tube having a closed end and an open end, extending upwardly into said tank with its closed end uppermost and its open end disposed in the opening in said plate and sealed thereto to provide a fluid-tight joint therebetween, a sleeve disposed about said tube in spaced relation thereto, said sleeve having communication with the upper and lowermost regions of said tank, a liquid inlet pipe arranged to discharge fluid into the uppermost end of said sleeve, and means for heating said tube from its upper end and then downwardly to its lower end.

12. A heater comprising a tank having an opening in the bottom thereof, a plate secured to the tank bottom and partially closing said tank bottom opening, said plate having an opening therein, a tube having a closed end and an open end, extending upwardly into said tank with its closed end uppermost and its open end disposed in the opening in said plate and sealed thereto to provide a fluid-tight joint therebetween, a sleeve disposed about said tube in spaced relation thereto, said sleeve having communication with the uppermost and lowermost regions of said tank, an inlet pipe arranged to discharge liquid into the uppermost end of said sleeve, a flue extending upwardly into said tube in spaced relation thereto, said flue being open at both ends and having its upper end near to the closed end of said tube and a burner disposed under the lowermost end of said flue, the hot gases from said burner rising upwardly through the flue and then downwardly through the space between the tube and flue and discharging at the lowermost ends thereof.

13. A heater comprising a tank having an opening in the bottom thereof, a plate secured to the tank bottom and partially closing said tank bottom opening, said plate having an opening therein, a tube having a closed end and an open end, extending upwardly into said tank with its closed end uppermost and its open end disposed in the opening in said plate and sealed thereto to provide a fluid-tight joint therebetween, a sleeve disposed about said tube in spaced relation thereto, said sleeve having communication with the uppermost and lowermost regions of said tank, an inlet pipe arranged to discharge liquid into the uppermost end of said sleeve, and means for heating said tube from its upper end and then downwardly to its lower end including a flue extending upwardly into said tube in spaced relation thereto, said flue being open at both ends and having its upper end near to the closed end of said tube, a burner disposed under the lowermost end of said flue, the hot gases from said burner rising upwardly through the flue and then downwardly through the space between the tube and flue and discharging at the lowermost ends thereof, and means collecting the gases discharging from said space at the lowermost ends of said tube and flue for discharge to the atmosphere.

In testimony whereof, I have hereunto subscribed my name this 22nd day of January, 1931.

ERNEST J. HORTON.