Aug. 1, 1944. J. P. WALKER ET AL 2,354,932

HEATING APPARATUS

Filed April 7, 1941 2 Sheets-Sheet 1

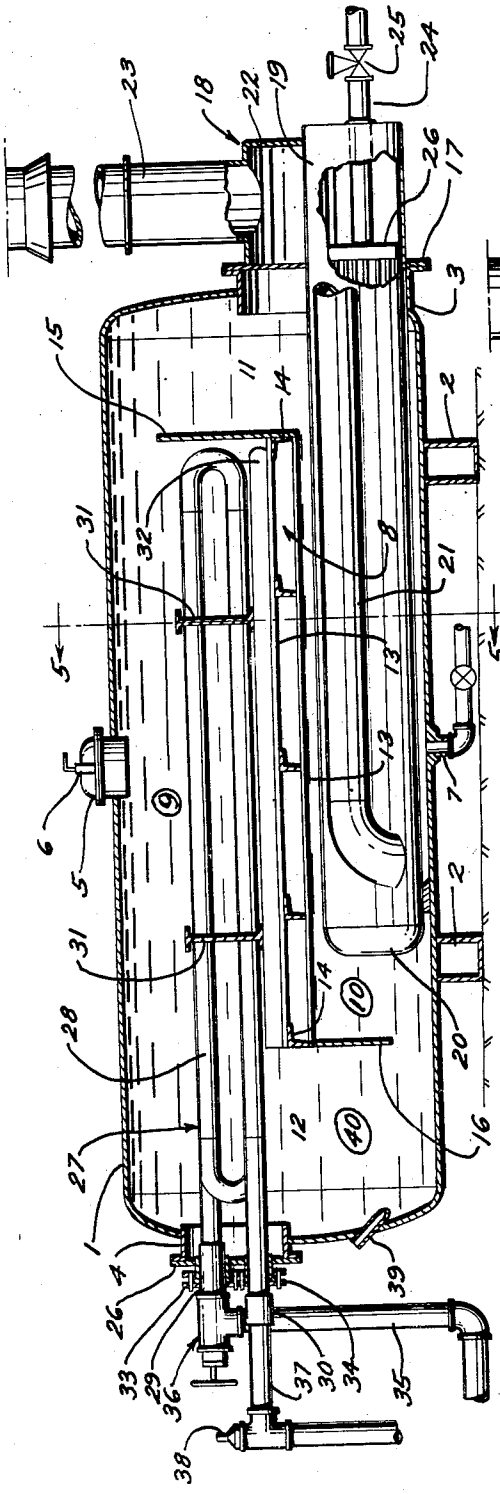


Fig. 1

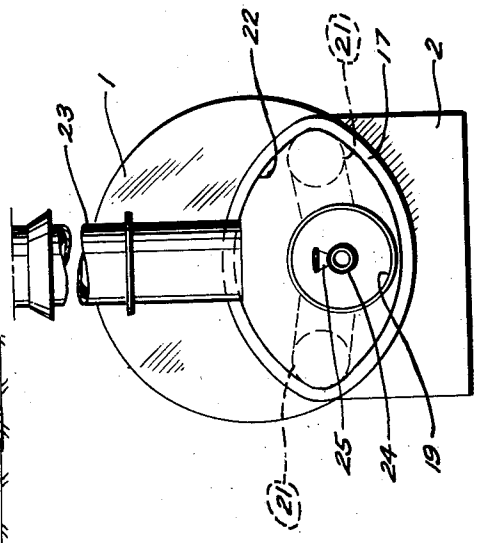


Fig. 3

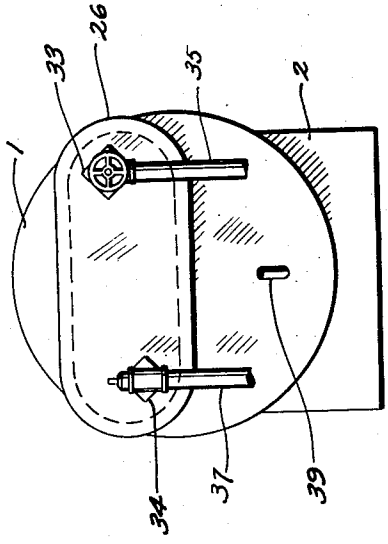


Fig. 2

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HEATING APPARATUS

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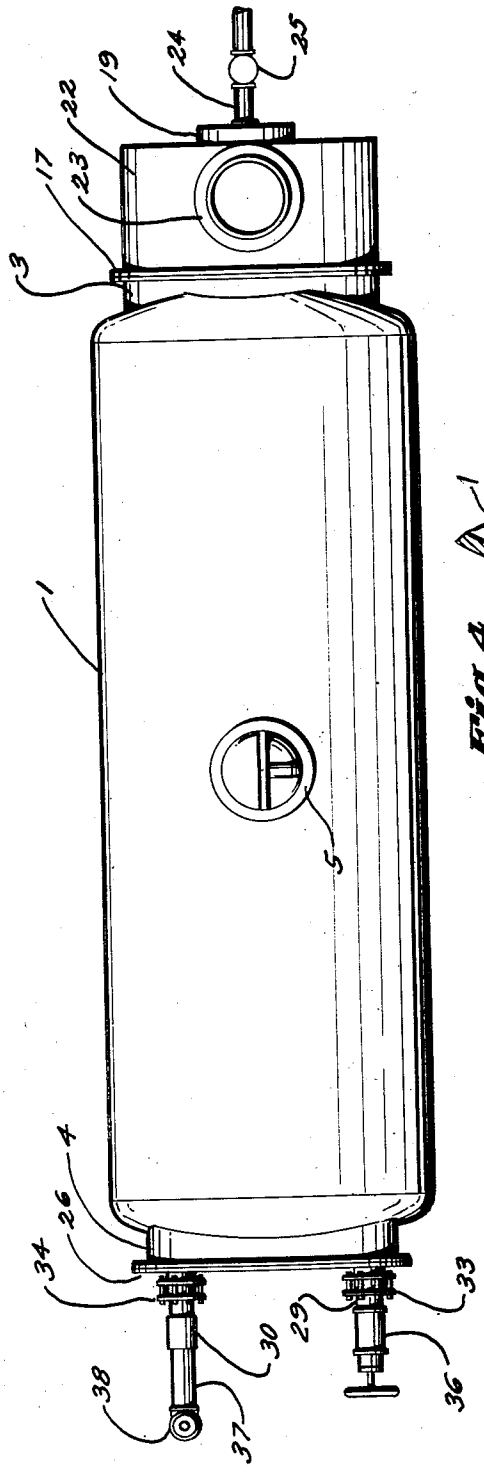


Fig. 5

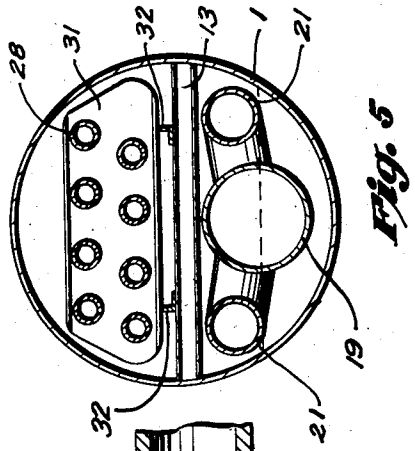


Fig. 4

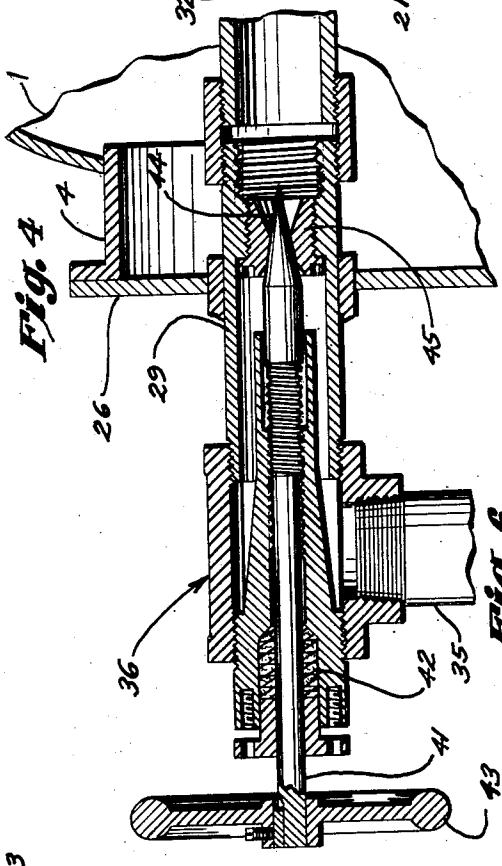


Fig. 6

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HEATING APPARATUS

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17 Claims. (Cl. 62—1)

This invention relates to apparatus for heating gases and liquids, and particularly to indirect heaters of the type employing a liquid heat transfer medium for conveying heat from a heat-supplying element to a heat-absorbing element, both of which are submerged in said medium.

Heaters of the type herein contemplated are useful particularly for the heating of various fluids such as oil, gas, water and the like to various temperatures at high or low pressures, and at a relatively high heat transfer efficiency.

In the production and handling of oil and gas, particularly, heating of these fluids is often required for a variety of purposes. In the case of oil, such purposes may include removal of suspended and emulsified water, reduction in viscosity, prevention of paraffin precipitation, etc., and in the case of gases, particularly high pressure moisture-containing gases, heating of the gas is often required for preventing the formation of solid hydrocarbon hydrates in the containing pipes and vessels, due to the low temperatures resulting from the reduction in pressure from high to low pressures.

In many of the more conventional heaters heretofore employed for these and kindred purposes, local over-heating and corrosion of the tubes, tanks, etc., in which the fluids are contained, often result from the direct application thereto of flames and high temperature combustion gases used for heating the fluids. In other cases, the heaters are relatively inefficient heat transfer devices and are, therefore, relatively expensive to construct and operate.

It is, therefore, a primary object of this invention to provide a relatively simple and efficient heater for heating the aforementioned fluids in a manner to avoid the various difficulties commonly encountered with more conventional heaters.

It is an important object of this invention to provide a heater of the type employing a liquid heat transfer medium and having novel features of construction whereby circulation of the medium is effected thermo-syphonically at comparatively high velocity and heat transfer efficiencies throughout the heater.

Another important object of this invention is the provision of a heater of the character described which is particularly adapted for heating high pressure gases while they are undergoing expansion to lower pressures to prevent formation of hydrates.

Other and more specific objects and advantages of this invention will become apparent from the following detailed description when read in conjunction with the accompanying drawings, which illustrate a heater in accordance with one embodiment of this invention. It will be understood, however, that this invention is not limited to any particular form of apparatus, but that various changes may be made in details but within the scope of the appended claims, without departing from the spirit of this invention.

In the drawings:

Fig. 1 is a longitudinal sectional view of a heater in accordance with one embodiment of this invention,

Figs. 2 and 3 are opposite end elevations thereof,

Fig. 4 is a top view of the heater of Fig. 1,

Fig. 5 is a cross-section taken along line 5—5 of Fig. 1, and

Fig. 6 is an enlarged fragmentary view of a detail of the apparatus.

Referring to the drawings, the heating device there illustrated includes an elongated cylindrical shell or tank 1, preferably horizontally positioned on suitable spaced support members 2—2. At one end the tank 1 is provided with an enlarged flanged manway 3 communicating with the lower portion of the tank, and at the opposite end with a second enlarged manway 4 communicating with the upper portion of the tank. The top of the tank is provided with a small vapor dome 5, into which is connected a more or less conventional type of combination pressure and vacuum relief valve 6. A valved filling and pump-out connection 7 is provided in the bottom of the tank.

A partitioning member, designated generally by the numeral 8, extends longitudinally and transversely through the interior of tank 1 and makes substantially liquid-tight connection along its side edges with the side walls of the tank. The partitioning member thus divides the tank into upper and lower compartments 9 and 10, respectively, and its longitudinal dimension is made less than that of the tank, whereby the ends of the partitioning member may be spaced from the adjacent ends of the tank to thereby provide longitudinally spaced, upright passageways 11 and 12, respectively, providing communication between the compartments at the opposite ends thereof. In the form shown in the drawings, partitioning member 8 is constructed of spaced parallel metal plates 13—13, separated by angle irons 14—14, which also serve to close the ends of the member. Since, as previously noted, the side edges of member 8 make liquid-tight connection with the side walls of the tank, and the ends are closed, as noted, by angles 14—14, the space between the plates becomes substantially a dead air space

which is thermally non-conducting, a feature which contributes importantly to the efficient functioning of the device, in preventing substantial transfer of heat directly from one compartment to the other through the partition. Instead of employing a partitioning member having a dead air space of the form described, it will be evident that a partitioning member constructed of any suitable thermally non-conducting material may be substituted therefor with similar advantages.

Attached to one end of partition member 8 is a baffle plate 15 which extends vertically into compartment 9 to a point spaced from the top of tank 1 and transversely thereof into substantially fluid-tight engagement with the sides of the tank. A similar baffle plate 16 is similarly attached to the opposite end of the partitioning member 8 and to the sides of the tank, but extends downwardly into compartment 10 to a point spaced from the bottom of the tank. Plates 15 and 16 operate to further define said passageways 11 and 12 and function as weirs to restrict the inlet and outlet areas of these passageways.

Manway 3 is provided with a removable cover plate 17 in which is mounted an elongated heating unit, designated generally by the numeral 18. The heating unit 18 comprises an elongated cylindrical fire tube 19 which is adapted to be inserted longitudinally into compartment 10 through manway 3 to a point adjacent but spaced from baffle plate 16. The inner end of fire tube 19 is closed by a head 20, and a pair of flue gas ducts 21—21 connect into opposite sides of fire tube 19 adjacent its inner end, return generally parallel to the fire tube through compartment 10, and emerge through cover plate 17 to discharge into a smoke box 22 which surrounds the outer end of the fire tube. A smoke stack 23 communicates with the top of the fire box. A fuel supply pipe 24, provided with a fuel control valve 25, extends into the outer end of fire tube 19 and connects to a burner head 26, which is so positioned in the fire tube as to direct flames and hot gases of combustion generated thereby through the fire tube, the gases of combustion then passing through ducts 21—21 to smoke box 22 and thence to stack 23. By mounting the entire heating unit 18 in cover plate 17, which is adapted to be bolted or otherwise conventionally connected to manway 3, the entire unit is readily removable, if desired, for repair or replacement or for shipment as a separate portion of the heater assembly.

Manway 4 is also provided with a removable cover plate 26 in which is mounted one end of a heat-extracting unit, designated generally by the numeral 27. The unit 27 comprises an elongated tubular coil 28 consisting of a plurality of connected tubing runs, and having an inlet tube 29 and an outlet tube 30 which extend through cover plate 26 to the exterior thereof. The remainder of coils 28 is adapted to be inserted longitudinally into compartment 9 through manway 4 to a point adjacent baffle plate 15. The tubes comprising coil 28 extend through a plurality of transverse tube sheets or supports 31, spaced longitudinally of the tank which provide support for the tubes and serve also as baffles to divide the coils into a plurality of sections. The coil 28 is spaced vertically from partitioning member 8 by resting the supports 31 on transversely spaced angle iron rails 32—32 which extend longitudinally on the upper surface of member 8. In passing through cover plate 26, inlet tube 29 and outlet tube 30 pass through stuffing boxes 33 and 34, respectively, to allow for removal of the cover plate from the tubes. Since the coil 28 is firmly held only at one end, namely, in the cover plate, it is free to move longitudinally with the thermal expansion and contraction thereof, the supports sliding on the rails 32. By mounting the heat-extracting unit 27 in the cover plate 26, which is adapted to be bolted or otherwise conventionally fastened by manway 4, the entire unit is removable bodily for repair or replacement or separate shipment, as may be desired.

Inlet tube 29 is provided with a pipe connection 35 through which a fluid to be heated may be supplied to the coil, and may also be provided with a valve, designated generally by the numeral 36, for purposes to be more fully described hereinafter. Outlet tube 30 is also provided with a pipe connection 37 for conveying the fluid heated in coil 28 to a suitable point of disposal (not shown). Connection 37 is ordinarily provided with a thermometer well 38 through which temperatures of the emerging fluid may be obtained when desired. A thermometer well 39 is also provided in the outlet end of tank 1 to enable the taking of temperatures of liquids within the tank.

The entire tank is filled with a suitable liquid heat transfer medium, designated by the numeral 40. This material is supplied to the tank and withdrawn also, if desired, through valved connection 7. The liquid heat transfer medium 40 may be any liquid suitable for transferring heat from heating unit 18 to heat-extracting unit 27, and is preferably one which remains in liquid state at the particular temperature and pressure employed in the device. Water is a cheap and convenient medium for use when temperatures below about 190° F. are employed, but it will be understood that this invention is not to be restricted to the use of water as the liquid heat transfer medium, since it will be readily appreciated that there are many liquids which are known to have suitable physical and chemical characteristics for this purpose.

The above-described apparatus is employed in the heating of a fluid in the following manner:

Assuming that the liquid is one which is to be heated to some temperature below the boiling point of water, the tank 1 is filled substantially completely with water and relief valve 6 is set to hold a pressure of one pound or so on the tank. The fluid to be heated is supplied from a suitable source through pipe 35 to the inlet of the coil 28 and circulated through the coil to the discharge connection 37 which conveys it to the desired point of disposal. Fuel is supplied through pipe 24 under the control of valve 25 to the burner 26 and burned in the entrance of fire tube 19. The resulting flames and hot gases of combustion then flow through the fire tube and return through ducts 21—21 to the stack 23, being aided by the draft normally created in stack 23. The flames and hot gases passing through the heating unit, heat the surfaces of the latter which transfer the heat to the adjacent liquid medium 40. The heated liquid rises, due to its decreased density and is displaced by the colder and consequently heavier liquid entering compartment 10 from passageway 12. The heated liquid is forced to flow beneath partitioning member 8 into passageway 11. Since member 8 limits the extent of the rise of heated liquid, a more rapid movement of the liquid results in the direction of passageway 11. Here baffle plate 15

forces the liquid to rise to the top of the baffle and flow through the relatively restricted inlet provided between the top of the baffle and the top of the tank, thereby further increasing its velocity. Also by forcing the liquid to rise to the top of the baffle 15, a maximum head is created for additionally increasing the velocity of the liquid. The heated liquid then strikes the relatively cooler coil 28 which absorbs heat from the liquid and transfers it to the fluid passing through the interior of the coil to heat the latter. As the transfer liquid continues its flow back toward passageway 12, more heat is continuously extracted from it and as it loses heat, the liquid increases in density and sinks to the upper surface of member 8 along which it is forced to flow to passageway 12, and thence back to compartment 10 thereby completing the thermo-syphonic cycle initiated by the heating in compartment 10. It will be seen that the direction of flow of the heated liquid is generally counter-current to approximately half of the flow, through the coil, of the fluid being heated and for that reason, is additionally efficient in transferring heat. The provision of the relatively non-conducting partitioning member 8 prevents dissipation upwardly over an extended area of the energy of the heated transfer liquid, and this feature together with the restrictive effect of baffles 15 and 16 forces the liquid to flow along a comparatively confined path and thereby produces relatively high velocity thermo-syphonic flow, which in turn results in high heat transfer rates between the carrier liquid and the heat extracting unit.

The supports 31, being upright and extending transversely of the tank, immediately above the rails 32, not only provide barriers to the thermo-syphonic flow of the heated transfer liquid, but serve to divert such flow downwardly of the coil. This arrangement also not only divides the downward flow, but it causes the liquid to flow, more or less, transversely of the coil tubes which promotes the over-all heat transfer efficiency. It further elongates the travel path and tends to, more or less, automatically proportion the flow of the liquid in accordance with the mean temperature differences between the heated transfer liquid and the segments of the coil defined by the supports 31. Obviously, the relatively broad longitudinal flow space along the upper side of the partition 8 and under the supports 31, provides a relatively cool zone which has its manifest beneficial results.

It will be understood that the heating device described above may be employed for heating various fluids to any desired temperatures under any desired pressures. The temperature employed determines the boiling point characteristics of the heat-transfer medium. In order to obtain maximum efficiency, the transfer medium should be retained in liquid condition throughout the heat transferring operation. Ordinarily the pressures applied to the transfer liquid are nominal pressures when the temperatures are below the normal boiling points of these liquids, or a higher pressure sufficient to prevent vaporization of these liquids, when their normal boiling temperatures are exceeded, may be employed.

Where water is used as the transfer medium, it is ordinarily employed where temperatures up to about 190° F. are desired. Under these conditions, by holding a nominal pressure of one or two pounds on the water by means of relief valve 6, practically no loss of water will occur, and heaters constructed in accordance with this invention are, therefore, highly efficient in this regard. It will be understood, of course, that the fluid to be heated in unit 27 may be processed at any desired pressure, it being only necessary to construct the coil 28 of materials sufficiently strong to withstand whatever pressure is required.

By keeping the heating unit 18 completely immersed in the liquid transfer medium, the heat generated in the unit is transferred very rapidly to the liquid, especially since a rapid thermo-syphon flow is maintained across the heater surfaces, and burning out of the metal of the fire tube and ducts is practically eliminated, or at least greatly reduced as compared with more conventional heaters. The immersion of the fire tube and ducts in the transfer liquid also permits absorption by the transfer liquid of maximum quantities of heat generated from the combustion of a given weight of fuel, thereby further increasing the over-all efficiency of the heating device.

A particularly useful adaptation of the heating device of this invention is its application to the prevention of hydrate formation resulting from the reduction of pressure of high pressure natural gases containing some water vapor. This application is coming into increasingly greater use due to the increasing production of very high pressure natural gases having initial pressures ranging generally from about 1000 lbs./sq. in. to 5000 or more lbs./sq. in. To process such gases for various commercial purposes, it is ordinarily necessary to greatly reduce these high pressures. Since such gases normally contain water vapor in varying amounts, the great reductions in temperatures which normally accompany the reductions in pressure result in the production of solid hydrocarbon-water compounds, commonly known as hydrates. These tend to gather at various points in the gas conduits and containing vessels, and particularly at the point of expansion of the gas, resulting in clogging of the lines and equipment, and are very troublesome and detrimental to continuously operating processes.

The heater of the present invention may be readily adapted for heating such gases during their expansion to prevent hydrate formation, by a slight modification of the previously described apparatus. The modification is illustrated particularly in Fig. 6. Gas at high pressures is supplied to coil 28 through connection 35 from a high pressure gas source, such as a well or a high pressure separator (not shown). Coil 28 will, of course, be constructed of heavy steel pipe and fittings to withstand the high pressures involved. Valve 36 will be a high pressure valve having an elongated stem 41, fitted at one end with a handle 43 and extending into tube 29 through a stuffing box 42. The stem is of sufficient length to extend well into inlet tube 29 to a point where the tube is immersed in the heat transfer liquid. At that point stem 41 is provided with a needle valve 44 which cooperates with a conical valve seat 45 through which the high pressure gas is expanded. Expansion of the gas through valve seat 45 will, therefore, take place at a point which is within the interior of tank 1 and which is subject to heating by contact with the transfer liquid. This arrangement will permit the transfer liquid to heat the expanding gas, at the point of expansion, to a temperature sufficiently high to prevent hydrate formation at that point. Of course, expansion of the gas will take place

through at least some of tubes of coil 27 as well, and as the gas proceeds through the coil, it will be heated to increasingly high temperatures until, at the outlet of the coil, the temperature will be that desired as a final temperature for the gas.

By this described arrangement for effecting expansion of the gas at the inlet to the heating zone, the minimum temperature produced at that point by the expansion of the gas will greatly promote the over-all heat transfer efficiency of the heater by providing at the inlet a maximum mean temperature difference between the gas to be heated and the heating medium.

In connection with the several modifications and applications of this invention, it is found that by maintaining a pressure slightly above atmospheric pressures on the transfer liquid in the tank, the entrance of air into the tank is effectively prevented, thereby greatly reducing the danger of corrosion of the metal surfaces of the tank and of the immersed units by the dissolution of air in the transfer liquid.

From the foregoing, it will be evident that heating, devices, constructed in accordance with this invention, provide many advantages over more conventional heaters, are comparatively simple in construction, and are highly efficient for heating a wide variety of fluids.

What we claim and desire to secure by Letters Patent is:

1. A heating apparatus, comprising, an enlarged chamber adapted to contain a body of a liquid heat transfer medium, a partitioning member dividing said chamber into separate generally upper and lower compartments, and means to produce thermo-syphonic circulation of said medium between said compartments comprising, a tubular coil positioned in the upper compartment, a heating gas conduit positioned in said lower compartment, both said coil and said conduit being adapted to be submerged in said medium, means to supply a high pressure heat-absorbing fluid to said coil, pressure reducing means associated with said coil for reducing the pressure of said fluid while in passage through said coil, means to supply heating fluid to said conduit, and spaced passageways through said partitioning member providing communication between said compartments.

2. A heating apparatus, comprising, an enlarged chamber adapted to contain a body of a liquid heat transfer medium, a partitioning member dividing said chamber into separate generally upper and lower compartments, and means to produce thermo-syphonic circulation of said medium between said compartments comprising, a tubular coil positioned in the upper compartment, a heating gas conduit positioned in said lower compartment, both said coil and said conduit being adapted to be submerged in said medium, means to supply a high pressure heat-absorbing fluid to said coil, pressure reducing means positioned adjacent the inlet of said coil and operative to reduce the pressure of said fluid in the adjacent inlet portion of said coil, means to supply heating fluid to said conduit, and spaced passageways through said partitioning member providing communication between said compartments.

3. A heating apparatus, comprising, an enlarged chamber adapted to contain a body of a liquid heat transfer medium, a heat insulating partitioning member dividing said chamber into separate generally upper and lower compartments, and means to produce thermo-syphonic circulation of said medium between said compartments comprising, a tubular coil positioned in said upper compartment, a heating unit positioned in said lower compartment, both said coil and said unit being adapted to be submerged in said medium, said heating unit including a combustion chamber, a flue gas return conduit and a burner means positioned adjacent the entrance of said combustion chamber, means to supply a heat-absorbing fluid to said coil, and spaced passageways through said partitioning member providing communication between said compartments.

4. A heating apparatus, comprising, an elongated horizontally positioned chamber adapted to contain a body of a liquid heat transfer medium, a thermally non-conductive partitioning member extending horizontally and longitudinally of said chamber to divide said chamber into generally upper and lower compartments, and means to produce thermo-syphonic circulation of said medium between said compartments comprising, passageways at opposite ends of said partitioning member providing communication between said compartments, an elongated tubular coil positioned in said upper compartment and extending longitudinally therein from one end of said chamber to a point adjacent one of said passageways, an elongated heating element positioned in said lower compartment and extending longitudinally therein from the opposite end of said chamber to a point adjacent the other of said passageways, means to supply a heat-absorbing fluid to said coil, and means to supply a heating fluid to said heating element.

5. A heating apparatus, comprising, an elongated horizontally positioned chamber adapted to contain a body of liquid heat transfer medium, a thermally non-conductive partitioning member extending longitudinally and horizontally of said chamber to divide said chamber into separate generally upper and lower compartments, and means to produce thermo-syphonic circulation of said medium between said compartments comprising, passageways at opposite ends of said partitioning member providing communication between said compartments, an elongated tubular coil positioned in said upper compartment and extending longitudinally therein from one end of said chamber to a point adjacent one of said passageways, an elongated heating element positioned in said lower compartment and extending longitudinally therein from the opposite end of said chamber to a point adjacent the other of said chamber to a point adjacent the other of said passageways, an inlet connection to supply a heat-absorbing fluid to said coil, a pressure-reducing valve positioned in said inlet connection and having its discharge orifice within said coil, and means to supply a heating fluid to said heating element.

6. A heating apparatus, comprising, an elongated horizontally positioned chamber adapted to contain a body of a liquid heat transfer medium, a thermally non-conductive partitioning member extending horizontally and longitudinally of said chamber to divide said chamber into generally upper and lower compartments, and means to produce thermo-syphonic circulation of said medium between said compartments comprising, passageways at opposite ends of said partitioning member providing communication between said compartments, an elongated tubular coil positioned in said upper compartment

and extending longitudinally therein from one end of said chamber to a point adjacent one of said passageways, a plurality of transverse baffle members spaced longitudinally along said coil to provide a plurality of separate paths across said coil for said medium, an elongated heating element positioned in said lower compartment and extending longitudinally therein from the opposite end of said chamber to a point adjacent the other of said passageways, means to supply a heat-absorbing fluid to said coil, and means to supply a heating fluid to said heating element.

7. A heating apparatus, comprising, an elongated horizontally positioned chamber adapted to contain a body of a liquid heat transfer medium, a thermally non-conductive partitioning member extending horizontally and longitudinally of said chamber to divide said chamber into generally upper and lower compartments, and means to produce thermo-syphonic circulation of said medium between said compartments comprising, passageways at opposite ends of said partitioning member providing communication between said compartments, an elongated tubular coil positioned in said upper compartment and extending longitudinally therein from one end of said chamber to a point adjacent one of said passageways, a plurality of transverse baffle members spaced longitudinally along said coil to provide a plurality of separate paths across said coil for said medium, an elongated heating element positioned in said lower compartment and extending longitudinally therein from the opposite end of said chamber to a point adjacent the other of said passageways, said heating element including an elongated combustion tube closed at its inner end, a pair of spaced parallel flue gas return conduits communicating with opposite sides of said combustion tube adjacent its inner end and returning to the exterior of said opposite end of said chamber, a smoke stack communicating with the outer ends of said return conduits, burner means positioned in the outer end portion of said combustion tube for supplying hot gases of combustion to said heating element, and means to supply a heat-absorbing fluid to said tubular coil.

8. A heating apparatus, comprising, a heating chamber containing a body of a liquid heat transfer medium, a partitioning member dividing said chambers into separate generally upper and lower compartments, a heat-supplying element positioned in the lower compartment and a heat-absorbing element disposed in the upper compartment, both said elements being submerged in said medium, spaced passageways through said partitioning member to provide communication between said compartments, means to supply a heating fluid to said heat-supplying element, means to supply high pressure gas to said heat-absorbing element to thereby produce thermo-syphonic circulation of said medium between said compartments, means arranged in said heat-absorbing element for reducing the pressure of said gas in an inlet portion thereof within said chamber farthest removed from the inlet portion of said heat supplying element to thereby produce a maximum mean temperature difference between said inlet portion of the heat-absorbing element and said medium.

9. A heating apparatus including, a heating chamber containing a body of liquid heat-transfer medium, a heat-supplying element and a heat-absorbing conductor both disposed in said chamber in spaced relation to each other, said element and said conductor being submerged in said medium, means to supply a heating fluid to said heat-supplying element, means to supply and provide a cooled high pressure gas flowing through the conductor to thereby produce thermo-syphonic circulation of said heat-transfer medium between said element and said conductor, and means for diverting the thermo-syphonic circulation flow to produce a maximum heat transfer between the conductor and said medium.

10. A heating apparatus as set forth in claim 9, and a heat-insulating partition disposed between the heat-supply element and the conductor.

11. A heating apparatus including, a chamber containing a body of liquid heat-transfer medium, a burner element and a heat-absorbing conductor both having portions disposed in said chamber and submerged in said medium in spaced relation to each other, means to supply a high pressure gas to said conductor for circulation therethrough, and means to reduce the pressure of said gas entering said conductor thereby cooling said gas and producing thermo-syphonic circulation of said medium between said element and said conductor.

12. A heating apparatus as set forth in claim 11, and means in the chamber for diverting the thermo-syphonic flow across the conductor to produce a maximum heat exchange between the heat-transfer medium and the gas.

13. A heating apparatus as set forth in claim 11, and a heat-insulating element spaced from and extending between the burner element and the conductor to induce thermo-syphonic circulation of said medium.

14. A heating apparatus including, an elongate substantially horizontal tank containing a body of heat-transfer medium, a partition within the tank extending medially and longitudinally thereof and dividing said tank into generally upper and lower longitudinal compartments, a circulating heat-transfer fluid-conductor connected to one end of the tank and disposed longitudinally of the partition in the upper compartment of the tank, a heating element connected to the opposite end of the tank and disposed in the lower compartment of the tank, the fluid-conductor and the heating element being fully immersed in the heat-transfer medium, the opposite ends of the partition terminating short of the ends of the tank to provide opposed circulating flow passages between the compartments to cause the heat-transfer medium to thermo-syphonically flow from the lower compartment to the upper compartment and longitudinally of the fluid-conductor and the partition and to return to the lower compartment.

15. A heating apparatus as set forth in claim 14, wherein the passages at the ends of the partition are provided with restrictions to cause the heat-transfer medium to flow from the lower compartment into the upper compartment at an increased velocity.

16. A heating apparatus as set forth in claim 14 and means in the upper compartment to divert the flow of the heat-transfer medium across the conductor to obtain maximum heat exchange.

17. A heating apparatus as set forth in claim 14 in which the heating element extends longitudinally in said lower compartment.

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