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(54) **WATER HEATER**

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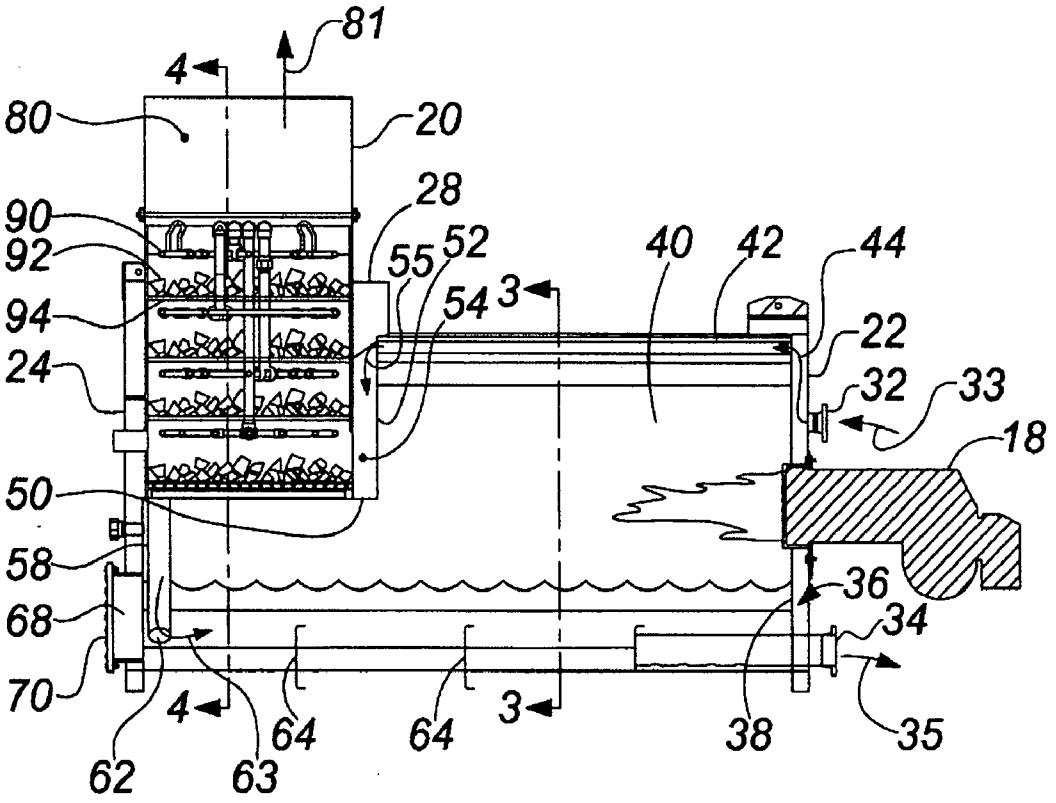
(57) **ABSTRACT**

An apparatus for heating water comprises a tank formed by a tank wall and having a water inlet and a water outlet and a water collection pan in a bottom portion thereof and a burner located through a wall of the tank so as to position a flame originating therefrom above a surface of water located in the collection pan. The apparatus further includes an exhaust pipe extending from the tank, at least one water distribution manifold sized to be located in the exhaust pipe of the water heater in fluidic communication with a water supply and having a plurality of ports therein to distributed water therethrough and at least one permeable layer supported below the at least one water distribution manifold.



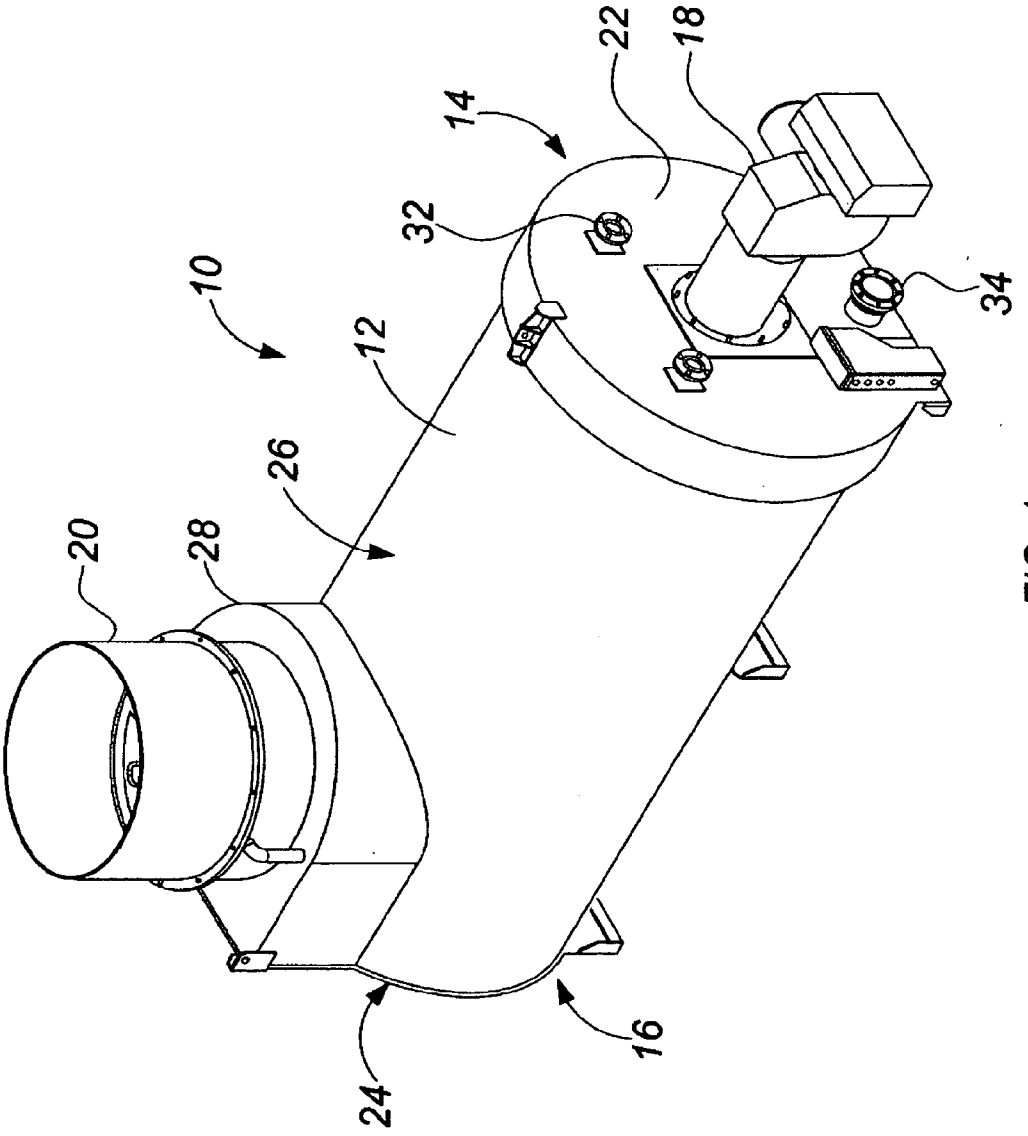


FIG. 1

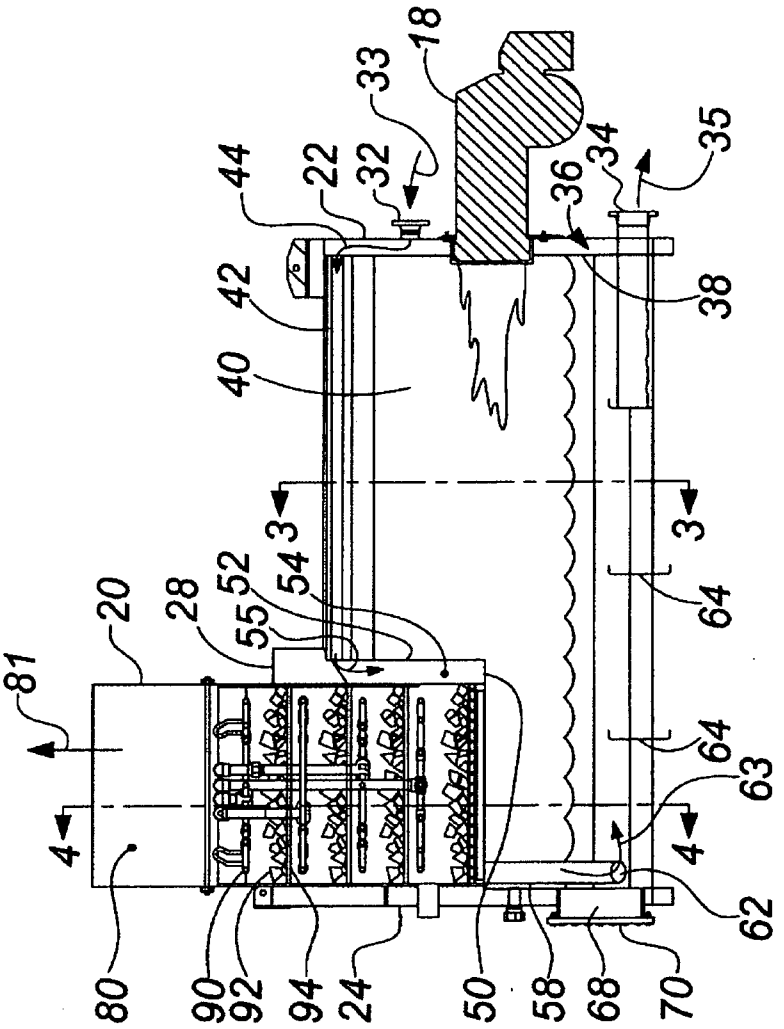

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FIG. 2

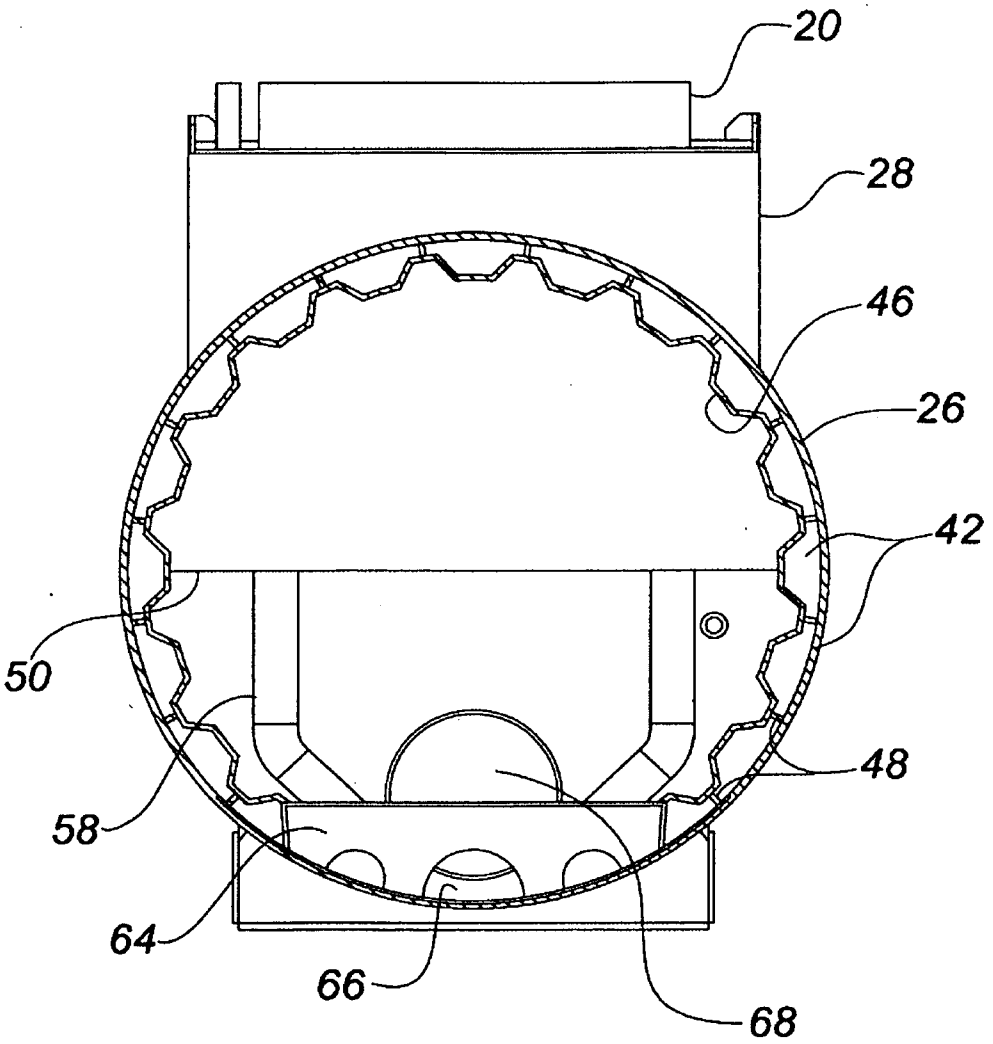

FIG. 3

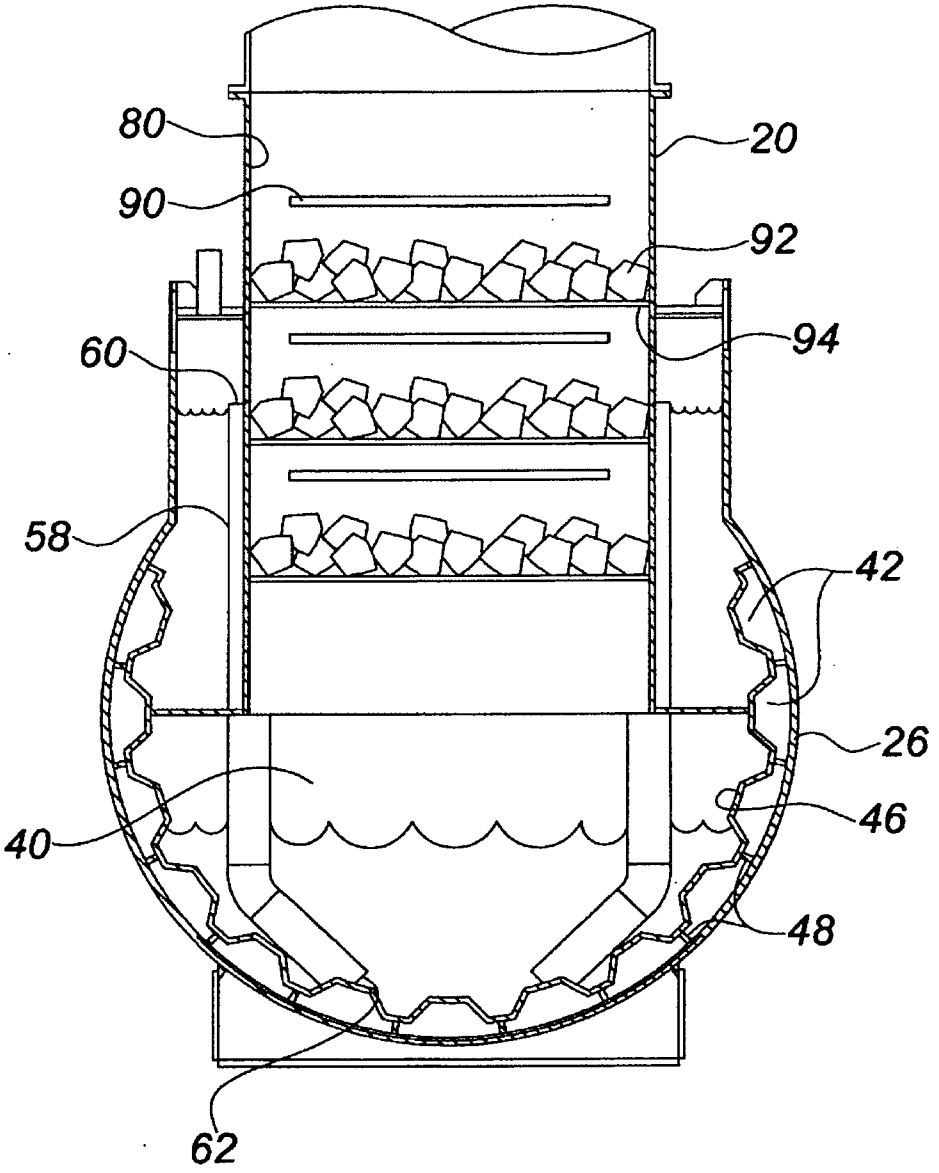

FIG. 4

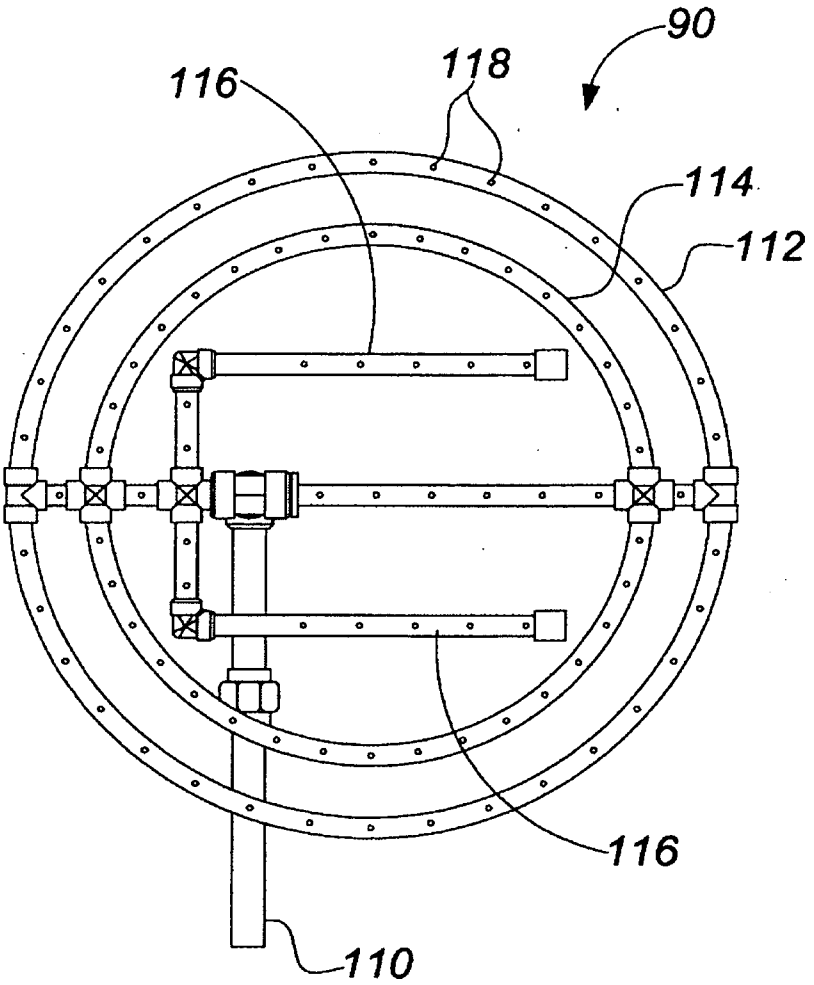

FIG. 5

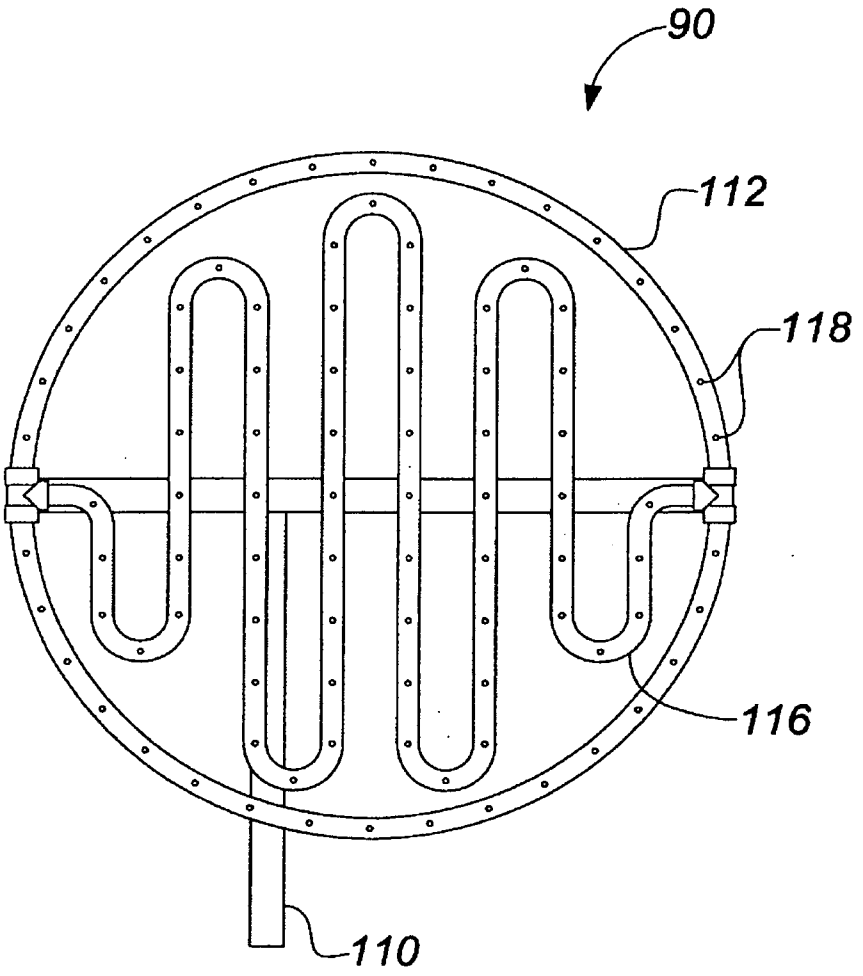

FIG. 6

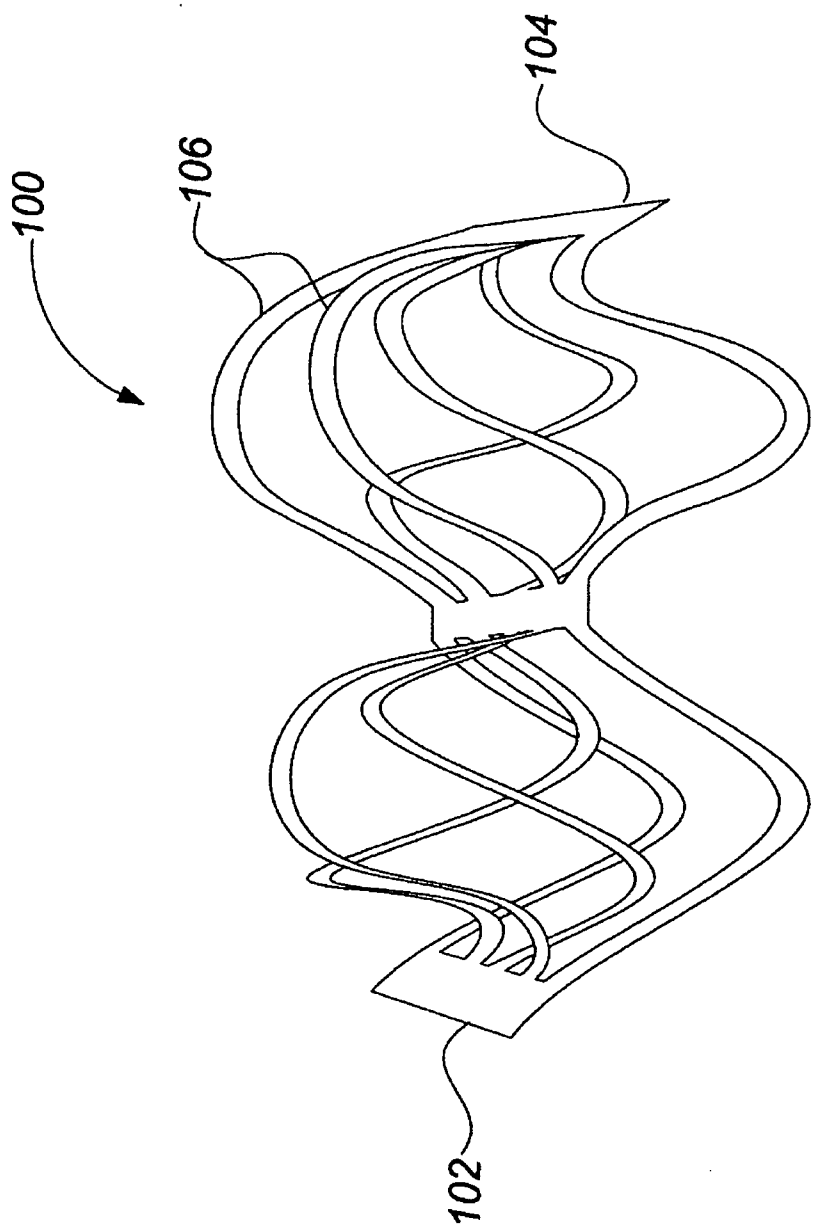

FIG. 7

WATER HEATER

BACKGROUND OF THE INVENTION

[0001] 1. Field of Invention

[0002] The present invention relates to water heaters in general and in particular to a water heater having heat recovery and exhaust cleaning.

[0003] 2. Description of Related Art

[0004] Many industries and locations require heated water for a wide variety of processes and application. For such uses, water heaters are commonly utilized which require a heat source to heat the water. Due to issues of availability and logistics, combustion of coal or hydrocarbons is a common heat source. Such heat sources require an air input and exhaust to maintain the combustion for heating. Disadvantageously, such exhaust is frequently a source of a reduction in efficiency of the heater due to the elevated temperature of the exhaust gas escaping through the exhaust port. Additionally, an additional difficulty with conventional gas fired water heaters is that the exhaust gasses produced by such combustion sources have a significant amount of pollutants.

SUMMARY OF THE INVENTION

[0005] According to a first embodiment of the present invention there is disclosed an assembly for heating water in a gas-fired water heater having an exhaust pipe. The apparatus comprises at least one water distribution manifold sized to be located in the exhaust pipe of the water heater in fluidic communication with a water supply and having a plurality of ports therein to distributed water therethrough and at least one permeable layer supported below the at least one water distribution manifold.

[0006] The permeable layer may comprise a plurality of bodies of expanded metal. The permeable layer may be supported by a water distribution manifold located thereunder. The permeable layer may be supported by a support grate located thereunder.

[0007] The water distribution manifold may comprise at least one pipe. The water distribution manifold may comprise a plurality of pipes distributed across the exhaust pipe.

[0008] According to a further embodiment of the present invention there is disclosed an apparatus for heating water comprising a tank formed by a tank wall and having a water inlet and a water outlet and a water collection pan in a bottom portion thereof and a burner located through a wall of the tank so as to position a flame originating therefrom above a surface of water located in the collection pan. The apparatus further includes an exhaust pipe extending from the tank, at least one water distribution manifold sized to be located in the exhaust pipe of the water heater in fluidic communication with a water supply and having a plurality of ports therein to distributed water therethrough and at least one permeable layer supported below the at least one water distribution manifold.

[0009] The water inlet may be located at a first end of the tank. The water inlet may distribute water through a jacket surrounding the tank to a second end of the tank. The water may be deposited from the jacket to the collection pan at the second end of the tank.

[0010] The distribution manifold may be in fluidic communication with the second end of the tank to as to pass water from the second end of the tank through the exhaust. The permeable layer may comprise a plurality of bodies of expanded metal. The permeable layer may be supported by a water distribution manifold located thereunder. The permeable layer may be supported by a support grate located thereunder.

[0011] The water distribution manifold may comprise at least one pipe. The water distribution manifold may comprise a plurality of pipes distributed across the exhaust pipe. The apparatus may further comprise a plurality of distribution manifolds each having an associated permeable bodies located thereunder.

[0012] Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] In drawings which illustrate embodiments of the invention wherein similar characters of reference denote corresponding parts in each view,

[0014] FIG. **1** is a perspective view of an apparatus for heating water according to a first embodiment of the present invention.

[0015] FIG. **2** is a cross sectional view of the apparatus of FIG. **1** as taken along the line **2-2**.

[0016] FIG. **3** is a cross sectional view of the Apparatus of FIG. **1** as taken along the line **3-3** of FIG. **2**.

[0017] FIG. **4** is a detailed perspective view of one of the permeable bodies.

[0018] FIG. **5** is a top plan view of the distribution manifold according to a first embodiment of the present invention.

[0019] FIG. **6** is a top plan view of the distribution manifold according to a further embodiment of the present invention.

[0020] FIG. **7** is a perspective view of a permeable body for use in the exhaust flume of the apparatus of FIG. **1**.

DETAILED DESCRIPTION

[0021] Referring to FIG. **1**, an apparatus for heating water according to a first embodiment of the invention is shown generally at **10**. The apparatus comprises a water tank **12** extending between first and second ends, **14** and **16**, respectively and having a burner assembly **8** at the first end **14** thereof and an exhaust flume **20** at the second end **16**. The burner assembly **8** may be of any conventional type and may burn any known fuel type. The burner assembly extends into the interior of the tank as will be described below so as to provide the heat of combustion produced by the burner assembly to the water contained within the tank interior.

[0022] As illustrated, the tank **12** may have a substantially circular cross-section, although it will be appreciated that other cross-section shapes may be useful as well, such as, by way of non-limiting example, square, oval, rectangular, octagonal or irregular. The tank **12** includes first and second end walls, **22** and **24**, respectively defining the first and second ends and cylindrical outer wall **26** extending therebetween. The burner assembly **18** passes through the first end wall **22**, and the exhaust flume **20** extends substantially vertically from a top portion of the outer wall **26**. The outer wall also includes an expanded section **28** containing an intermediate collection pan as will be more fully described below extending around the base of the exhaust flume.

[0023] The first end wall **22** of the tank includes at least one water inlet **32** and at least one water outlet **34** extending therethrough. As illustrated, more than one inlet or outlet may

be provided to balance the water flow through the heater as desired by a user. The water inlets **32** are sized to provide the desired water flow into the heater. By way of non-limiting example, two water inlets **32** may be utilized and selected to have a nominal diameter of between 3 and 6 inches (76 and 152 mm) although other diameters and quantities may be useful as well. Also by way of non-limiting example, one water outlet **34** may be utilized and selected to have a nominal diameter of between 4 and 8 inches (102 and 203 mm) although other diameters and quantities may be useful as well.

[0024] Turning now to FIGS. **2** through **4**, cross-sectional views of the tank is shown. The tank includes an inlet distribution chamber **36** located proximate to the first end **14** behind the first end wall **22**. An intermediate wall **38** may be utilized to separate the distribution chamber **36** from an interior **40** of the tank **12**. As shown in FIGS. **3** and **4**, the tank **12** includes plurality of water channels **42** extending the length of the tank proximate to the outer wall **26**. The water channels **42** are in fluidic communication with the inlet distribution chamber **36** such that water introduced into the inlet distribution chamber **34** is distributed into each of the water channels **42** along a flow path generally indicated at **44**.

[0025] As illustrated in FIG. **3**, the water channels **42** may be formed between the outer wall **26** and an inner wall **46** with dividing walls **48** extending therebetween to separate the water channels **42** from each other. It will be appreciated that a common inner wall **46** may be utilized with separate dividing walls **48**. Optionally, each water channel **42** may be formed from a separate inner wall which extends to the outer wall **26** or to adjacent inner walls. The water channels **42** extend around the circumference of the tank **12** so as to completely surround and encase the flame produced by the burner with at least some water which is to be heated. The separation of each water channel from each other along paths longitudinally extending along the tank **12** ensures that flow path of water in each channel **42** flows from the first end of the tank **12** to the second end **16** and further ensures that none of the water channels has stagnant water contained therein which may be susceptible to overheating or boiling. The inner wall **46** and divider walls **48** may be secured to each other and to the outer wall **26** by any commonly known means, such as, by way of non-limiting example, welding, adhesives, fasteners or the like.

[0026] With further reference to FIG. **2**, the water exits each of the water channels at a free distal end. As set out above, the tank **12** further includes an intermediate collection pan **50** extending substantially horizontally across the interior **40** of the tank **12** below the exhaust flume **20**. The intermediate collection pan **50** further has an end wall **52** extending from an end of the intermediate collection pan **50** to the outer wall **26** of the tank thereby separating and defining an intermediate tank **54** around the exhaust flume **20** from the interior **40** of the tank **12**. For the water channels **42** which are located above the intermediate collection pan **50**, such water channels **42** terminate at the end wall **52** such that the water transferred by such water channels **42** is into the intermediate tank **54** in a direction generally indicated at **55**. For the water channels **42** which are located below the intermediate collection pan **50**, such channels will terminate proximate to the second end wall **24** so as to discharge the water transported by such water channels **42** into the interior **40** of the tank.

[0027] The intermediate tank **54** further includes transfer pipes **58** having top and bottom open ends, **60** and **62** extending through the intermediate collection pan **50**. The top end **60** is located at a height within the intermediate tank **54** such that water contained within the intermediate tank **54** will flow into the transfer pipes **58** when the water level reaches a predetermined height. The bottom end **62** of the transfer pipe **58** discharge into the interior **40** of the tank **12**. In such a way when the water in the intermediate tank reaches a predetermined level, it is discharged down into the interior **40** of the tank in a direction generally indicated at **63**. Furthermore, the water level within the intermediate tank **54** is maintained at that predetermined level so as to ensure heat within the exhaust flume is recovered.

[0028] With reference to FIG. **2**, as set out above, the transfer pipes **58** and the water channels **42** located below the intermediate tank **54** each discharge into the tank interior **40**. As set out above the burner extends into the tank interior so as to produce an open flame within the tank interior. As illustrated, the burner assembly **8** extends through both of the first end wall and the intermediate wall **38** so as to separate the flame produced by the burner assembly from the water within the water distribution manifold **36**. The water that is discharged from the transfer pipes **58** and the water channels **42** is contained within the tank interior **40** with free top surface below the open flame produced by the burner assembly **8**. In such a way the water within the tank interior **40** will be heated by the flame. Optionally, the tank may include one or more baffles **64** extending thereacross so as to slow and control the flow of water within the tank interior from the second end **16** to the first end **14** of the tank. The baffles may also include one or more bore **66** therethrough to further control the flow of water as is commonly known. As illustrated in FIG. **2**, a clean out port **68** may be provided through the second end wall **24** of the tank **12** which is covered by a sealed plate **70** so as to permit an operator to clean out the tank interior **40** during maintenance.

[0029] As illustrated in FIGS. **2** and **4**, the exhaust flume **20** comprises a tubular member having a central passage **80** therethrough extending into the interior **40** of the tank **12**. Although the central passage **80** is illustrated as having a substantially circular cross-section, it will be appreciated that other shapes will be useful as well, such as, by way of non-limiting example, square, triangular, oval, rectangular, octagonal or irregular.

[0030] As illustrated in FIGS. **2** and **4**, the exhaust flume **20** includes a plurality of water distribution manifolds **90**, a plurality of support grates **94** and a plurality of water permeable layers **92**. Each water permeable layer is supported on a support grate with a water distribution manifold **90** located thereabove. In operation, exhaust gasses from the burner assembly **18** pass through the exhaust flume **20** and transfer heat contained therein to the water permeable layer. During such use, the water distribution manifolds distributes water across the water permeable layer **92**. In such a manner, water is carried by and runs across the water permeable layer so as to transfer heat that is absorbed by the water permeable layer to the water. The heated water is then permitted to flow down the exhaust flume **20** to be collected in the interior **40** of the tank. It will be appreciated that such heated water increases the efficiency of the apparatus **10** as it reduces the amount of heat which is permitted to escape out the exhaust flume. Additionally, the water running over and passing through the water permeable layer will provide some measure of absorption of any combustion gasses, such as CO2, NO2, particles and other pollutants. The absorption of such pollutants

reduces the amount of such gasses and particles which are permitted to escape the heater into the atmosphere.

[0031] With reference to FIG. **5**, the manifolds **90** may comprise a plurality of pipes arranged to extend across the exhaust flume **20**. In particular, with reference to FIG. **5**, the manifold may include an inlet pipe **110** and an outer ring **112** sized to extend around the interior of the central passage **80** proximate to the wall thereof. One or more secondary rings **114** may be arranged inside the outer ring **112** coplanar with the outer ring. Additionally, one or more inner pipes **116** may extend through the interior of the inner ring **114**. The inner and outer rings **112**, **114** and inner pipes **116** may be distributed across the central passage **80** so as to substantially evenly cover the central passage. Optionally, the manifold may have an outer ring **112** and a serpentine inner pipe **116** extending through the interior thereof as illustrated in FIG. **6**. The inner and outer rings **112**, **114** and inner pipes **116** are connected to each other by connection pipes as illustrated to be in fluidic communication with each other and with the inlet pipe. The inner and outer rings **112**, **114** and inner pipes **116** each include a plurality of holes or nozzles **118** extending therethrough. The nozzles **118** permit water supplied from the inlet pipe **110** to be dispensed from the manifold and are oriented in a downward direction. The nozzles may have a diameter selected to dispense water from the manifold **90** at a desired rate according to known methods. The manifold **90** may be formed of any suitable heat resistant material, such as, by way of non-limiting example, steel, stainless steel and copper and may be formed as a unitary member or may optionally be formed of individual elements connected together by welding, brazing, soldering, threading or the like.

[0032] The permeable layer **92** may be formed of any suitable permeable material able to pass air and water therethrough while providing a surface to retain water to come into contact with the exhaust gasses. In particular, the permeable layer **92** may be formed of a plurality of permeable bodies **100**. With reference to FIG. **7**, the permeable bodies **100** may be formed of a sheet of metal extending between first and second ends, **102** and **104**, respectively and having a plurality of slits cut thereinto to form a plurality of ribbons between the first and second ends **102** and **104**. Thereafter the plurality of ribbons may be bent or otherwise formed out of the plane of the sheet to form a plurality of loops **106**. The permeable body **100** thus formed will therefore provide a greater surface area than the sheet alone while also providing many flow paths around and through the permeable blocks **100** so as to ensure exhaust flowing therethrough will contact each area of the permeable block **100** to transfer heat to the block and the water contained thereon. The permeable blocks **100** may be formed of any suitable heat stable material, such as, by way of non-limiting example, stainless steel, aluminium or copper. The permeable blocks may also have a thickness selected to provide adequate heat transfer between the water and the exhaust gas, such as, by way of non-limiting example, between **10** and **36** gauge although other thicknesses may be useful as well. With reference to FIGS. **2** and **4**, the support grates **92** may be of any suitable permeable grill type, and may be secured or otherwise supported within the exhaust flume **20** by welding, adhesives, support pins, rods, fasteners or the like. The material and thickness of the support grates **92** should be selected to provide adequate support for the permeable blocks located thereon. The apparatus **10** may be provided with one or more sets of manifolds **90**, permeable bodies **92** and support grates **94**. As illustrated in FIGS. **2** and **4**, **4** and **3**, respectively sets of manifolds **90**, permeable bodies **92** and support grates **94** may be utilized although it will be appreciated that other quantities may be used as well.

[0033] In operation, water is pumped into the inlet pipes **32** by pumps (not shown) in a direction generally indicated at **33** which then flows through the distribution chamber **36** into the individual water channels **42** which then flow into the tank interior **40** as set out above. The burner assembly **18** provides a flame above the water level in the tank interior **40** so as to heat the water therein as well as the water in the water channels **42**. The exhaust gas from the burner assembly then flows up the exhaust flume **20** through the permeable bodies **100** thereby transferring heat thereto. Water may then be pumped by external pumps (not shown) into the inlet pipes **110** of the manifolds to be dispensed through the nozzles **118** which will thereafter fall onto the permeable bodies **100** below. The water flowing past the permeable bodies will collect the heat contained within the permeable bodies as well as capture some of the pollutants in the exhaust gasses. Thereafter the water will fall into the tank interior **40** to combined with the water flowing through the water channels **42**. The water within the tank interior **40** will then be removed therefrom through the water outlet **34** in a direction generally indicated at **35** for the use desired by a user. Furthermore, the exhaust gas will be permitted to flow away from the heater in a direction generally indicated at **81** through any other exhaust stacks or the like as are commonly known.

[0034] While specific embodiments of the invention have been described and illustrated, such embodiments should be considered illustrative of the invention only and not as limiting the invention as construed in accordance with the accompanying claims.

What is claimed is:

1. An assembly for heating water in a gas-fired water heater having an exhaust pipe, the apparatus comprising:

a water distribution manifold sized to be located in said exhaust pipe of said water heater in fluidic communication with a water supply and having a plurality of ports therein to distributed water therethrough; and

a water permeable layer supported below said at least one water distribution manifold.

2. The assembly of claim **1** wherein said permeable layer comprises a plurality of bodies of expanded metal.

3. The assembly of claim **1** wherein said permeable layer is supported by a water distribution manifold located thereunder.

4. The assembly of claim **1** wherein said permeable layer is supported by a support grate located thereunder.

5. The assembly of claim **1** wherein said water distribution manifold comprises at least one pipe.

6. The assembly of claim **5** wherein said water distribution manifold comprises a plurality of pipes distributed across said exhaust pipe.

7. An apparatus for heating water comprising:

a tank formed by a tank wall and having a water inlet and a water outlet and a water collection pan in a bottom portion thereof;

a burner located through a wall of said tank so as to position a flame originating therefrom above a surface of water located in said collection pan;

an exhaust pipe extending from said tank; and

at least one of the assemblies of claim **1**.

8. The apparatus of claim **7** wherein said water inlet is located at a first end of said tank.

9. The apparatus of claim **8** wherein said water inlet distributes water through a jacket surrounding said tank to a second end of said tank.

10. The apparatus of claim **9** wherein said water is deposited from said jacket to said collection pan at said second end of said tank.

11. The apparatus of claim **10** wherein said distribution manifold is in fluidic communication with said second end of said tank to as to pass water from said second end of said tank through said exhaust.

12. The apparatus of claim **7** wherein said permeable layer comprises a plurality of bodies of expanded metal.

13. The apparatus of claim **7** wherein said permeable layer is supported by a water distribution manifold located thereunder.

14. The apparatus of claim **7** wherein said permeable layer is supported by a support grate located thereunder.

15. The apparatus of claim **7** wherein said water distribution manifold comprises at least one pipe.

16. The apparatus of claim **15** wherein said water distribution manifold comprises a plurality of pipes distributed across said exhaust pipe.

17. The apparatus of claim **7** further comprising a plurality of distribution manifolds each having an associated permeable bodies located thereunder.

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