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(54) A steam generator with external probe housing unit

(57) A steam generator for use with a steam cooker includes a heating chamber defining a volume for holding water. A heating system is associated with the heating chamber that is configured to heat water in the heating chamber so as to generate steam. An external probe housing unit is in communication with the heating chamber. The external probe housing unit includes a housing part defining a cavity therein. The housing part includes a first end through which water passes to and from the heating chamber, a second end opposite the first end, a top, a bottom and sides extending between the ends. A first probe support surface is located at a first probe receiving portion at the top of the housing part and a second probe support surface located at a second probe receiving portion at the top of the housing part. The first probe support surface is offset vertically from the second probe support surface.

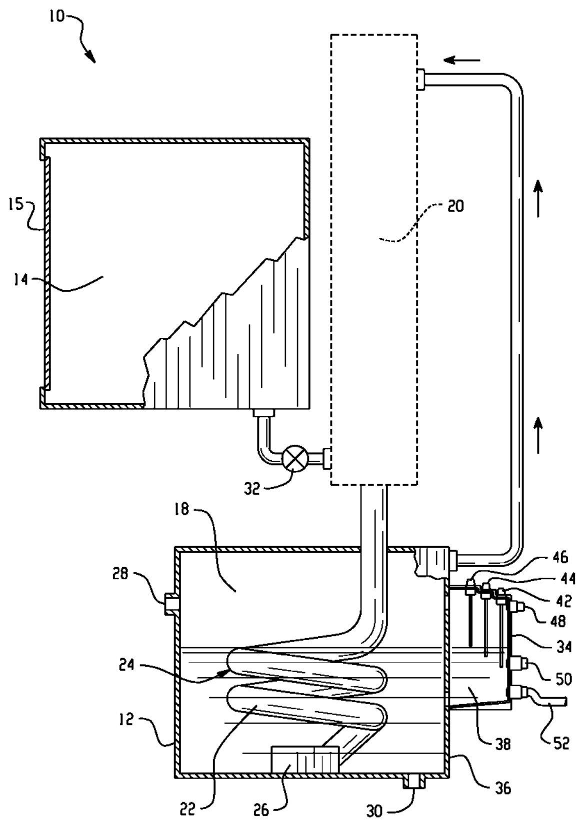

Fig. 1

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Description

TECHNICAL FIELD

[0001] The present application relates to steam generators and more particularly to a steam generator including an external probe housing unit.

BACKGROUND

[0002] Steam cookers have been successfully employed by restaurants, hospitals and other food service operations to prepare quickly and conveniently large quantities of food. Steam cookers typically include a steam generator that is used to generate steam for delivery to a cooking chamber. Conditions within the steam generator may be monitored to provide effective steam generation. For example, a control system has been proposed to maintain a predetermined water level within a heating chamber of a steam generator. The control system signals when the water level reaches a predetermined second low water level and cuts off delivery of fuel to the steam generator in the event that the water level drops to a dangerous or predetermined third low water level. The control system utilizes horizontally oriented, vertically spaced-apart electrodes that extend horizontally into a tubular member in communication with the steam generator. The electrodes are used to detect the water level within the tubular member which corresponds to the water level within the steam generator. Vertically oriented, horizontally spaced-apart electrodes have also been proposed.

SUMMARY

[0003] In an aspect, a steam generator for use with a steam cooker includes a heating chamber defining a volume for holding water. A heating system is associated with the heating chamber that is configured to heat water in the heating chamber so as to generate steam. An external probe housing unit is in communication with the heating chamber. The external probe housing unit includes a housing part defining a cavity therein. The housing part includes a first end through which water passes to and from the heating chamber, a second end opposite the first end, a top, a bottom and sides extending between the ends. A first probe support surface is located at a first probe receiving portion at the top of the housing part and a second probe support surface located at a second probe receiving portion at the top of the housing part. The first probe support surface is offset vertically from the second probe support surface.

[0004] In another aspect, a method of monitoring operating conditions within a steam generator is provided. The method includes connecting an external probe housing unit to an outer surface of a steam generator to provide communication between a heating chamber of the steam generator and a cavity of the external probe housing unit. The external probe housing unit includes a housing part defining the cavity therein. The housing part includes a first end through which water passes to and from the heating chamber, a second end opposite the first end, a top, a bottom and sides extending between the ends. A first probe support surface is located at a first probe receiving portion at the top of the housing part and a second probe support surface is located at a second probe receiving portion at the top of the housing part. The first probe support surface is offset vertically from the second probe support surface. A first water level is detected within the cavity using a first water level probe supported by the first probe support surface and extending downward into the cavity. A second water level is detected within the cavity using a second water level probe supported by the second probe support surface and extending downward into the cavity.

[0005] In another aspect, a steam generator for use with a steam cooker includes a heating chamber defining a volume for holding water. The heating chamber has a sidewall portion including an opening. A heating system is associated with the heating chamber, the heating system being configured to heat water in the heating chamber so as to generate steam. An external probe housing unit is connected to the sidewall portion of the heating chamber at the opening. The external probe housing unit includes a housing part defining a cavity therein. The housing part includes a first end through which water passes to and from the heating chamber through the opening of the sidewall portion, a second end opposite the first end, a top, a bottom and sides extending between the ends. A first water level probe extends through the housing part at the top of the housing part. A second water level probe extends through the housing part at the top of the housing part. A lower tip of the first water level probe is located at a higher elevation than a lower tip of the second water level probe. A baffle structure is sized and located to limit migration of surface level turbulence from the heating chamber into the cavity of the external probe housing unit.

[0006] The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Fig. 1 is a schematic illustration of a low pressure steam cooker including steam generator with an embodiment of an external probe housing unit;

[0008] Fig. 2A is a side view of the external probe housing unit of Fig. 1 with certain components removed;

[0009] Fig. 2B is an end view of the external probe housing unit of Fig. 2A;

[0010] Fig. 2C is a top view of the external housing unit of Fig. 2A;

[0011] Fig. 3 is a side view of the external housing unit of Fig. 1 with a side removed;

[0012] Fig. 4 is a diagrammatic illustration of an embodiment of a control system for the steam cooker of Fig. 1;

[0013] Fig. 5 is a side section view of the external probe housing unit of Fig. 1;

[0014] Fig. 6 is a front, exploded view of an embodiment of a housing part of the external probe housing unit of Fig. 1;

[0015] Fig. 7 is a side view of another embodiment of an external probe housing unit;

[0016] Fig. 8A is a side view of another embodiment of an external probe housing unit suitable for use with a high pressure steam cooker;

[0017] Fig. 8B is a front view of the external probe housing unit of Fig. 8A; and

[0018] Fig. 8C is a top view of the external probe housing unit of Fig. 8A.

DETAILED DESCRIPTION

[0019] Referring to Fig. 1, a low-pressure steam cooker 10 includes a steam generator 12 for generating steam and a cooking chamber 14 that is in communication with the steam generator. The cooking chamber 14 may be formed by an insulated housing and includes an access opening with a door 15 that is movable between open and closed conditions. The steam generator 12 includes a heating chamber 18 where steam is generated under relatively low pressure conditions (e.g., in some embodiments, at most about five psi, such as about three psi). As indicated by the dotted lines, in some embodiments, a steam superheater 20 may be used to superheat steam traveling from the heating chamber 18 to the cooking chamber 14.

[0020] Disposed within the heating chamber 18 is a gas heat exchanger 22 in the form of a submerged heat exchange tube. As shown, heat exchanger 22 includes a helical portion 24, however, any suitable design can be used. The heat exchanger 22 is connected to a burner unit 26 (e.g., a metal fiber, fan-driven burner having a stainless steel mesh and stainless steel tube, such as a Model BCT0027, available from N.V. Acotech S.A., Kennesaw, GA) that is capable of generating hot gases for delivery to the heat exchanger. Heat exchanger 22 is located in the heating chamber 18 such that it can be in a heat exchange relationship with water disposed therein. While the illustrated heat exchange relationship with the water is via submersion of the heat exchanger 22, it is possible that hot gas could pass through ducts that are not submerged, such as ducts that run along the exterior wall of the heating chamber 18. Likewise, the heat exchanger 22 could be in the nature of a resistive type heating element.

[0021] The heating chamber 18 includes an inlet 28 for ingress of water into the heating chamber from a water source (not shown) and an outlet 30 for egress of water from the heating chamber (as when the chamber is to be drained). A valve (not shown) is opened and closed to control water flow into the heating chamber, e.g., to maintain a desired water level within the heating chamber 18 during steam production. A valve 32 is used to control the flow rate of steam into the cooking chamber (in some embodiments, the flow rate of steam into the cooking chamber is between about 35 and about 90 pounds per hour, such as about 50 pounds per hour where the volume of the cooking chamber is between about 164 and 245 cubic inches).

[0022] An external probe housing unit 34 is used to monitor operating conditions of the steam generator 12. The external probe housing 34 is connected to an outer surface 36 of the steam generator 12 (such as by welding or any other suitable method) as shown. The external probe housing unit 34 includes a cavity 38 that is in communication with the heating chamber 18. The communication between the cavity 38 and the heating chamber 18 allows for passage of water between the cavity and heating chamber and provides similar pressure and temperature conditions within the cavity as are present within the heating chamber.

[0023] The external probe housing unit 34 includes water level probes 42, 44 and 46 for monitoring the water level within the cavity 38, a pressure sensor 48 for monitoring pressure conditions within the cavity and a temperature sensor 50 for monitoring temperature of water located in the cavity. The probes 42, 44, 46, the pressure sensor 48 and the temperature sensor 50 are connected to a controller to provide a signal thereto indicative of water level, pressure and temperature, respectively, within the cavity. A fluid line 52 is connected to the external probe housing unit 34, which is used to deliver a flushing material (e.g., a scale clean, delime release agent) for use in breaking scale build-up from the external probe housing unit during a flushing operation.

[0024] Figs. 2A-2C show the external probe housing unit 34 with the water level probes 42, 44, 46, pressure sensor 48, temperature sensor 50 and fluid line 52 removed for clarity. The external probe housing unit 34 includes a housing part 54 forming the cavity 38 with a top 56, a bottom 58, an open end 60, an end 62 opposite the open end and sides 64 and 66 extending between the ends 60, 62. Located at the top 56 of the housing part 54 are stepped portions 68, 70 and 72. Stepped portions 68, 70 and 72 each form probe receiving portions that are offset vertically from each other. Probe coupling members 74, 76 and 78 extend outwardly from the top 56 at each stepped portion 68, 70, and 72, respectively, and form openings 80, 82 and 84 (Fig. 2C) that extend through the top to provide access to the cavity 38. While the probe coupling members 74, 76 and 78 are illustrated as extending outwardly from the top 56 about the same distance, in other embodiments, the probe coupling members may extend outwardly from the top differing distances. Additionally, while three stepped portions 68, 70 and 72 are shown, more or less than three stepped portions may be used.

[0025] Probe coupling members 74, 76 and 78 connect the water level probes 42, 44 and 46 to the housing part 54 with the probes extending through the respective openings 80, 82 and 84 (see Fig. 3). Each probe coupling member 74, 76, 78 has a probe support surface 86 (see Fig. 2C) against which respective water level probes 42, 44, 46 may be seated. Due to the stepped portions 68, 70 and 72, the support surfaces 86 are offset vertically from each other with the support surface of coupling member 74 being at a lowest elevation, the support surface of coupling member 76 being at an intermediate elevation and the support surface of the coupling member 78 being at a highest elevation. Shown most clearly by Figs. 2B and 2C, the probe coupling member 76 is also offset horizontally from probe members 74 and 76 to provide spacing between the various components located within the cavity 38. The probe coupling members 74, 76, 78 and their respective probe support surface 86 are used in operatively connecting and locating the water level probes 42, 44, 46 at desired locations to the housing part 54.

[0026] The external probe housing unit 34 further includes sensor coupling members 88 and 90 and fluid line coupling 92. Referring particularly to Fig. 2B, coupling 92 is offset horizontally from the coupling members 88 and 90. The coupling members 88 and 90 and coupling 92 are used in operatively connecting and locating the pressure sensor 48, temperature sensor 50 and fluid line 52 at desired locations to the housing part 54.

[0027] Fig. 3 shows the external probe housing unit 34 with side 64 removed to allow for viewing of the water level probes 42, 44, 46, pressure sensor 48 and temperature sensor 50.

Each water level probe 42, 44, 46 includes a housing part 92, a probe part 94 and a probe length PL that extends from a tip 96 of the respective probe part 94 up to the respective housing part 92. In some embodiments, the PL of each water level probe 42, 44 and 46 is substantially equivalent to the PL of the other water level probes. In some embodiments, the water level probes 42, 44 and 46 may be all identical. As an example, one or more of the water level probes may be a Model 3L1D-XX, commercially available from Gems Sensors, Inc., Plainville, CT. In other embodiments, the water level probes may be different and have different probe lengths.

[0028] Tips 96 of the water level probes 42, 44 and 46 are located at different elevations E_1, E_2 and E_3 within the cavity 38 and at different distances from the bottom 58 notwithstanding that the length of each water level probe is substantially the same. This is due to stepped portions 68, 70 and 72 being offset vertically from each other as described above. As can be seen, tip 96 of water level probe 46 is located at the highest elevation E_3 for detecting a HIGH water level, tip 96 of water level probe 44 is located at an intermediate elevation E_2 for detecting a LOW water level and tip 96 of water level probe 42 is located at a lowest elevation E_1 for detecting a MINIMUM water level. As will be described below, during normal operating conditions the water level within the cavity is preferably maintained between the HIGH and LOW water levels. However, other configurations are contemplated.

[0029] Pressure sensor 48 detects pressure within the cavity 38 and is disposed above the tip 96 of the water level probe 46 (i.e., above the HIGH water level) during use. Temperature sensor 50 detects water temperature and is disposed below the tip 96 of the water level probe 44 (i.e., below the LOW water level) during use. In some embodiments, the temperature sensor 50 is located below the tip 96 of the water level probe 42 (i.e., below the MINIMUM water level). Fluid line 52 and its associated inlet 98 are located below the temperature sensor 50 and nearest the bottom 58. Bottom 58 is slanted downwardly from the end 62 toward the open end 60 to facilitate water drainage from the cavity 38 back into the heating chamber 18.

[0030] Referring now to Fig. 4, the water level probes 42, 44 and 46, the pressure sensor 48 and the temperature sensor 50 are connected to the controller 100. Controller 100 is capable of controlling operation of an inlet control assembly 102 (e.g., a flow control valve), an outlet control assembly 104 and the water heating system 106 based, at least in part, on signals provided by the water level probes 42, 44, 46, pressure sensor 48 and temperature sensor 50. In some embodiments, controller 100 may also control operation of valve 32 (see Fig. 1) that allows for steam delivery to the cooking chamber 14.

[0031] Fig. 5 illustrates the external probe housing unit 34 connected to a wall 108 of the steam generator 12. A pair of openings 110 and 112 extending through the wall 108 provide communication between the heating chamber 18, the open end 60 and thus cavity 38 of the housing part 54. The openings 110 and 112 are spaced apart vertically to provide a flow obstruction or baffle 114 therebetween to limit the impact of turbulent water conditions within the chamber 18 on the water level within the cavity 38. Baffle 114 serves to maintain a relatively steady state within the cavity 38 despite certain conditions (e.g., ripples) within the heating chamber 18, which can provide more reliable water level indications to the controller 100 (see Fig. 4). Opening 110 is located at the bottom 58 of the housing part 54 to allow for ingress and egress of water into and out of the cavity 38 to levels substantially equal to that within the heating chamber 18 during normal operation while opening 112 is located above the HIGH water level to allow pressure conditions within the cavity 38 to be normally substantially equal to that within the heating chamber. The baffle 114 is located at an elevation corresponding to the normal water levels of the heating chamber 18. In an alternative embodiment, there may be only a single, larger opening extending through the wall 108 (e.g., that is slightly smaller than the open end 60 of the housing part 54) that provides communication between the cavity 38 and the heating chamber 18.

[0032] Under normal operating conditions (illustrated by Fig. 5), the water level is maintained between the LOW and HIGH water levels as defined by the tips 96 of the water level probes 44 and 46. In an exemplary control process, water level probes 42 and 44 provide an ON signal to the controller 100 while water level probe 46 is OFF. Controller 100 includes logic stored in memory that, based on the signals provided by the water level probes 42, 44, 46, determines that the current water level is within normal operating conditions. If the current water level falls below tip 96 of the water level probe 44, controller 100 determines that the current water level is low and can open the inlet control assembly 102 to allow water to enter the heating chamber 18 through the inlet 28 (Fig. 1) until the probe 44 again provides an ON signal. If the current water level rises above tip 96 of probe 46, the controller 100 determines that the current water level is high and can open the outlet control assembly 104 to allow water to drain from the heating chamber through the outlet 30 (Fig. 1) until the probe 46 is OFF. If the current water level falls below tip 96 of the water level probe 42, the controller determines that the water level is below the MINIMUM water level and can shut down various components of the steam cooker 10 such as the burner 26 (Fig. 1).

[0033] As noted above, controller 100 may control other operating conditions of the steam cooker 10 based on input from the pressure sensor 48 and the temperature sensor 50. For example, if a temperature value provided by the temperature sensor 50 falls below a certain threshold value, controller 100 can increase the burner temperature. As another example, if a pressure value provided by the pressure sensor 48 rises above a certain threshold value, the controller may turn the burner OFF.

[0034] The external probe housing unit 34 may be formed by any suitable method. In some embodiments, housing part 54 is formed using a sheet metal (e.g., formed of stainless steel). For example, referring to Fig. 6, housing part 54 is formed using three separate sheets 114, 116 and 118, e.g., stamped or cut from a single sheet or from different sheets. Sheet 116 may be bent to form the stepped portions 68, 70, 72, bottom 58 and end 62. Sheets 114 and 118 may then be joined to sheet 116 by welding to form sides 64 and 66.

[0035] Fig. 7 shows a variation on the external probe housing unit described above. External probe housing unit 120, instead of stepped portions, includes probe coupling members 122, 124 and 126 that extend to different elevations above the top 56 of housing part 128 with coupling member 126 having a greatest height, coupling member 124 having an intermediate height and coupling member 126 having a lowest height. In a fashion similar to that described above, the differing heights of the coupling members 122, 124 and 126 place tips of associated water level probes (not shown) at different elevations within the cavity 38 of the housing part 128.

[0036] Referring now to Figs. 8A-8C, an external probe housing unit 130 suitable for use with a high pressure steam cooker (e.g., having operating pressures exceeding 10 psi) includes a cast housing part 132 (e.g., formed of stainless steel). External housing unit 130 includes many of the features described above including stepped portions 134, 136 and 138 that are used in locating water level probes 140, 142, 144 and 146 at different heights within cavity 148 and a bottom 150 that is slanted downwardly toward an open end 152 of the housing part 132. Water level probes 140, 142, 144 and 146 provide a signal to a controller (not shown) to maintain a desired water level in a fashion similar to that described above.

[0037] Also supported on the stepped portions 136 and 138 are a first pressure sensor 152 that provides an indication at a higher pressure threshold (e.g., 15 psi) and a second pressure sensor 154 that provides an indication at a lower pressure threshold (e.g., 13 psi). The first and second pressure sensors 152 and 154 provide the indication to the controller to maintain a normal operating pressure of between the higher and lower pressure thresholds.

[0038] A flange 156 is located about a periphery of the open end 152. Flange 156 provides connecting structure so that the external probe housing unit 130 can be fastened (e.g., bolted through openings 158) to a wall of a high pressure steam generator. In some embodiments, a sealing material such as a gasket (not shown) may be located between the flange 156 and the wall of the high pressure steam generator to provide a fluid-tight seal therebetween. This arrangement can provide replaceable probe housing module that can be removed and replaced by a similar or identical probe housing module with relative ease. A temperature sensor to monitor temperature conditions within the cavity 148 and a fluid line to deliver a flushing fluid to the cavity may also be included (not shown).

[0039] The above-described external housing units 34, 120 and 130 provide locating structures that position the water level probes at different elevations within the cavity of their housing part. These locating structures eliminate any need to utilize water level probes having differing probe lengths to set HIGH, LOW and MINIMUM water levels. This can even allow for use of identical probes to set each of the water levels. As a further advantage, the HIGH water level probe, LOW water level probe and MINIMUM water level probe can be visually identified without any need to remove the water level probe (e.g., for a repair operation) based upon their elevation. For example, the water level probe located on the highest step should be the HIGH water level probe, the water level probe located on the intermediate step should be the LOW water level probe and the water level probe located on the lowest step should be the MINIMUM water level probe.

[0040] It is to be clearly understood that the above description is intended by way of illustration and example only and is not intended to be taken by way of limitation, and that changes and modifications are possible. Accordingly, other embodiments are within the scope of the following claims.

Claims

1. A steam generator for use with a steam cooker, the steam generator comprising:

a heating chamber defining a volume for holding water;
a heating system associated with the heating chamber, the heating system configured to heat water in the heating chamber so as to generate steam; and
an external probe housing unit in communication with the heating chamber, the external probe housing unit comprising

a housing part defining a cavity therein, the housing part including a first end through which water passes to and from the heating chamber, a second end opposite the first end, a top, a bottom and sides extending between the ends;
a first probe support surface located at a first probe receiving portion at the top of the housing part; and
a second probe support surface located at a second probe receiving portion at the top of the housing part;

wherein the first probe support surface is offset vertically from the second probe support surface.

2. The steam generator of claim 1, wherein the first probe support surface and the second probe support surface are offset by a step defined by the top of the housing part.

3. The steam generator of claim 1 or 2, wherein the external probe housing unit further comprises a first probe coupling member that includes the first probe support surface and a second probe coupling member that includes the second probe support surface, the first probe coupling member extending outwardly a greater distance from the top of the housing part than the second probe coupling member.

4. The steam generator of claim 1, 2 or 3, wherein the first probe receiving portion is nearer the first end than the second probe receiving portion.

5. The steam generator of any one of the preceding claims further comprising

a first water level probe extending into the cavity of the external probe housing unit at the first probe receiving portion at the top of the housing part; and
a second water level probe extending into the cavity of the external probe housing unit at the second probe receiving portion at the top of the housing part.

6. The steam generator of claim 5, wherein a tip of the first water level probe is a greater distance from the bottom of the housing part than a tip of the second water level probe, the first water level probe capable of providing a high water level indication and the second water level probe capable of providing a low water level indication.

7. The steam generator of claim 6, wherein the first water level probe has a first probe length and the second water level probe has a second probe length, the first and second probe lengths being substantially the same.

8. The steam generator of claim 6 or 7 wherein the external probe housing unit is secured to a side portion of a heating chamber housing, the heating chamber housing includes an opening for delivering water into the cavity via the first end of the housing part, the opening of the heating chamber housing sized and located such during typical steam generator operation the heating chamber housing acts as a baffle against turbulent surface level water flow into the cavity of external probe housing unit.

9. The steam generator of any one of the preceding claims 5 to 8, wherein the external probe housing unit further comprises

a pressure sensor coupling configured to operatively connect a pressure sensor to the housing part for detecting pressure within the cavity; and
a pressure sensor connected to the pressure sensor coupling that provides a signal indicative of a pressure within the cavity;

wherein the pressure sensor is located above the tip of the first water level probe.

10. The steam generator of claim 9, wherein the external probe housing unit further comprises

a temperature sensor coupling configured to operatively connect a temperature sensor to the housing part for detecting temperature within the cavity; and
a temperature sensor connected to the temperature sensor coupling that provides a signal indicative of a temperature within the cavity;

wherein the temperature sensor is located below the tip of the second water level probe.

11. The steam generator of any one of the preceding claims 5 to 10 further comprising a third probe support surface located at a third probe receiving portion at the top of the housing part, wherein the third probe support surface is offset vertically from the second probe support surface and the first probe support surface; and a third water level probe extending into the cavity of the external probe housing unit at the third probe receiving portion at the top of the housing part.

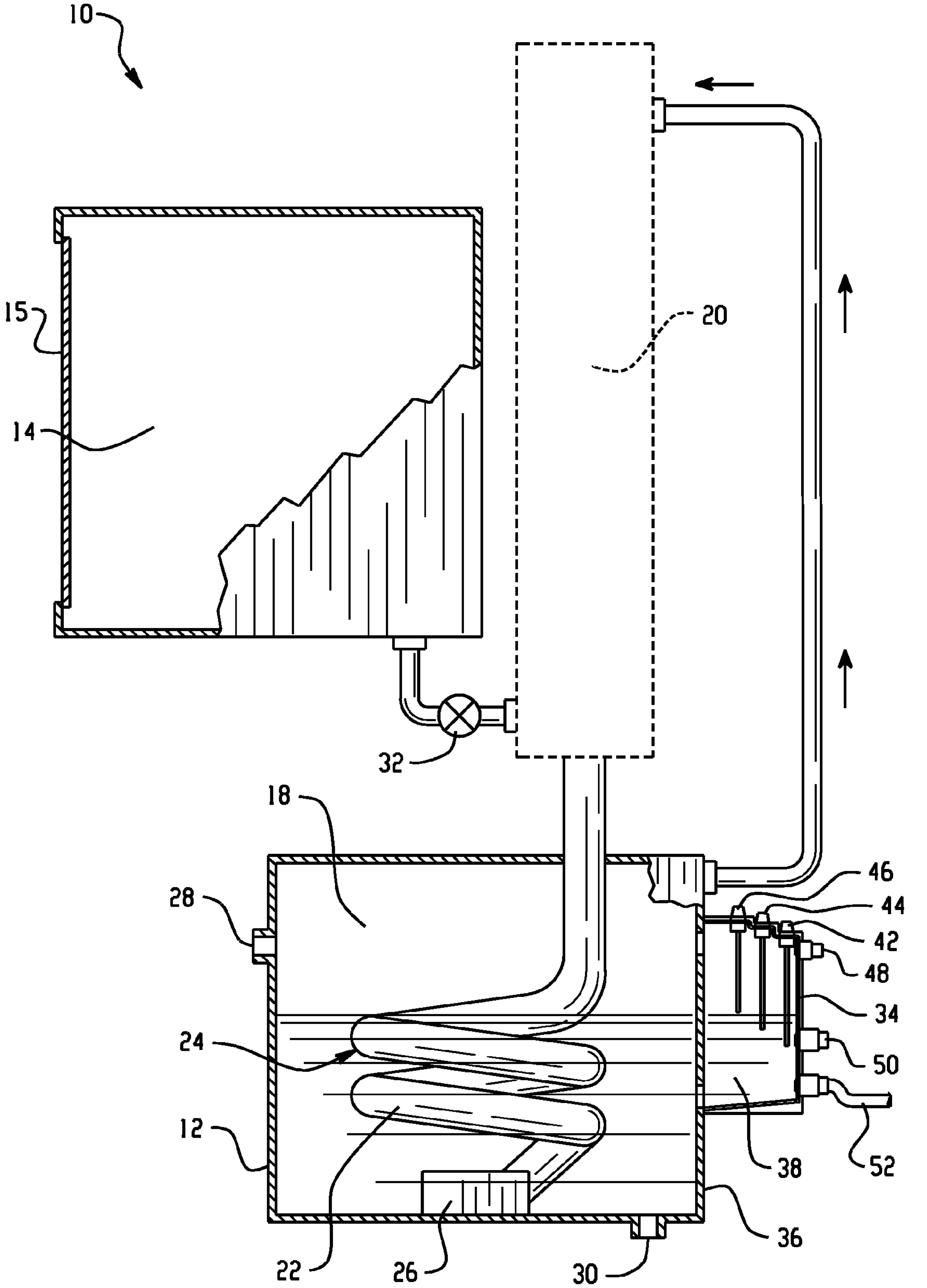

Fig. 1

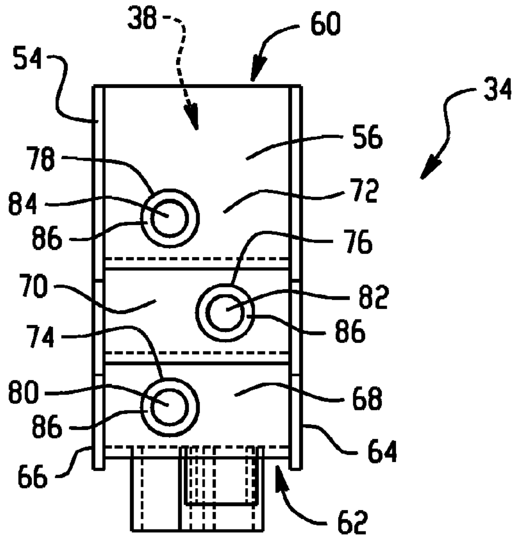

Fig. 2C

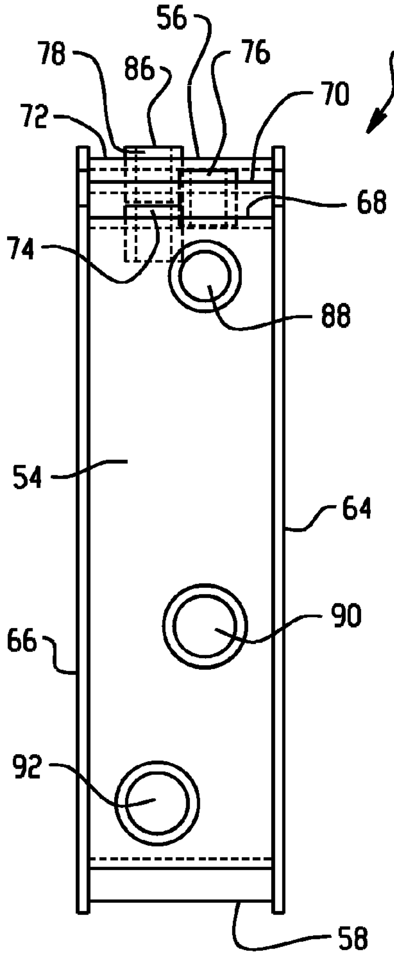

Fig. 2B

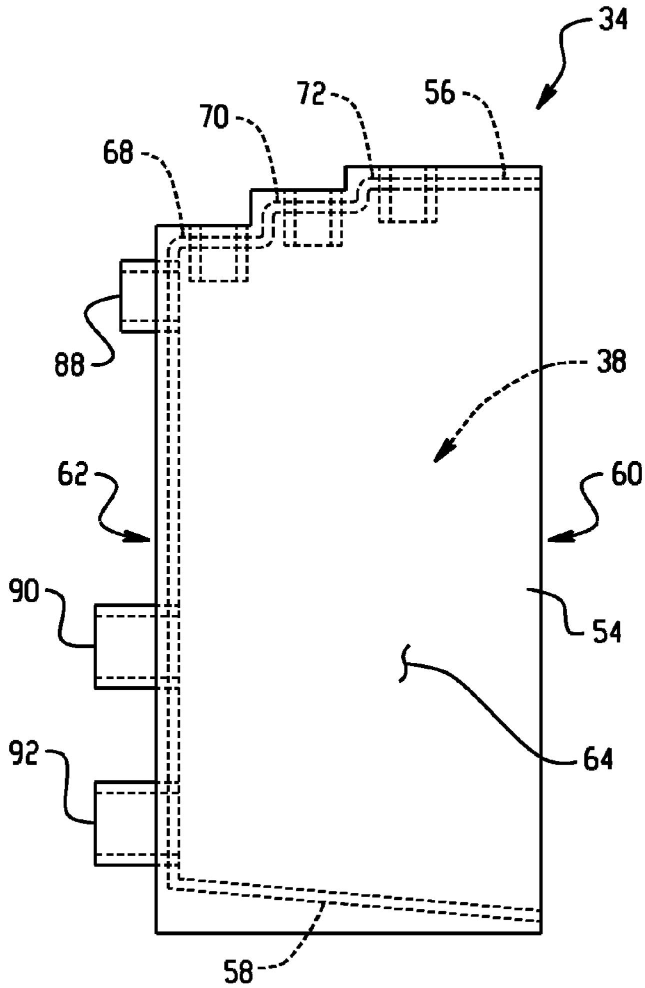

Fig. 2A

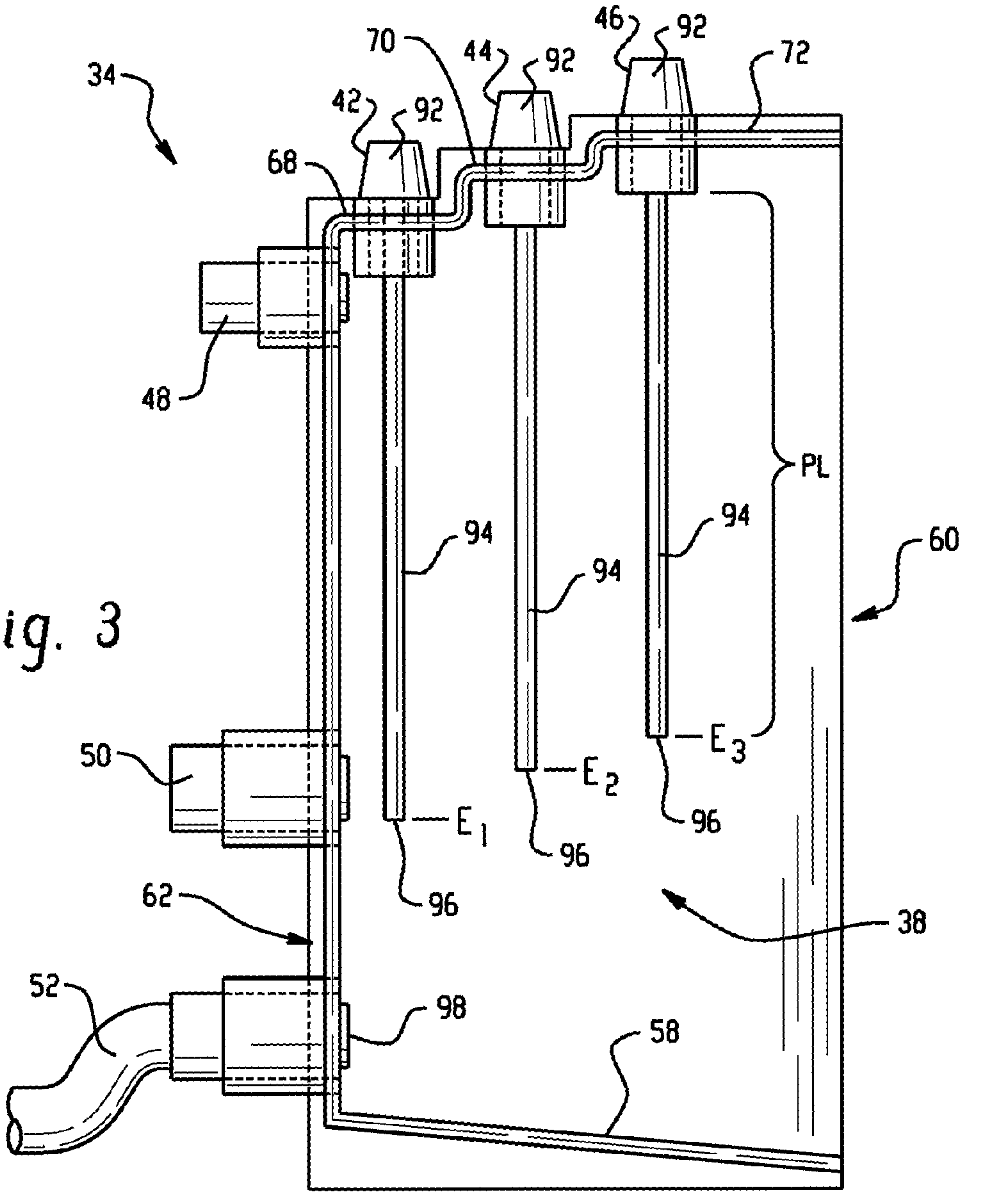
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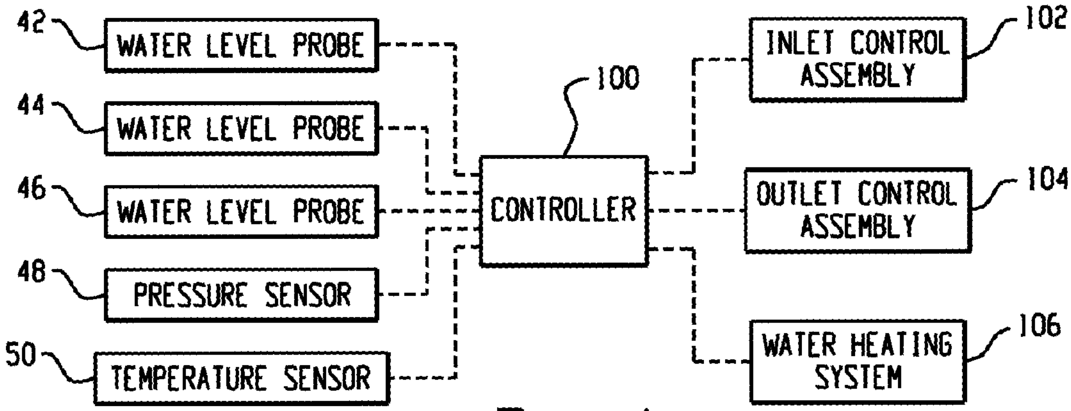
Fig. 3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WATER LEVEL PROBE
46
WATER LEVEL PROBE
48
PRESSURE SENSOR
50
TEMPERATURE SENSOR
100
CONTROLLER
102
INLET CONTROL ASSEMBLY
104
OUTLET CONTROL ASSEMBLY
106
WATER HEATING SYSTEM

Fig. 4

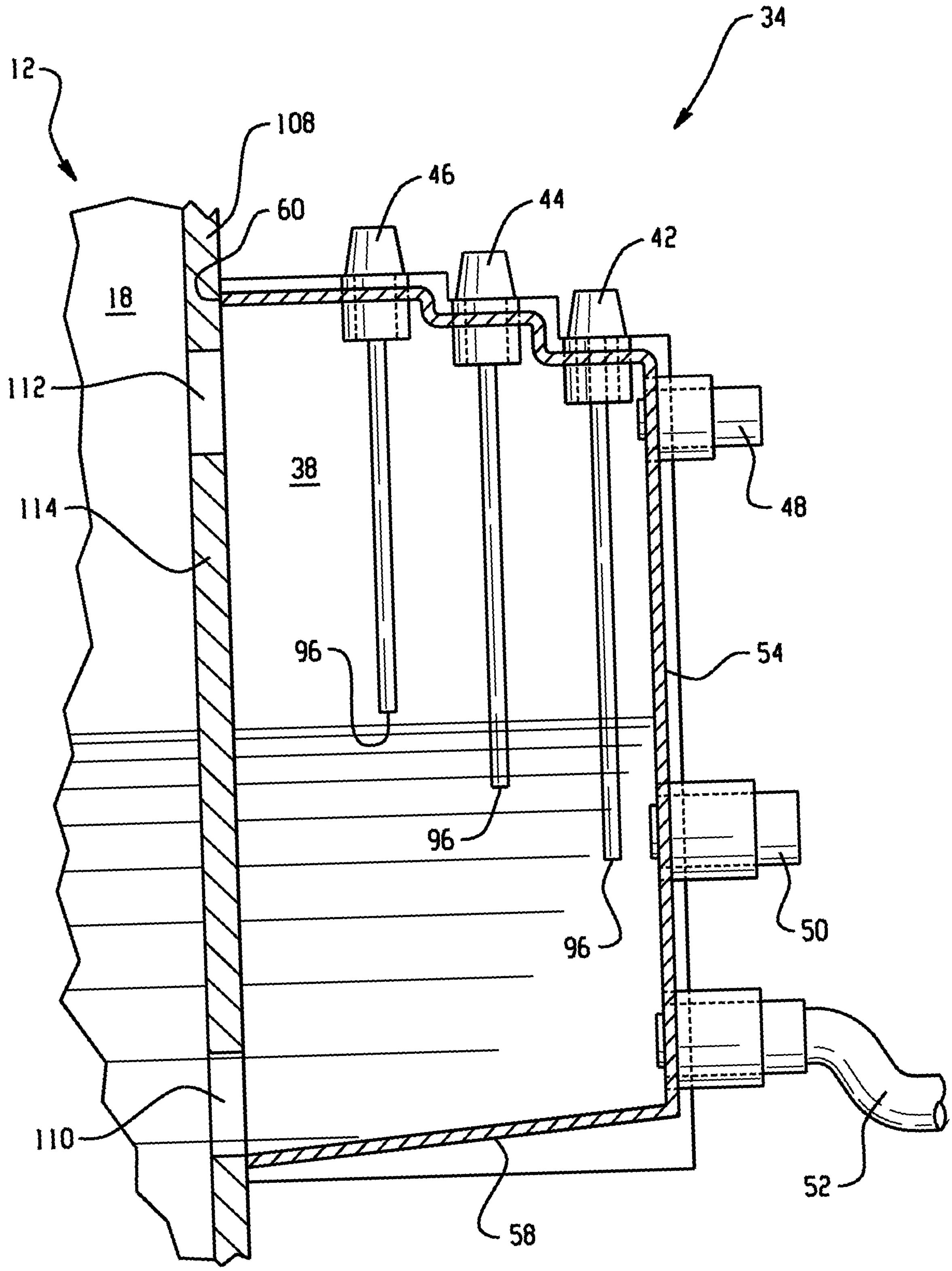

Fig. 5

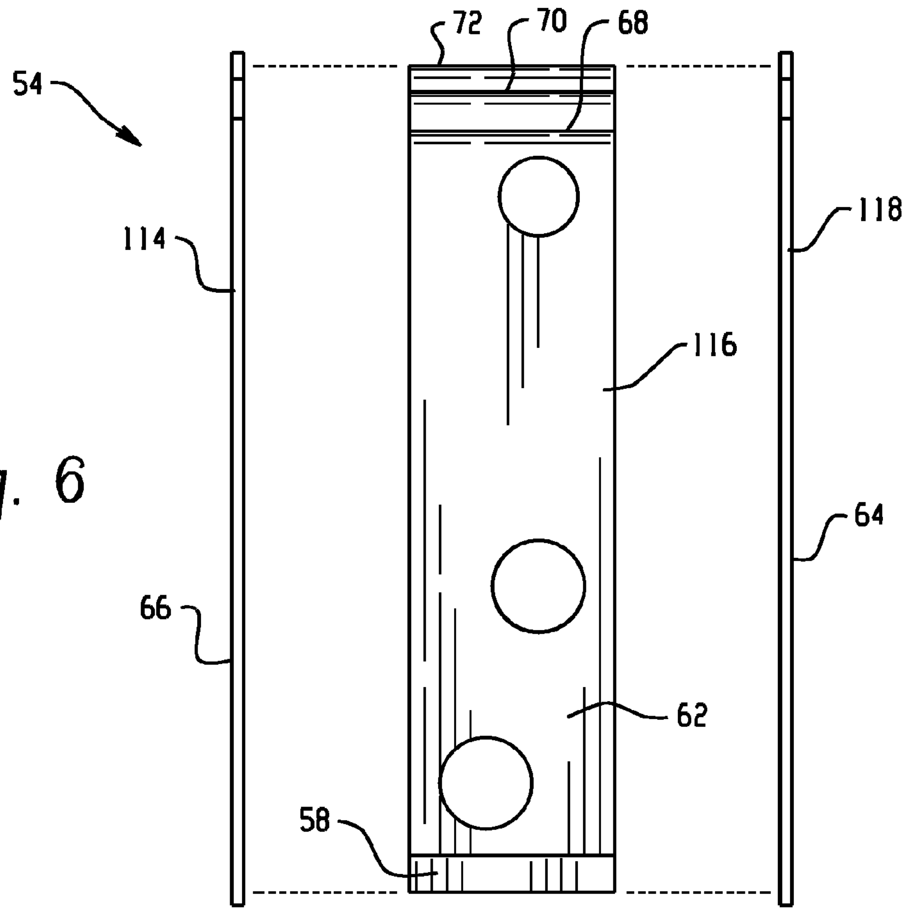

Fig. 6

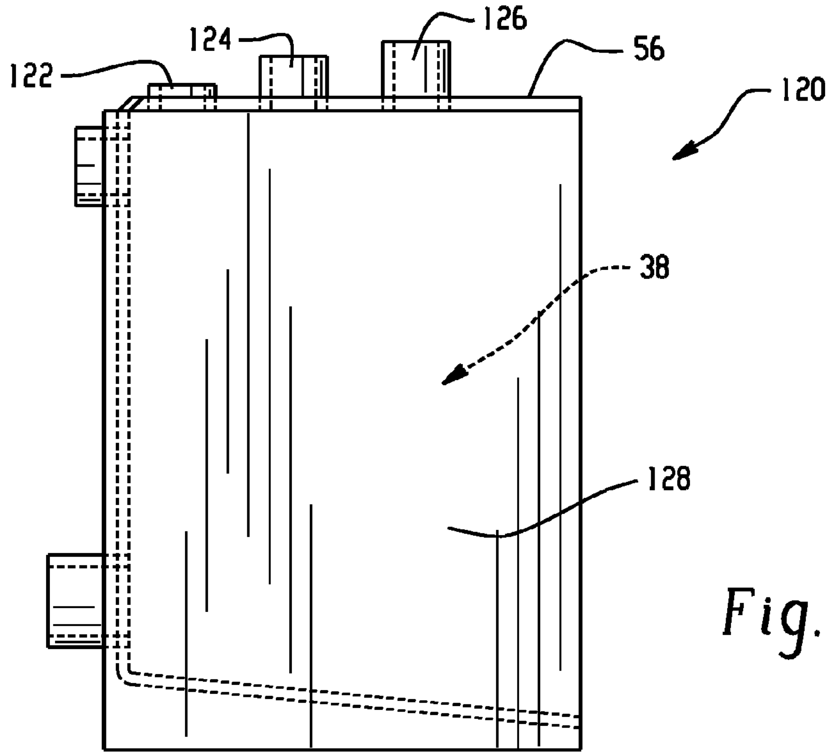

Fig. 7

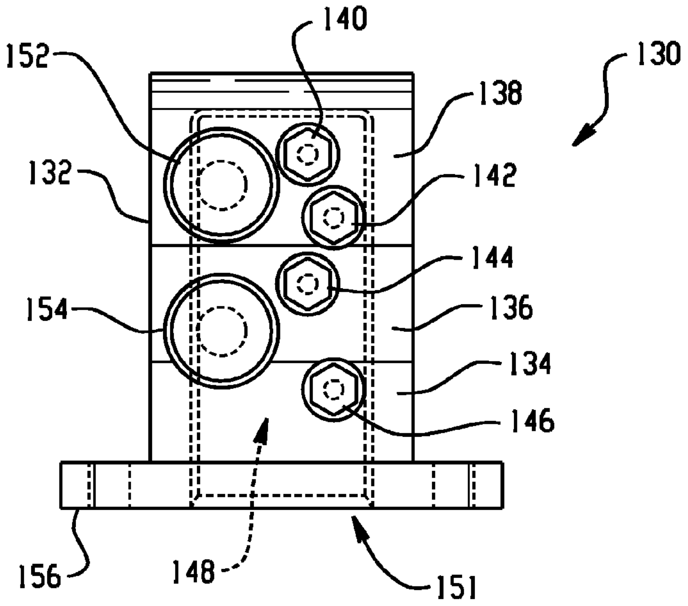

Fig. 8C

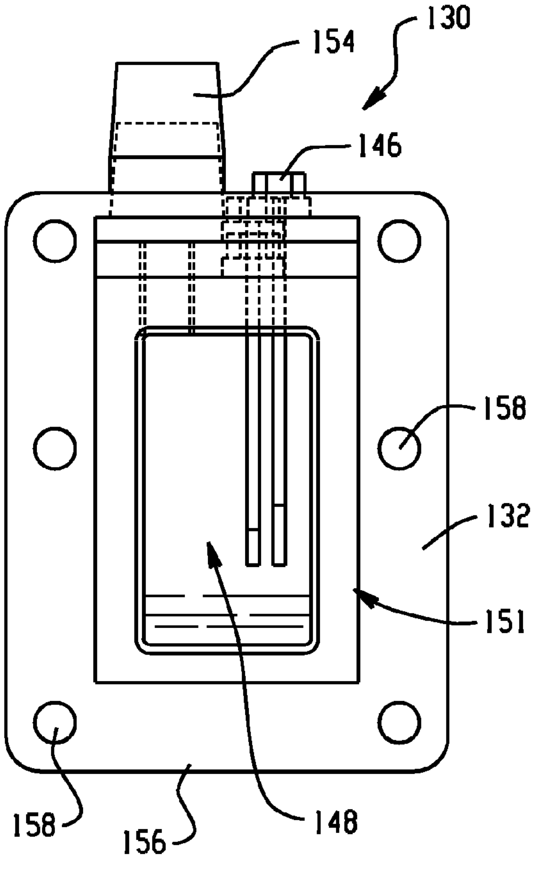

Fig. 8B

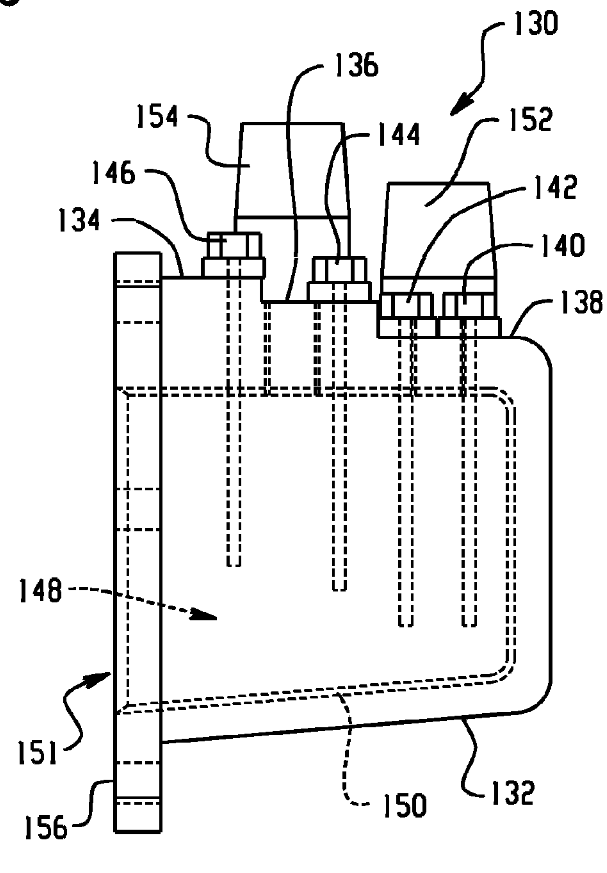

Fig. 8A