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(54) **Steam cleaning apparatus**

(57) A steam cleaning device comprises a housing; a steam head coupled to the housing and arranged to clean a surface; a thermal heat store and an electrical circuit. The electrical circuit comprises an electrical heating element for heating the thermal heat store. The steam cleaning device comprises a water cooling circuit comprising a water input in fluid communication with a water tank and a steam output in fluid communication with the steam head and a fluid flow path between the water input

and the steam output. The water cooling circuit is in thermal contact with the thermal heat store. The thermal heat store comprises a meltable portion arranged to be in a solid phase during normal operation of the steam cleaning device and the meltable portion is arranged to melt when the thermal heat store exceeds a normal operating temperature. The electrical circuit comprises at least one electrical circuit breaking device located near the meltable portion.

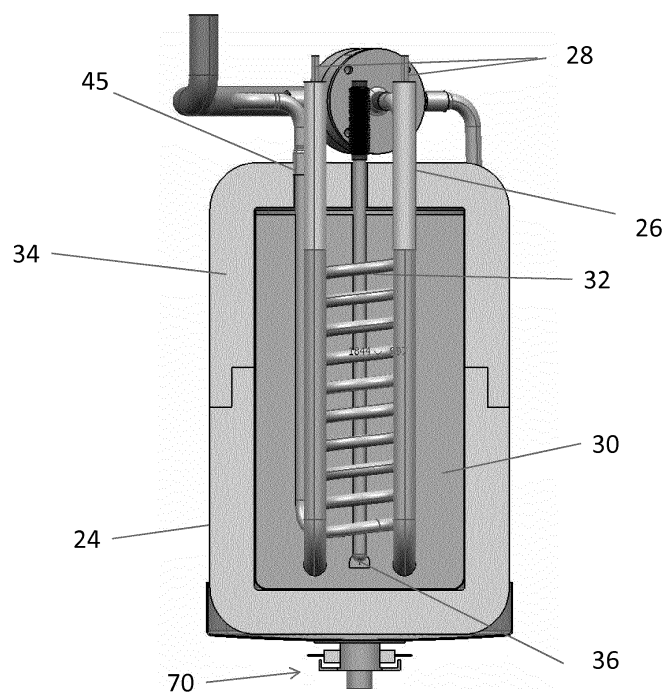


Figure 2

Description

[0001] The present invention relates to a steam cleaning apparatus. In particular the present invention relates to a steam cleaning apparatus which can be used for cleaning when disconnected from an external source electrical power.

[0002] Steam cleaning appliances having become increasingly popular over the last few years. An example of such a steam cleaning apparatus is a steam cleaning mop for cleaning tiled or hardwood floors. Handheld steam cleaning appliances can be used for cleaning work surfaces such as in the kitchen.

[0003] A steam cleaning apparatus comprises a boiler which transfers sufficient heat energy to water in order to convert it into steam. The steam is then directed via a steam cleaning head to the surface which is to be cleaned. Current steam cleaning appliances are powered by an external source of electricity which supplies energy to an electrical heating element in a boiler. A problem with using an external source of electricity is that the steam cleaning apparatus must be connected by an electrical cord to the electricity power supply. This means that the steam cleaning apparatus is tethered to the electricity socket and the user can only use the steam cleaning apparatus within a certain distance of the electricity socket.

[0004] EP1795108 discloses a cleaner having a steam generator having an external power supply for supplying AC electricity to a steam generator. The cleaner also has a battery which may be charged from the AC power supply. The battery can supply power to the steam generator and generate steam once the AC power supply is disconnected.

[0005] A problem with using a battery to supply power to a steam generator is that energy is required to raise the ambient temperature of the water and a significant amount of energy is required to change the phase of water from liquid to steam. The energy stored in a battery is limited and this will mean that there may be a very short runtime when the steam cleaner is solely running on a battery.

[0006] Other steam generators are known. US 2007/0133962 discloses a reheatable steam cleaning device that can be used with or without a power cord. The steam cleaning device comprises a pressure vessel and a power base station working in conjunction with the steam pressure vessel. When the steam cleaning device is coupled to the power base station, the electrical heating element heats the water in the pressure vessel. The electrical heating circuit comprises a thermostat and a thermal fuse. The thermal fuse can prevent the device from overheating. A problem with this arrangement is that the arrangement requires a pressurised heating chamber which holds the water for steam production and the pressurised steam together. If the thermal fuse trips, the pressure vessel will still contain pressurised steam which the user may not know about and could accidentally release.

Another problem is that these types of steam cleaners take a long time to reuse, and if the user has to refill the pressure vessel, the user has to wait for the pressure vessel to cool down and then heat up again.

[0007] Embodiments of the present invention aim to address the aforementioned problems.

[0008] According to an aspect of the present invention there is a steam cleaning device comprising: a housing; a steam head coupled to the housing and arranged to clean a surface; a thermal heat store; an electrical circuit comprising an electrical heating element for heating the thermal heat store; and a water cooling circuit comprising a water input in fluid communication with a water tank and a steam output in fluid communication with the steam head and a fluid flow path between the water input and the steam output, wherein the water cooling circuit is in thermal contact with the thermal heat store; wherein the thermal heat store comprises a meltable portion arranged to be in a solid phase during normal operation of the steam cleaning device and the meltable portion is arranged to melt when the thermal heat store exceeds a normal operating temperature; and the electrical circuit comprises at least one electrical circuit breaking device located near the meltable portion.

[0009] The melting characteristic of the thermal heat store is a physical property which does not vary. By using an inherent melting property of the thermal heat store of the steam cleaning apparatus, the steam cleaning apparatus can be reliably operated at a higher temperature close to the melting temperature. This means that if a fault develops on the steam cleaning apparatus, the steam cleaning apparatus will not be able to overheat, burn out or catch fire because the meltable portion of the thermal heat store will melt. The steam cleaning apparatus will stop producing steam and will not burn out. The user will not accidentally expose themselves to overheated steam after the apparatus has stop working either. By using a meltable portion of the thermal heat store to trip the electrical circuit breaking device, a high temperature boiler is compatible with existing electrical components which trip at lower temperatures. This means that the steam cleaning apparatus will heat up quicker.

[0010] Preferably the at least one electrical circuit breaking device is a thermal trip which is arranged to trip when the liquid meltable portion is in proximity of the thermal trip. Preferably the thermal trip has an activation temperature less than the melting temperature of the meltable portion. This means that the thermal trip activates when the high temperature meltable portion touches the thermal trip. Since the melting point of the meltable portion is an inherent characteristic, the thermal trip will always trip once the meltable portion has melted.

[0011] Preferably the at least one electrical circuit breaking device is located beneath the meltable portion of the thermal heat store such that the liquid melted portion falls under gravity onto the at least one electrical circuit breaking device. Since the liquid flows under the force of gravity, the liquid meltable portion will always

flow on to the thermal fuse providing a reliable tripping mechanism.

[0012] Preferably the steam cleaning device comprises an insulating jacket for housing the thermal store. This means that the thermal energy in the thermal energy store is better retained in the thermal heat store and not lost to the surrounding environment.

[0013] Preferably the insulating jacket is between the meltable portion and the at least one electrical circuit breaking device and the insulating jacket comprises a hole for passage of the liquid meltable portion there-through. In this way the hole better guides the liquid meltable portion to the thermal fuse.

[0014] Preferably the heating element is embedded in the thermal heat store. Preferably the thermal heat store is cylindrical. This means that the thermal heat store is the easiest shape to manufacture whilst being efficient at retaining the stored thermal energy due to the ratio of mass to surface area.

[0015] Preferably the at least one electrical circuit breaking device is adjacent to the underside of the thermal heat store.

[0016] Preferably the thermal heat store is a metal, metal alloy and / or electrical conductor.

[0017] Preferably the at least one electrical circuit breaker is an electrical fuse or an electrical circuit breaker and the liquid meltable portion is electrically conductive and connects an electrical circuit when the liquid meltable portion is in contact with the at least one electrical circuit breaking device and thereby breaks the electrical circuit comprising the heating element.

[0018] Preferably the steam cleaning device comprises a tilt sensor arranged to break the electrical circuit comprising the electrical heating element if the steam cleaning device is not upright. This means that the steam cleaning apparatus will only charge in the upright position which in turn means the meltable portion will only melt in a position whereby it can flow under gravity on to the thermal fuse.

[0019] Preferably the at least one circuit breaking device is located in a tray for collecting the liquid meltable portion. This means that the liquid meltable portion can collect around the electrical circuit breaking device and more reliably trip.

[0020] Preferably the at least one electrical circuit breaking device is a plurality of electrical circuit breaking devices positioned on a plurality of faces of the thermal heat store. This means that at least one of the electrical circuit breaking devices will trip if there is a fault no matter what orientation the steam cleaning apparatus is in.

[0021] Preferably the meltable portion of the thermal heat store is located at the hottest part of the thermal heat store during operation. This means that the meltable portion will always melt when the boiler overheats. Preferably the whole thermal heat store is made from the same material as the meltable material. In this way the meltable portion is the portion which will melt first because it is at the hottest point of thermal heat store.

[0022] Various other aspects and further embodiments are also described in the following detailed description and in the attached claims with reference to the accompanying drawings, in which:

Figure 1 shows a perspective view of the steam cleaning apparatus;

Figure 2 shows a partial cross sectional view of the steam cleaning apparatus;

Figure 3 shows a partial perspective view of the steam cleaning apparatus;

Figure 4 shows a schematic block diagram of the steam cleaning apparatus;

Figure 5 shows a partial cross sectional view of the steam cleaning apparatus;

Figure 6 shows another partial cross sectional view of the steam cleaning apparatus;

Figure 7 shows a circuit diagram of the steam cleaning apparatus;

Figure 8 shows another circuit diagram of the steam cleaning apparatus; and

Figure 9 shows a partial cross sectional view of the steam cleaning apparatus.

[0023] Figure 1 shows a perspective view of a steam cleaning apparatus 10. The steam cleaning apparatus can be any appliance for generating steam for cleaning surfaces. Figure 1 shows an exemplary steam mop 10 which is a non-limiting example of a steam cleaning appliance. Hereinafter the term steam mop will be used to describe the steam cleaning appliance, but the present invention can be applicable to steam cleaning appliances other than steam mops.

[0024] The steam mop 10 comprises a steam head 12 for delivering steam to a surface to be cleaned. Typical surfaces are tiled floors or hardwood floors, but other surfaces may be cleaned with the steam mop 10. The steam head 12 may comprise a pad or cloth (not shown) fixed to the underside of the steam head 12 to pick up dirt dislodged by the steam cleaning action.

[0025] The steam head 12 is coupled to a body 14 by an articulated joint 16. The articulated joint 16 may comprise a universal joint for allowing at least two degrees of freedom between the steam head 12 and the body 14. The articulated joint 16 is hollow and comprises a steam duct (not shown) for delivering steam to the steam head 12.

[0026] The body 14 of the steam mop may comprise a clam shell construction. The two halves of the clam shell are fixed together with screws and encase a steam generating apparatus 24. The steam generating apparatus 24 is not shown in Figure 1, but will be described in further detail in the subsequent Figures.

[0027] The body 14 is coupled to a water tank 18 for holding a water reservoir. The water tank 18 is in fluid communication with the steam generating apparatus 24. The water tank 18 may be removable for allowing the user to refill with water.

[0028] A handle 20 is coupled to the body 14 and provides a grippable portion for the user to hold during use. The body 14 and the handle 20 may have controls for operating the steam mop. The controls are coupled to an electronic controlling circuit (not shown). The steam mop 10 comprises an electrical heating circuit 60 which may be electrically coupled to a power cord (not shown) for connecting to an alternating current (AC) electricity supply. The AC electricity supply is configured to deliver electrical energy to the steam generating apparatus 24. In some embodiments a power cord is not needed because the steam mop 10 electrically and physically couples with a docking and charging station. In some alternative embodiments, the steam mop may be powered by a DC electricity supply such as a battery (not shown).

[0029] Turning to Figure 2, which shows a schematic cross sectional diagram of the steam generating apparatus 24 will be described in further detail. The steam generating apparatus in some embodiments is a boiler 24 and will be referred to hereinafter as a boiler. The boiler 24 comprises a resistive electrical heating element 26. The ends 28 of the resistive heating element 26 are electrically coupled to the electric heating circuit 60 which is shown in more detail in Figure 4. The electric heating circuit 60 comprises an electrical circuit breaking device 70 which will be discussed in further detail in relation to figures 4, 5, 6 and 7.

[0030] The resistive heating element 26 is embedded in a solid thermal mass 30. The thermal mass 30 is configured to be heated by the resistive heating element 26. By heating the thermal mass 30 with the resistive heating element 26, electrical energy is converted to thermal energy and the thermal energy is stored in the thermal mass. The thermal mass 30 is a thermal heat store but will be referred to a thermal mass hereinafter. A portion of a water cooling circuit 32 is also embedded within the thermal mass 30. The water cooling circuit 32 provides a water heating path across the boiler 24 extending from a boiler water input 45 to a boiler superheated steam output 47. As the water flows through the water heating path 32, the water is heated and turned into steam. In some embodiments the water cooling circuit 32 is a helical coil, however in other embodiments the water cooling circuit 32 may have a conduit following a different path through the thermal mass. Ideally the water cooling circuit 32 traces a circuitous route through the thermal mass heat the water to a sufficient degree. This also aids draining the thermal energy from the thermal mass 30. In some embodiments the thermal mass 30 is integral with the boiler 24. This means that if the thermal mass 30 is not a good thermal conductor, the thermal mass immediately surrounds the water cooling circuit 32 and the resistive heating element 26.

[0031] In some embodiments, the thermal mass is a cylinder or substantially cylindrical. By using a cylinder, the thermal energy density of the thermal mass 30 can be increased over other volumes such as cubes or cuboids. The cylindrical shape has a good ratio of volume

to surface area. In another embodiment the thermal mass is spherical in shape. However a cylinder is preferable because the helical coil is easier to manufacture and embedded in a cylinder.

[0032] In some embodiments the thermal mass 30 comprises a metal material although the thermal mass can be any material suitable for storing thermal energy.

[0033] The resistive heating element 26 heats the thermal mass 30 up to an initial operating temperature. The initial operating temperature is close but below the melting point, for example at about 400°C, of the material of the solid thermal mass. Preferably in some embodiments the thermal mass is heated between 400 - 425 °C.

[0034] When the thermal mass 30 is heated to its initial operating temperature, the resistive heating element 26 is no longer needed to heat the thermal mass 30. At this point, the thermal mass 30 stores enough energy to heat and power the boiler 24 without an additional heating source. This means that the steam cleaning device 10 can be used remote from an electrical power source. As the water is converted into steam by the boiler 24, the temperature of the thermal mass 30 is reduced as the boiler 24 depletes the thermal energy from the thermal mass 30.

[0035] In order to achieve a useful runtime with the boiler 24 using energy from the thermal mass 30, the thermal mass 30 needs to be heated to a temperature which is significantly higher than the boiling point of water. This means that the boiler will operate at a very high temperature and initially generate superheated steam at the boiler superheated steam output 47 when water flows through the water cooling circuit.

[0036] Turning back to Figure 2, the thermal mass 30 is surrounded with an insulating jacket 34 which limits heat loss from the external surfaces of the thermal mass 30. The insulating jacket 34 comprises two halves which couple together to completely encase the thermal mass. The insulating jacket 34 is made from a ceramic material but the insulating jacket can be made from any suitable insulator.

[0037] A thermostat or thermocouple 36 is also embedded in the thermal mass 30 for determining the temperature of the thermal mass 30. The thermostat 36 is coupled to the electronic controlling circuit (not shown) and the electronic controlling circuit switches off the electrical power to the heating element 26 once the thermal mass reaches a predetermined temperature.

[0038] The predetermined temperature of the thermal mass is selected on the basis that the thermal mass stores sufficient thermal energy to convert a required mass of water to steam without supplying further energy to the thermal mass. In this way the steam mop 10 can be heated up with an AC electricity supply and then used remotely without an electricity supply.

[0039] Since the thermal mass 30 has to be heated in excess of the boiling point of water, the superheated steam initially exits the boiler 24 at the boiler superheated steam output 47. The superheated steam is unnecessary

for the application of domestic steam cleaning and the temperature of the superheated steam is reduced until it becomes wet steam. Optionally the temperature of the superheated steam can be reduced such that it is wet steam, the steam cleaning device can be made with conventional plastics material which can withstand the lower temperature of the steam.

[0040] The water cooling circuit 32 will now be discussed in reference to Figure 3. Figure 3 shows a schematic perspective view of the steam generating apparatus 22 without the thermal jacket 34.

[0041] Water is supplied from the water tank 18 to the steam generating apparatus 22 by cold water tube 38. The cold water tube 38 is coupled to an optional steam cooling element 40. The embodiment as described in reference to Figure 3, the optional steam cooling element 40 is also a heat recovery element 40 and the cold water tube is coupled via water inlet 42. The water then flows out of the heat recovery element 40 via water outlet 44. The water outlet is coupled to and in fluid communication with the embedded helical coil 33 via a boiler water input 45. As the water flows through the helical coil 33, the water heats up and is converted into steam. The other end of the helical coil 33 comprises a boiler superheated steam output 47 and the boiler superheated steam output 47 is coupled to and in fluid communication with a steam inlet 46 of the heat recovery element 40. Wet steam passes out of the heat recovery element 40 via steam outlet 48. The steam outlet 48 is coupled to the steam head 12 via conduit 50. As indicated above, the steam cooling element 40 is an optional feature and is not necessary.

[0042] Operation of the steam mop 10 will now be discussed in reference to Figure 4, which shows a schematic flow diagram of the steam mop 10. First the user turns the steam mop 10 on. This connects the electrical heating circuit 60 to an AC electrical supply 66. The electrical heating circuit 60 is coupled to the resistive heating element 26 via an electrical circuit breaking device 70. The heating element 26 heats the thermal mass 30 of the steam generating apparatus 22 until the thermal mass 30 reaches a predetermined temperature (e.g. 400°C). As mentioned above, the thermal mass 30 is thermally coupled to the boiler 24 because the thermal mass 30 is integral with the boiler 24. At this point the steam mop 10 is fully charged and the user can use the steam mop 10. A user may then disconnect the steam mop 10 from the electrical supply 66. Due to the low heat loss achieved by the insulation, the user can leave the steam mop 10 disconnected for over an hour and the boiler 24 is still able to produce enough usable steam.

[0043] Water is stored in a water tank 18. When the user operates the steam mop 10 an internal battery 64 powers a pump 62. The pump 62 pumps water from the water tank 18 to the heat recovery element 40 via the water inlet 42. The cold water passes over the heat exchanger 56 and the cold water absorbs the thermal energy from the hot heat exchanger 56. The warm water exits the heat recovery element 40 via the water outlet

44. The warm water then passes through the water cooling circuit 32 comprising the helical coil 33 and is converted into superheated steam in the boiler 24. The superheated steam enters the heat recovery element at steam inlet 46. The superheated steam passes over the heat exchanger 56 and dissipates thermal energy to the heat exchanger 56 which cools the steam. Cooler steam then exits the heat recovery element 40 at steam outlet 48 and the steam is delivered to the steam head 12.

[0044] For safe operation of the steam cleaning apparatus 10, it is desirable to have a secondary failsafe to switch off the electrical power to the heating element 26. This is because if a fault develops in the thermostat or the thermocouple 36 connected to the control circuit, the electrical power may not be switched off to the heating element 26. This could mean that the heating element 26 is uncontrolled and could reach a temperature above the safe working limits of various components in the steam mop 100. Furthermore components of the steam mop 10 could burn out or damage the steam cleaning apparatus 10. The electrical circuit breaking device 70 trips and stops the electric heating circuit 60 powering the heating elements 26 if the boiler 24 overheats.

[0045] The electrical circuit breaking device 70 will now be discussed in further detail in reference to figures 5 to 9. Figure 5 shows a detailed schematic cross sectional view of the electrical circuit breaking device 70. In some embodiments the electrical circuit breaking device can be any suitable means for breaking the electric heating circuit 60. In some embodiments the electric circuit breaking device 70 can be a circuit breaker. In other embodiments the electric circuit breaking device 70 can be a thermal trip. Preferably the electrical circuit breaking device cannot be reset. By providing a fusible element, once the fusible element fuses the steam cleaning device is rendered inoperable. This means that the user cannot carry on using the steam cleaning apparatus if a fault develops.

[0046] The boiler 24 comprises a meltable portion 75. The meltable portion 75 is arranged to melt if the boiler 24 exceeds a threshold temperature whereby the threshold temperature is the melting point of the meltable portion 75. The meltable portion 75 is engineered to be the first hot spot or the first zone to melt. In some embodiments the meltable portion 75 is integral with the thermal mass 30. The dotted line in Figure 5 represents that the meltable portion 75 is the part of the thermal mass 30 which melts first. The thermal mass 30 is entirely made from the same meltable material which melts when the temperature of the thermal mass 30 exceeds a predetermined threshold temperature. In some embodiments the threshold temperature for the thermal mass to melt at is at 450°C. This means that the meltable portion 75 only melts if the boiler 24 exceeds the normal operating temperature.

[0047] Alternatively in some other embodiments, the thermal mass 30 comprises a separate meltable portion 75 which is in thermal contact with the rest of the thermal

mass 30. The meltable portion 75 has a melting point which is lower than the melting point of the rest of the thermal mass 30. This means that the meltable portion 75 can be manufactured separately and combined with the boiler 24 at a later point. In some embodiments the meltable portion is inset in a recess 80 in the thermal mass 30 as shown in figure 6. Figure 6 is exactly the same as Figure 5, except that the meltable portion 75 is inset at the bottom of the thermal mass 30. The meltable portion 75 as shown in Figure 6 can be cast in situ in the recess in the thermal mass or placed in the recess so long as there is good thermal contact between the 75 mass 30 and the meltable portion. Alternatively the meltable portion 75 is positioned underneath the thermal mass 30, between the thermal mass 30 and the insulating jacket 34.

[0048] In some embodiments the meltable portion 75 coincides with the hottest point of the boiler 24 when the boiler is in use. This means that the meltable portion will always be the hottest part of the thermal mass 30 and if the boiler overheats, the meltable portion 75 will always melt first.

[0049] In some embodiments the meltable portion is a metal alloy or an intermetallic compound. An intermetallic compound has reliable properties with respect to its liquid state. This means that the intermetallic compound easier to cast. In some embodiments the metal alloy is a eutectic metal alloy. A eutectic metal alloy is advantageous because the melting point of the eutectic metal alloy can be significantly reduced. In some embodiments the meltable portion 75 comprises a metal material with a low melting point. In one embodiment the thermal mass is made from an intermetallic compound of Aluminium (Al), Magnesium (Mg) and Zinc (Zn) with a melting point of approximately 450°C. In some embodiments the intermetallic compound comprises a composition of Al-34%Mg-6%Zn. Advantageously an intermetallic compound with a composition of a composition of Al-34%Mg-6%Zn is an eutectic intermetallic compound with a melting point lower than each of Magnesium and Aluminium components. A relatively small amount of Zinc is needed and this reduces the melting point of the intermetallic compound by approximately 200°C.

[0050] The meltable portion 75 is positioned above a hole 76 in the insulating jacket 34. This means that when the meltable portion 75 changes phase from a solid to a liquid, the liquid meltable portion 75 is permitted to flow towards the electrical circuit breaking device 70. In some embodiments the meltable portion 75 is aligned with the hole 76 so that the liquid meltable portion flows towards the electric circuit breaking means under gravity. In some other embodiments the liquid meltable portion 75 will automatically flow through the hole because the meltable portion material expands when it turns into a liquid from a solid and the liquid meltable portion 75 is under pressure.

[0051] In one embodiment the electrical circuit breaking device 70 comprises a thermal fuse or thermal trip

72 which is in series with the electrical heating circuit 60. Figure 7 shows a simplified circuit diagram of the electrical heating circuit. The main supply 66 is in electrical series with the resistive heating element 26 and the electrical circuit breaking device 70.

[0052] The thermal trip 72 comprises two connections 73, 74 which are connected to the rest of the electrical heating circuit 60 (not shown in Figure 5). The thermal fuse is configured to trip if the thermal trip 72 is exposed to a temperature above a predetermined threshold. The predetermined threshold is a temperature which is below the normal operating temperature of the boiler 24. Typically the threshold temperature at which the thermal trip trips at is around 225°C. This means that the relatively small portion of meltable material can by giving up some energy easily raise the temperature of the thermal trip above its activation temperature. Optionally, the thermal trip 72 is located directly underneath the boiler 24. This means when the boiler 24 is in use, the thermal trip 72 is underneath the boiler 24 and the liquid meltable portion 75 will flow under gravity to the thermal trip 72. The thermal trip 72 is located in a metal collecting tray 78. The collecting tray 78 catches the liquid meltable portion 75.

[0053] If a fault occurs in the heating element 26, the thermal mass 30 will overheat. This will heat the meltable portion 75 such that it turns from a solid to a liquid. Typically the steam cleaning apparatus 10 will be connected to the main electricity supply whilst the steam cleaning apparatus 10 is in a vertical orientation and the thermal mass 30 is above the thermal trip 72. The liquid meltable portion 75 flows down through the hole 76 and comes into contact with the thermal trip 72. The temperature of the meltable portion 75 is approximately 450°C which significantly exceeds the threshold temperature of the thermal trip 72. The thermal trip 72 trips the electric heating circuit 60 and the steam cleaning apparatus 10 is no longer operable. Heat from the liquid meltable portion 75 quickly dissipates when it comes into contact with the collecting tray 78 which has a large surface area.

[0054] Alternatively the thermal trip 72 can be located at any point around the thermal mass and aligned with a hole in the insulating jacket if the flow of the liquid meltable portion 75 is due to the expansion of the liquid phase of the meltable material.

[0055] Figure 8 shows a circuit diagram of an alternative embodiment. Figure 9 shows the same figure as Figures 5 and 6 except that the thermal trip has been replaced. In the alternative embodiment, the thermal trip 72 is replaced with an electrical trip 80 for protecting against an electrical short. The electrical trip 80 does not have to be located in the collecting tray 84 may be located anywhere in the steam cleaning apparatus 10. The electrical trip 80 is not shown in Figure 9.

[0056] The electrical heating circuit 60 as shown in figure 8 comprises an open branch 82 of a parallel circuit. The open branch 82 of the parallel circuit is housed in the modified collecting tray 84. The modified collecting tray 84 comprises two connection points 86, 88 which

are electrically insulated from each other. However when the liquid metallic material flows into the tray, the two connection points 86 and 88 are in electrical connection and the heating circuit 60 shorts. This in turn makes the electrical trip 80 trip and stops power being delivered to the electric heating circuit.

[0057] In some embodiments the steam cleaning apparatus comprises a tilt switch (not shown). The tilt switch is in series with the electrical heating circuit and is in an "ON" position when the steam cleaning apparatus is in a vertical position. This means that the steam cleaning apparatus 10 will only be able to heat the thermal mass 30 when the steam cleaning apparatus 1 is in an upright position. This also means that since the electrical heating circuit 60 is only operational when the steam cleaning apparatus 10 is upright, the meltable portion 75 will flow under gravity on to the thermal trip 72. The tilt switch can be any suitable means for detecting inclination of the steam cleaning apparatus 10. For example, the tilt switch can be a mercury tilt switch or a ball bearing tilt switch.

[0058] In some alternative embodiments there can be a plurality of the electrical circuit breaking devices as described in relation to the previous embodiments wherein each of the electrical circuit breaking devices is positioned on a different side of the thermal mass 30.

[0059] In another embodiment two or more embodiments are combined. Features of one embodiment can be combined with features of other embodiments.

[0060] Embodiments of the present invention have been discussed with particular reference to the examples illustrated. However it will be appreciated that variations and modifications may be made to the examples described within the scope of the invention.

Claims

1. A steam cleaning device comprising:

a housing;
a steam head coupled to the housing and arranged to clean a surface;
a thermal heat store;
an electrical circuit comprising an electrical heating element for heating the thermal heat store; and
a water cooling circuit comprising a water input in fluid communication with a water tank and a steam output in fluid communication with the steam head and a fluid flow path between the water input and the steam output, wherein the water cooling circuit is in thermal contact with the thermal heat store;
wherein the thermal heat store comprises a meltable portion arranged to be in a solid phase during normal operation of the steam cleaning device and the meltable portion is arranged to melt when the thermal heat store exceeds a nor-

mal operating temperature;

and the electrical circuit comprises at least one electrical circuit breaking device located near the meltable portion.

2. A steam cleaning device according to claim 1 wherein the at least one electrical circuit breaking device is a thermal trip which is arranged to trip when the liquid meltable portion is in proximity of the thermal trip.
3. A steam cleaning device according to claim 2 wherein the thermal trip has an activation temperature less than the melting temperature of the meltable portion.
4. A steam cleaning device according to any of the preceding claims wherein the at least one electrical circuit breaking device is located beneath the meltable portion of the thermal heat store such that the liquid melted portion falls under gravity onto the at least one electrical circuit breaking device.
5. A steam cleaning device according to any of the preceding claims wherein the steam cleaning device comprises an insulating jacket for housing the thermal store.
6. A steam cleaning device according to claim 5 wherein the insulating jacket is between the meltable portion and the at least one electrical circuit breaking device and the insulating jacket comprises a hole for passage of the liquid meltable portion therethrough.
7. A steam cleaning device according to any of the preceding claims wherein the heating element is embedded in the thermal heat store.
8. A steam cleaning device according to any of the preceding claims wherein the thermal heat store is cylindrical.
9. A steam cleaning device according to any of the preceding claims wherein the at least one electrical circuit breaking device is adjacent to the underside of the thermal heat store.
10. A steam cleaning device according to any of the preceding claims wherein the thermal heat store is a metal, metal alloy or electrical conductor.
11. A steam cleaning device according to claim 10 wherein the at least one electrical circuit breaker is an electrical fuse or an electrical circuit breaker and the liquid meltable portion is electrically conductive and connects an electrical circuit when the liquid meltable portion is in contact with the at least one electrical circuit breaking device and thereby breaks the electrical circuit to the heating element.

12. A steam cleaning device according to any of the preceding claims wherein the steam cleaning device comprises a tilt sensor arranged to break the electrical circuit to the electrical heating element if the steam cleaning device is not upright. 5
13. A steam cleaning device according to any of the preceding claims wherein the at least one circuit breaking device is located in a tray for collecting the liquid meltable portion. 10
14. A steam cleaning device according to any of the preceding claims wherein the at least one electrical circuit breaking device is a plurality of electrical circuit breaking devices positioned on a plurality of faces of the thermal heat store. 15
15. A steam generating device according to any of the previous embodiments wherein the meltable portion of the thermal heat store is located at the hottest part of the thermal heat store during operation. 20

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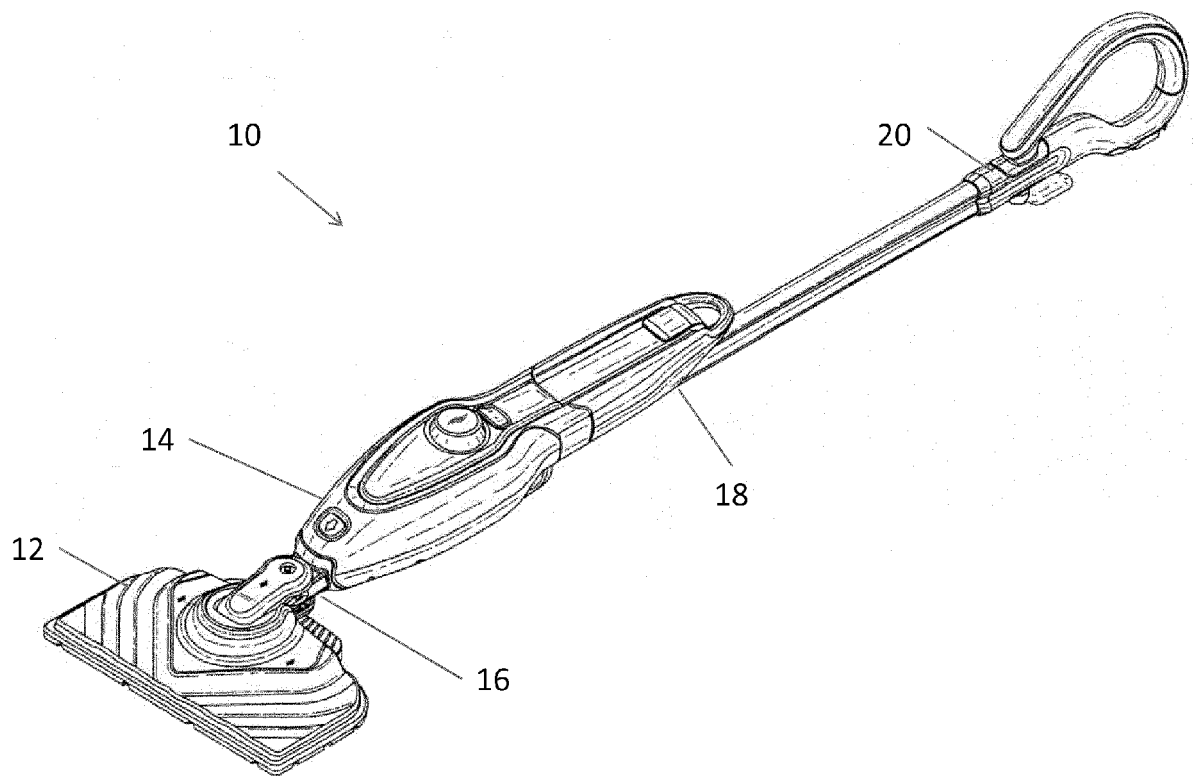


Figure 1

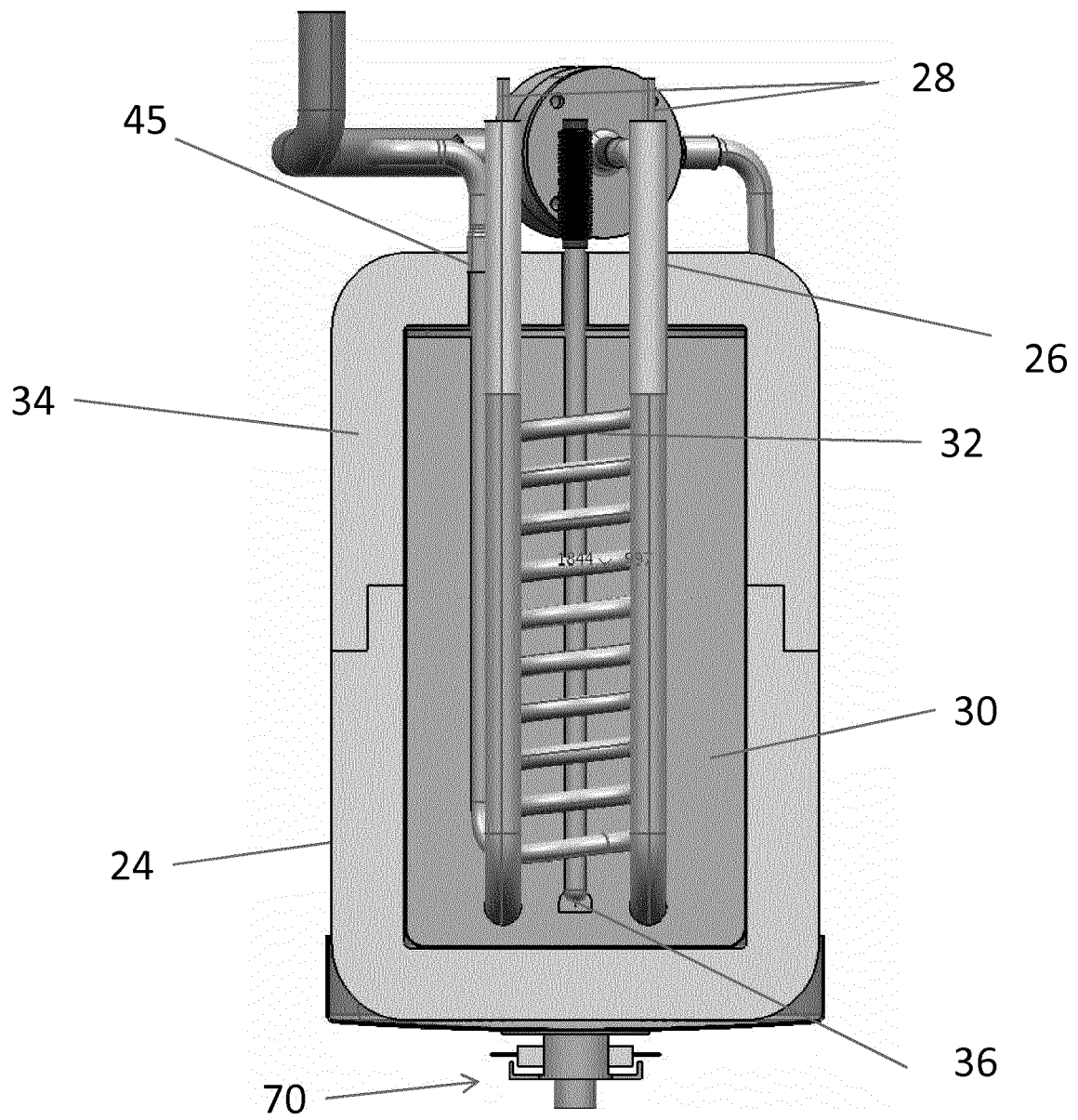


Figure 2

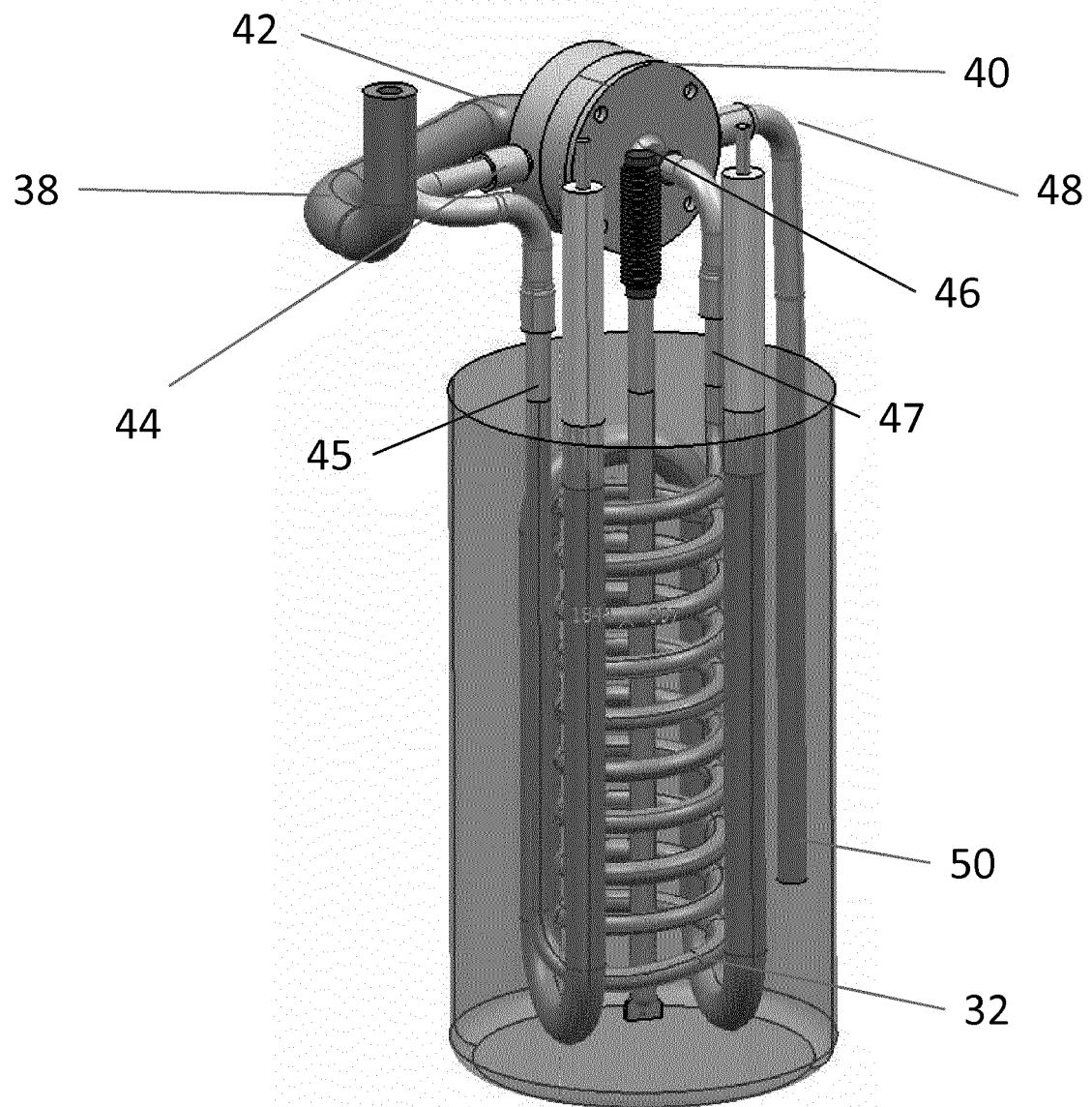


Figure 3

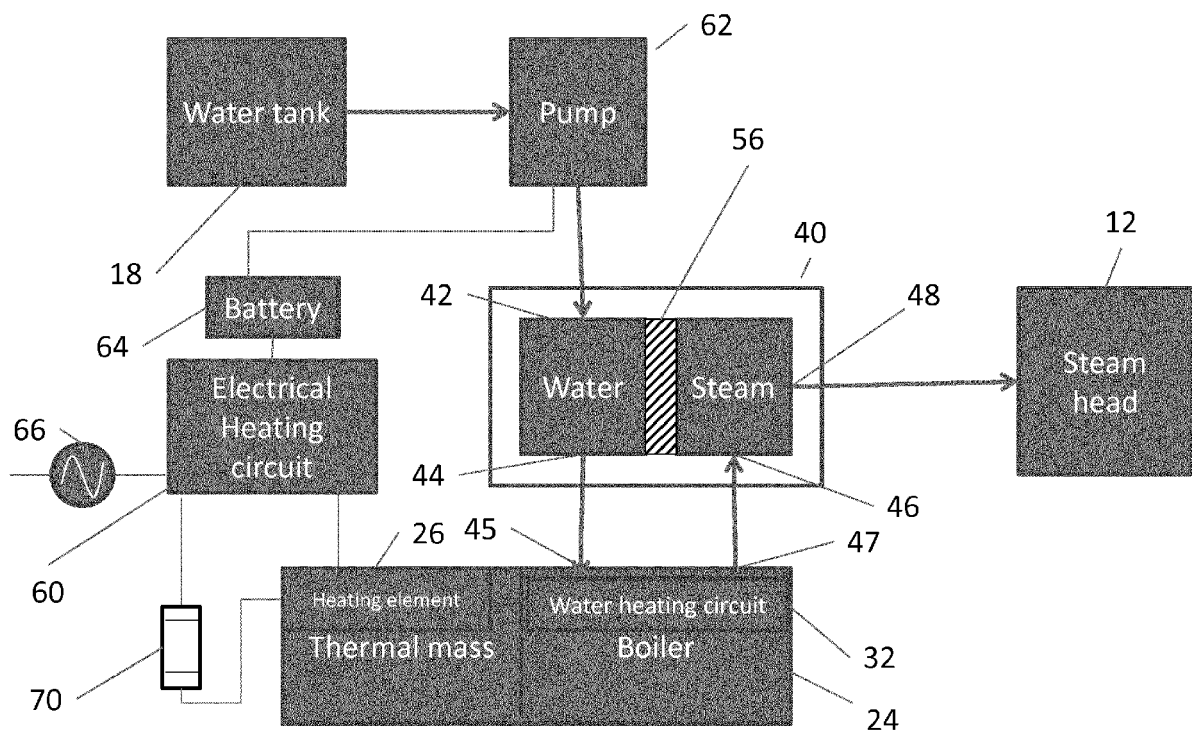


Figure 4

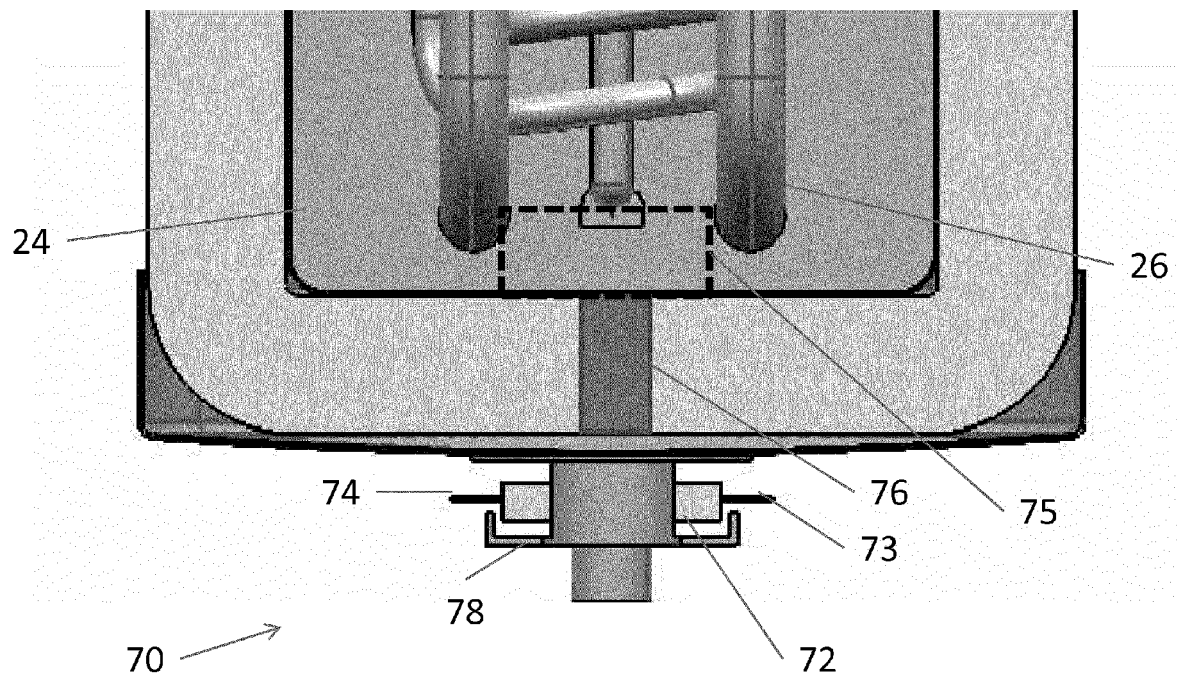


Figure 5

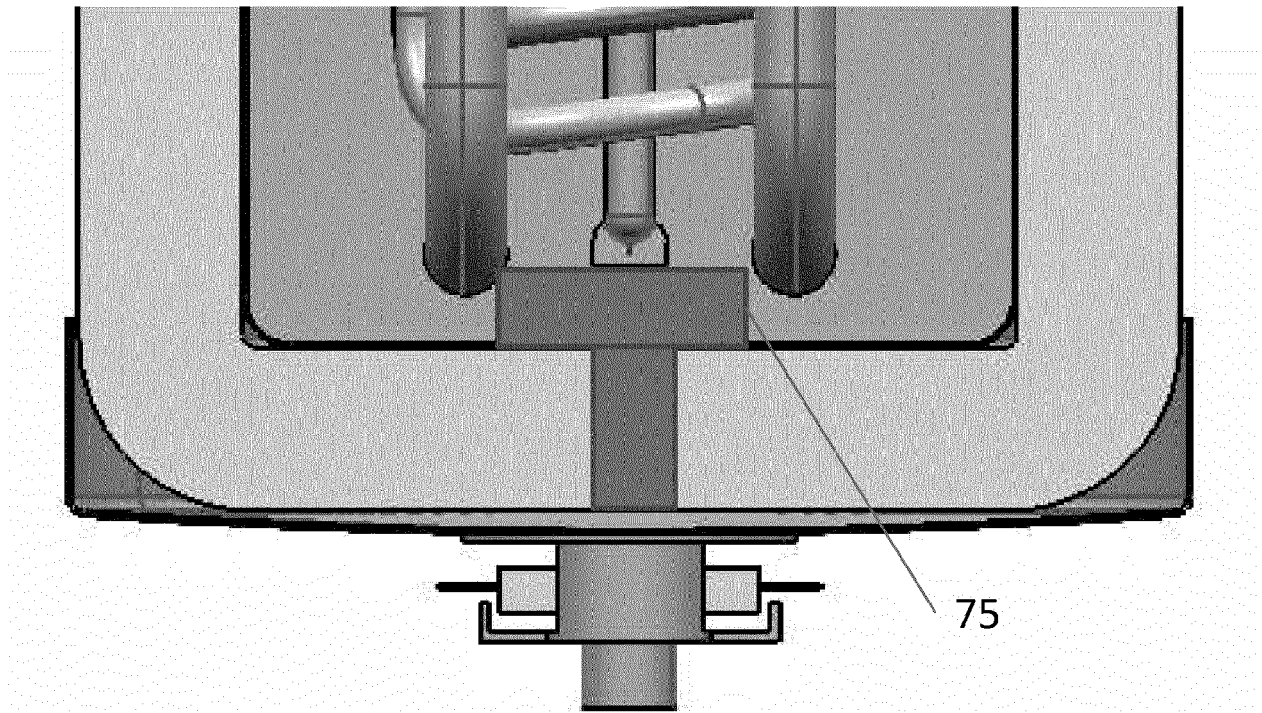


Figure 6

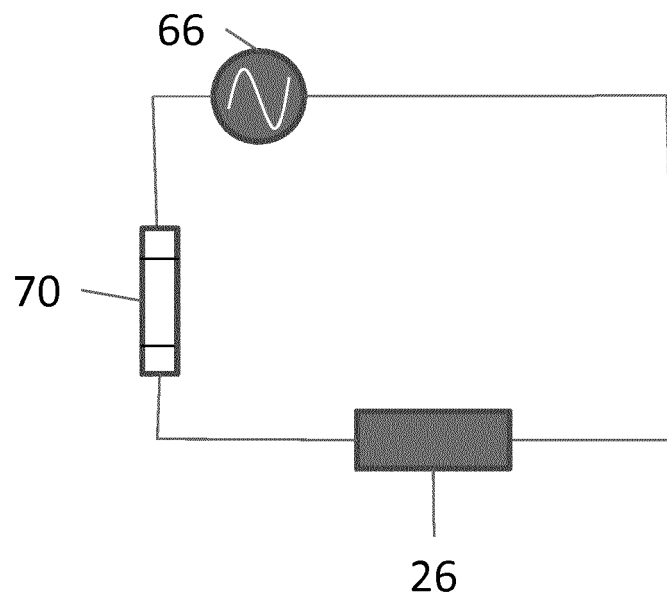


Figure 7

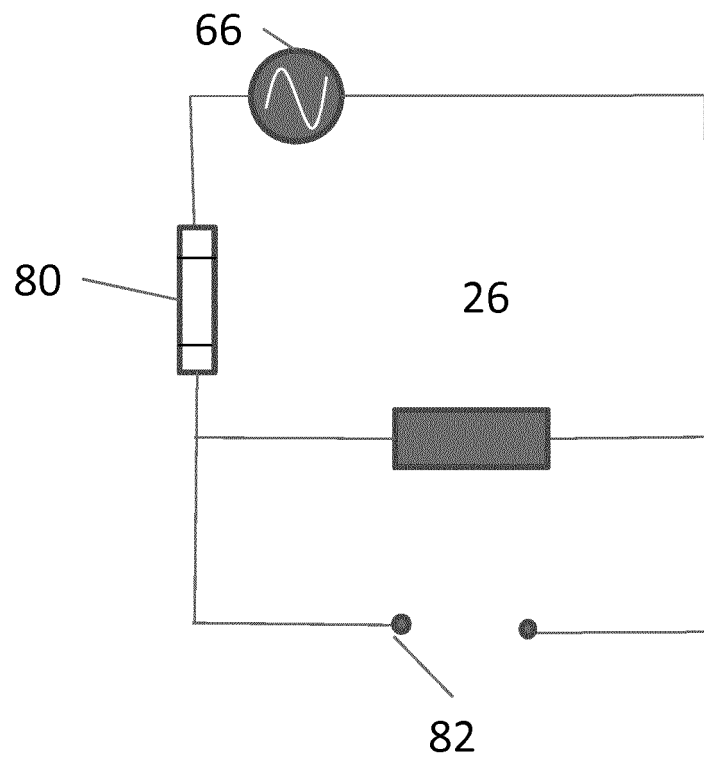


Figure 8

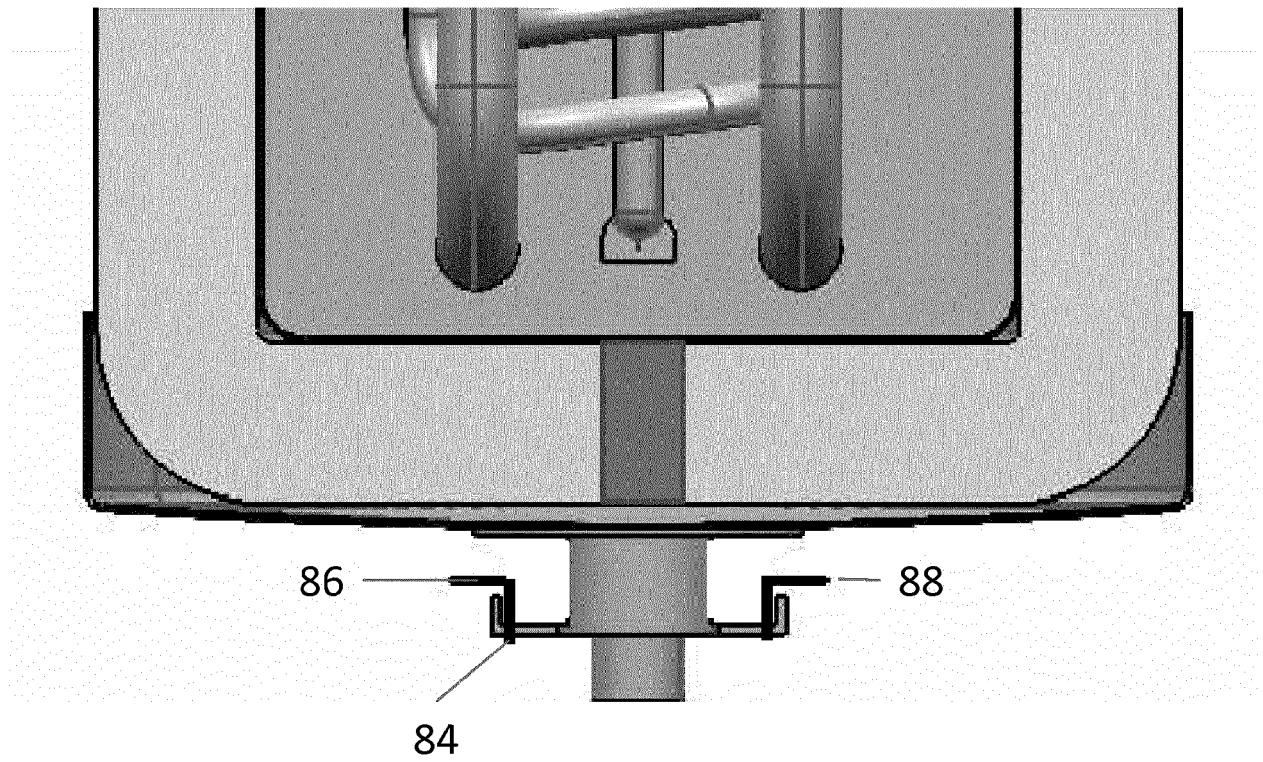


Figure 9



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Place of search Munich		Date of completion of the search 24 April 2015	Examiner Eckenschwiller, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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