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(54)

Condensate drain pan

(57)

A condensate drain pan in particular for use in combination with a HVAC system, comprising a sump, an inlet and an outlet for gases, in particular combustion gases, as well as an outlet for condensate. The sump is made of a non-corrodible or corrosion-resistant material,

such as a chemically inert-synthetic plastics material, in particular a thermoplastic elastomer, preferably elastic thermoplastic copolyester. The pan may be produced by rotational molding, preferably as one piece. The invention also concerns a HVAC system provided with such condensate drain pan.

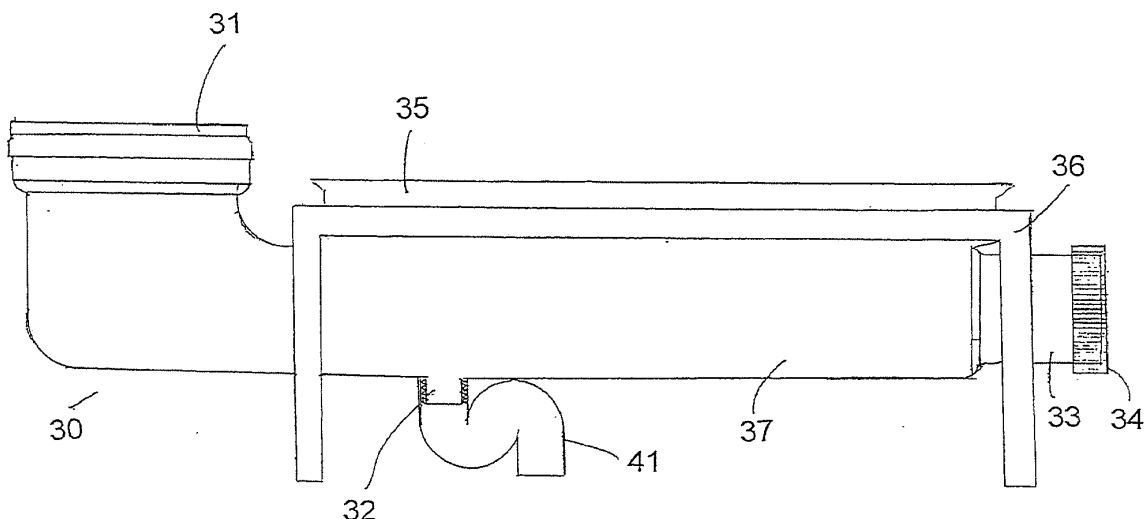


Fig. 3

Description

[0001] The invention relates to a condensate drain pan in particular for use in combination with a HVAC system, comprising a sump, an inlet and an outlet for gases, in particular combustion gases, as well as an outlet for condensate. The invention further concerns a HVAC system provided with a condensate drain pan according to the invention.

[0002] A condensate drain pan is for instance applied in HVAC systems (heating, ventilation, air conditioning), in particular in heating systems. For instance in a heating system, combustion gases of a boiler flow through a heat-exchanger. Most of the heat of the combustion gases will be transferred to a fluid in the heating system. The combustion gases then flow through a flue. Combustion gases contain water vapor and combustion product gases such as SO² and CO². During cooling of the combustion gases the vapor will condensate. The condensate water will contain dissolved gases and is therefore acid. The acid condensate water may react with the drain pan and the flue. In time regular inspection is required and may result in costly replacement of affected parts.

[0003] Such condensate drain pan is for instance described in GB 2.425.588. The sump of the condensate drain pan is made of a metal suitable for application in an acid environment, such as aluminum or stainless steel. Still such sump is vulnerable to acid corrosion, in particular for the, above average acid condensate of the flue. GB 2.425.588 therefore provides for a collector device located between the flue and the sump. The collector device is made of non-corrodible or corrosion-resistant material. This known condensate drain pan has several disadvantages. The main part of the sump, in particular the metal part between the heat exchanger and the flue, is still vulnerable to acid corrosion. Although the condensate of the heat exchanger is less acid than that of the flue, it still provides an acid environment. Therefore also this condensate drain pan requires regular inspection. It has to be designed such that inspection is possible, for instance by applying expensive inspection ports in the sump, or by opening the condensate drain pan during inspection. Opening of the condensate drain pan for inspection and replacement of the drain pan will in most cases also require replacement of the sealing. Inspection of the condensate drain pan and replacement of affected parts thereof is therefore expensive. Further, this condensate drain pan consists out of many parts, which makes it expensive and vulnerable for failure. Moreover, the several drainage outlets are vulnerable for obstruction, for instance by calcification or acid disposition. In addition, the design freedom is restricted. The outlet of the sump has to be positioned under the flue. The requirement that the parts of the condensate drain pan should be replaceable, further restricts the freedom of design. For this reason, in general, at least the sump is releasable attached to the flue and the heat exchanger, while the flue and the heat exchanger are supported in-

dependent of the sump. The heat exchanger may for instance be placed on a supporting frame.

[0004] Further, EP 1 182 408 (A2) recites a heater with an exhaust gas and condensate collecting bath passing directly through a channel in its side wall to the exhaust connection. The bath, the channel and the connection are combined in a one-piece injection-molded connecting component able to be connected by connecting elements to the underside of the cast heat radiator.

[0005] However, the above document does not indicate how an outlet can be made using the mold of fig. 2 thereof. Even further, the mold of fig. 2 can from a practical point of view not lead to a product as indicated therein, especially as element 50 is either obstructing the movement of the mold, or provided as a detachable element or the like, leading to leakage when molding. In general it is noted that injection molding or blow molding does not provide products having required specifications. As a consequence further processing is required, making the products expensive. Also the quality, life time, product strength, etc., are not sufficient. In short, the recitation of the above document can not be put into practice.

[0006] WO200900324 (A1) recites a water heater for heating water including various elements. In an example a water heater having a condensate duct to direct condensate into the water for chemically treating the water is recited.

[0007] The document is not considered relevant for the present invention, as it does not relate to a condensate drain pan at all; it only relates to a collection base of plastic. The base itself has no further function.

[0008] US5,476,088 (A) recites methods and apparatus for exhausting flue products and removing condensate from a combustion of air/gas mixtures provide a condensate collecting pan for flue products. That pan is provided with an inlet for flue products and condensate, and with an outlet for flue products spaced from that inlet. That inlet is provided with a larger cross-section for flue product and condensate flow than the outlet. A space is provided in the pan for a flow of flue products from the inlet at a substantially even velocity across the larger cross-section of the inlet to the smaller cross-section outlet. Condensate collecting in that space is removed from the pan.

[0009] The above document is silent on the material of the pan. Further no exhaust is provided.

[0010] WO200908209 (A1) recites a heat exchanger of an upward combustion type condensing boiler. The heat exchanger includes a condensed-water tray that discharges condensed water generated from the latent heat exchange unit. A latent heat exchange unit is installed in such a manner that the flow direction of the exhaust gas passing through the latent heat exchange unit vertically coincides with the falling direction of condensed water generated from the latent heat exchange unit.

[0011] The above condensate water tray is assembled out of many pieces.

[0012] DE 10 2006 026613 A1 recites amongst others

a plastic siphon in order to prevent drying up thereof.

[0013] Many of the above documents can not relate to a condensate drain pan made of a plastic material, as it is not possible to manufacture such a plastic by molding, specifically by injection molding. Dimensional tolerance of such molding are in the order of less than 1 mm, such as 0.2 mm. However such precise components made of plastic typically have a variation in dimensions of a few mm, such as 2-5 mm, which is fully unacceptable for the intended purpose. Such is particularly the case when parts of plastic need to be attached or combined with other elements, or need to be melted together, such as for outlets and inlets. Also provision of a mold is typically quite expensive.

[0014] The present invention intends to solve one or more of the problems of the prior art as described above, and it is in particular an objective of the invention to provide a condensate drain pan that is durable in acid environment.

[0015] The condensate drain pan according to the invention is characterized by one or several of the appended claims.

[0016] In a first aspect of the invention at least the sump is made of non-corrodible or corrosion-resistant material. The material used is preferably also resistant to acids, such as to a pH of less than 5, preferably less than 3, and can withstand high temperatures, such as up to 120 °C. Such sump will not corrode, even not in the aggressive acid environment of combustion gases and condensate of boilers. Inspection of the condensate drain pan is therefore not required and under normal circumstances the parts of the condensate drain pan need not to be replaced. Inspection ports may be omitted and more design freedom is obtained. The position of the outlet for condensate and that of the outlet for combustion gases may be chosen independent of each other.

[0017] According to the invention a suitable material may be a chemically inert-synthetic plastics material, such as in particular a thermoplastic elastomer, of which category elastic thermoplastic polymer, such as a copolyester proves to be very suitable. In particular polypropylene and polyphenylene sulphide are suited. These material are not only non-corrosive or corrosion resistant, they also provide a good formability, strength and heat resistance. The choice of a suited polymer is not trivial. As mentioned the polymer should be resistant to a relative high and especially a relative low pH, it should be capable of withstanding high temperature, such as above 100 °C, and low temperature (e.g. during transport -20 °C), it should be capable of withstanding expansion and shrinking during temperature variations and temperature cycles, it should not absorb water. Further many polymers can not be processed using rotation molding. For not too high temperatures poly propylene may be used, for even higher temperature polyphenylene sulphide is a good candidate. In order to have polymers being processed in rotation molding it is preferred to use pellets or granules, preferably pellets of a suitable size having a

relatively narrow size distribution, e.g. of 1 sigma of 10% relative, preferably less than 5% relative, even more preferably less than 2% relative. It is noted that the prior art typically relates to use of a metal, such as stainless steel or aluminum. These metals will however corrode, typically at unexpected locations.

[0018] The condensate drain pan may be manufactured by rotational molding. Rotational molding provides very smooth surfaces, which facilitates the condensate to stream to the outlet for condensate. Even(large)condensate drain pans with a complicated design may be produced in a single production step. The condensate drain pan may accordingly be one single part, avoiding assembly of parts, sealing thereof and edges that easily get contaminated, the typical places of condensate accumulation and therefore corrosion. The present method provides a condensate drain pan substantially free of stress, having a high durability. The present method also allows for a large variety in shape and size of products. Also the tolerance of e.g. inside dimensions can now be met. Such inside tolerance is in the order of $\pm 0.5\%$ or less, such as $\pm 0.1\%$ (relative). A typical thickness of the condensate drain pan is 2-20 mm, such as 3-10 mm, or 5-8 mm. A thickness of the mold is typically 8-10 mm. The life time of the present condensate drain pan is increased dramatically, such as up to 10 years and longer. The sump may be profiled to further facilitate streaming of condensate toward the outlet opening. According to the invention even the inlets and outlets of gases and condensate may form an integral part of the sump and may be produced in the single production step. The condensate outlet may be shaped as siphon. The invention further provides for the possibility to have an inspection port as integral part of the sump. Such inspection port may be provided with a cover. According to the invention one or more of the inlets, outlets, siphon and inspection port may be provided with, internal or external, thread.

[0019] To a further aspect of the invention the condensate drain pan is suitable for placement on a surface. Such condensate drain surface pan does not require attachment to for instance a heat exchanger. The condensate drain pan may in this respect be provided with legs in order to obtain free space under the sump for the outlet and/or the siphon. In a further embodiment of the invention the condensate drain pan has a support surface to support the HVAC system or a part thereof such as a heat exchanger. A support frame for the HVAC system may therefore be omitted. The condensate drain pan may accordingly be provided with reinforcements.

[0020] The various aspects of the invention will now be described in more detail and will be elucidated, by way of example only, with reference to the accompanying drawing which shows in

- Figure 1, a heat exchanger of a HVAC system, provided with a state of art condensate drain pan;
- Figure 2, a schematic cross sectional view of the system of figure 1;

- Figure 3, a schematic view of an embodiment of the condensate drain pan according to the invention;
- Figure 4, a schematic view of another, self-supporting embodiment of the drain pan according to the invention;
- Figure 5, a heat exchanger of a HVAC system, provided with a condensate drain pan according to the invention and supporting the heat exchanger; and
- Figure 6, a mold according to the invention,
- Figure 7, and in figure 8 a condensate drain pan (30) obtained.

[0021] In figure 1 a state of art heat exchanger 1 is shown. The heat exchanger 1 has at its upper side a burner with an inlet 4 for gases. Also an inlet 2 and an outlet 3 for the liquid of a heating system are provided. The heat exchanger 1 is placed on a supporting structure 5. Under the heat exchanger 1 a condensate drain pan 6 is provided. The condensate drain pan 6 has an outlet 7. The outlet 7 may be provided with a flue.

[0022] The heat exchanger 1 of figure 1 is in a schematic cross-sectional view shown in figure 2. In figure 2 at the outlet 7 a flue is positioned. Gases will enter the heat exchanger 1 at inlet 4 and will be heated by a burner. Fluid of heating systems enters the heat exchanger 1 at inlet 2, flows through the heat exchanger 1 and will exit at outlet 3. In counter flow the flue gases will heat the fluid of the heating systems. The flue gases will flow to the sump 6 and exit the sump 6 at outlet 7. The outlet 7 is provided with a flue 8. The flue 8 will guide the combustion gases to the environment.

[0023] The combustion gases cool down and expand while cooling down in the heat exchanger 1 and in the flue 8. Combustion gases contain water vapor and combustion product gases such as SO_2 and CO_2 . During cooling of the combustion gases the vapor will condensate. The condensate water will contain dissolved gases and is therefore acid. The condensate water will be accumulated in the sump 6 and will leave sump 6 through outlet 12. The acid condensate water may react with the drain pan and the flue. In time regular inspection is required and may result in costly replacement of affected parts. Accordingly all these parts are replaceable attached to the heat exchanger. The sump of the state of art condensate drain pan is made of a metal suitable for application in an acid environment, such as aluminum or stainless steel. Still, such sump is vulnerable to acid corrosion, in particular for the, above average acid condensate of the flue. Therefore, in this prior art condensate drain pan, a collector device 13 is provided and located between the flue and the sump. The collector device 13 is made of non-corrodible or corrosion-resistant material. This is an expensive, complicated solution and still is not satisfying as it does not solve the corrosion problem of the condensate drain pan in general and as it is still vulnerable for clogging.

[0024] Figure 3 provides a schematic view of an embodiment of the condensate drain pan according to the

invention. The lower part of a heat exchanger 35 is placed on a support frame 36. The support frame provides even better dimensional specifications of the product, such as $\pm 0.05\%$. Under the heat exchanger 35 a condensate drain pan 30 according to the invention is provided. The condensate drain pan 30 consists of one piece. The condensate drain pan 30 consists of a sump 37, an outlet 31 for connection with a flue, an outlet 32 with siphon 41 and an inspection port 33, all formed in one single production step. The outlets 31, the siphon 41 and the inspection port 33 are provided with thread. On the outlet 31 a flue may be positioned. The outlet 32 with siphon 41 may be connected to a sewer. On the inspection hole 33 a cover 34 is placed. The condensate drain pan 30 is made of a chemically inert-synthetic plastics material in particular a thermoplastic elastomer such as elastic thermoplastic copolyester. These materials are also heat resistant and strong. Moreover they prove to be very suitable for rotational molding. Rotational molding not only enables production of the condensate drain pan as one part, it also provides a smooth internal surface and rounded edges. This will enhance flow of the condensate to outlet 32. In this respect the sump 37 may have an internal surface that is profiled, for instance with a sloped bottom with the lower point at the outlet 32. The outlet 32 of condensate drain pan 30 according to the invention, may be placed at any suitable position under the sump 37. In general the teachings of the invention provide substantial design freedom for the condensate drain pan 30 as such and for its application in HVAC systems in general. The condensate drain pan 30 is resistant to corrosion and therefore replacement of parts due to corrosion will not any longer occur. Although in this embodiment the pan 30 is provided with an inspection port 33, inspection for corrosion is not any longer required. Such inspection port 33 is still provided to conform present specifications for condensate drain pans. The expectation is however that in time, due to the invention, such requirement will disappear from specification.

[0025] The present invention therefore provides a 'sealed for life' solution. The embodiment of the invention as shown in figure 4 is such sealed for life condensate drain pan. An inspection port has been omitted. The upper part of the sump 37 of the condensate drain pan 30 is provided with inlet 38 for connection with a heat exchanger. The edge of inlet 38 is provided with a groove 39. In the groove 39 a sealing may be positioned. A Quad ring will provide a dynamic sealing between the condensate drain pan and a heat exchanger. The condensate drain pan 30 is provided with legs 40 and may accordingly be self-supporting placed on a surface. As the condensate drain pan 30 according to the invention is very strong, which strength may be further increased by applying suitable reinforcements, the condensate drain pan 30 may even support the heat exchanger. Accordingly the support frame 36 as shown in the embodiment of figure 3 may even be omitted. In figure 5 such combination is shown. The condensate drain pan 30 is provided

with legs 40 and placed on a surface. On the condensate drain pan 30 the heat exchanger 1 is positioned. The condensate drain pan 30 is sufficiently strong to support the heat exchanger 1 and as the combination is sealed for life the combination will be connected during life time of the heating system.

[0026] In figure 6 a multi (three) piece mold is shown. A left part (61a), a right part (61b) and a top part (64) forming a condensate pan (61). Further the mold is provided with bars (62) to make a support (36). In principle the various pieces may be further sub-divided into extra pieces. The mold is preferably made from aluminum.

[0027] In figure 7 a condensate drain pan (71) obtained by the mold of figure 6, further having sealing rings for exhaust gas (76, 77, bars (82) and an outlet (75) are shown.

[0028] In figure 8 a condensate drain pan (81) obtained by the mold of figure 6, further having sealing rings (84) for sealing between the condensate drain pan and heat exchanger (85) gas (76, 77, are shown.

[0029] To the person skilled in art it is obvious that the above given embodiments represent only a few of the many possible variations in which the condensate drain pan according to the invention may be embodied. Therefore the embodiments given here must be understood as an elucidation to the appended claims without limiting the scope of the invention. Within the protective scope numerous variations are conceivable. For instance rotation molding also provides the possibility to apply inserts, for instance threaded insert for connection of the condensate drain pan with a heat exchanger.

Claims

1. A single part condensate drain pan (30) in particular for use in combination with a HVAC system, comprising a sump (37), an inlet (38) and an outlet (31) for gases, in particular combustion gases, as well as an outlet (32) for condensate, **characterized in that** at least the sump (37) is made of a non-corrodible or corrosion-resistant material.
2. A condensate drain pan (30) according to claim 1, **characterized in that** sump (37) is of a chemically inert-synthetic plastics material, preferably wherein the plastics material is a thermoplastic elastomer.
3. A condensate drain pan (30) according to claim 2, **characterized in that** the thermoplastic elastomer is an elastic thermoplastic polymer, such as a copolyester, such as polypropylene copolymer, or polyphenylene sulphide.
4. A condensate drain pan (30) according to one of the preceding claims, **characterized in that** the sump is manufactured by rotational molding.
5. A condensate drain pan (30) according to one of the preceding claims, **characterized in that** the inlet (38) for gases and/or the outlet (31) for gases and/or the outlet for condensate (32) and/or a siphon (41) form an integral part of the sump (37).
6. A condensate drain pan (30) according to claim 1, **characterized in that** the sump (37) is provided with an inspection port (33).
7. A condensate drain pan according to claim 1 or claim 6, **characterized in that** one or more of the inlets (38), outlets (31, 32), siphon (41) and inspection ports (33) is provided with thread.
8. A condensate drain pan (30) according to claim 6 or 7, **characterized in that** the inspection port (33) is provided with a cover (34).
9. A condensate drain pan (30) according to one of the preceding claims, **characterized in that** the sump (37) has a profiled internal bottom.
10. A condensate drain pan (30) according to one of the preceding claims, **characterized in that** the condensate drain pan (30) is suitable for placement on a surface, preferably wherein the condensate drain pan (30) is provided with legs (40).
11. A condensate drain pan (30) according to claim 10, **characterized in that** the condensate drain pan (30) has a support surface to support the HVAC system or a part thereof, such as a heat exchanger (1).
12. A condensate drain pan (30) according to one of the claims 10-11, **characterized in that** the condensate drain pan (30) is provided with reinforcements.
13. HVAC system provided with a condensate drain pan (30) according to one of the preceding claims.
14. Multi piece mold for manufacturing a condensate drain pan (30) comprising a left portion (61a), a right portion (61b), wherein the left and right portion provide an outlet (32), a sump (37) an outlet (31), and a third top portion (64) providing an inlet (38).
15. A method of producing a condensate drain pan (30) according to one of the claims 1-12, comprising the steps of providing a three or four part mold, combining the mold, providing a thermoplastic elastomer, such as an elastic thermoplastic copolyester, such as polypropylene copolymer, or polyphenylene sulphide, and forming the condensate drain pan by rotational molding.

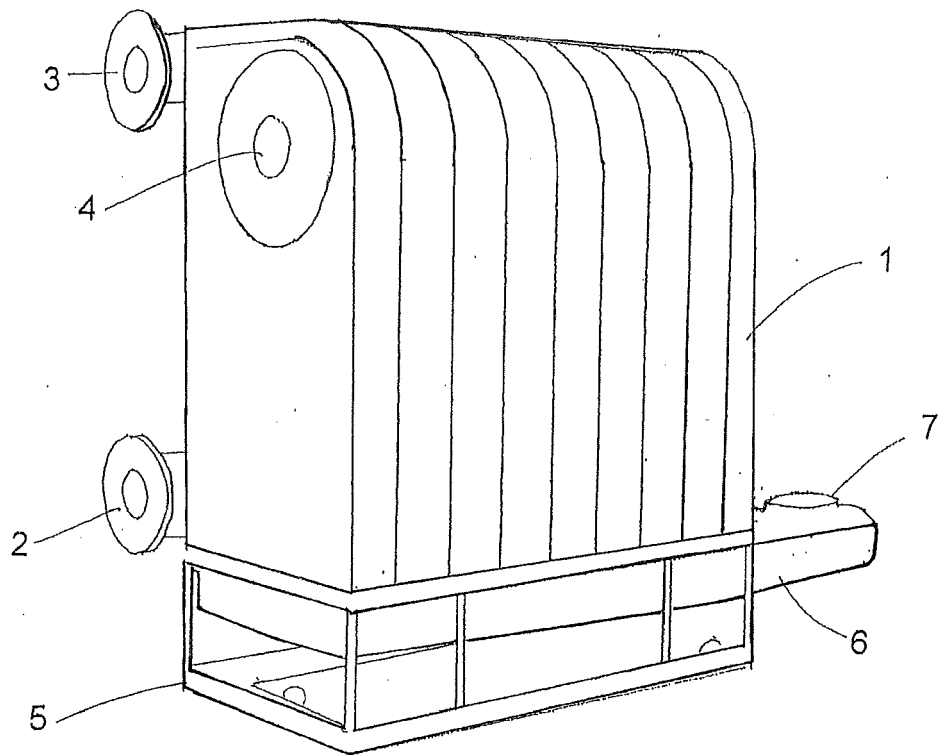


Fig. 1

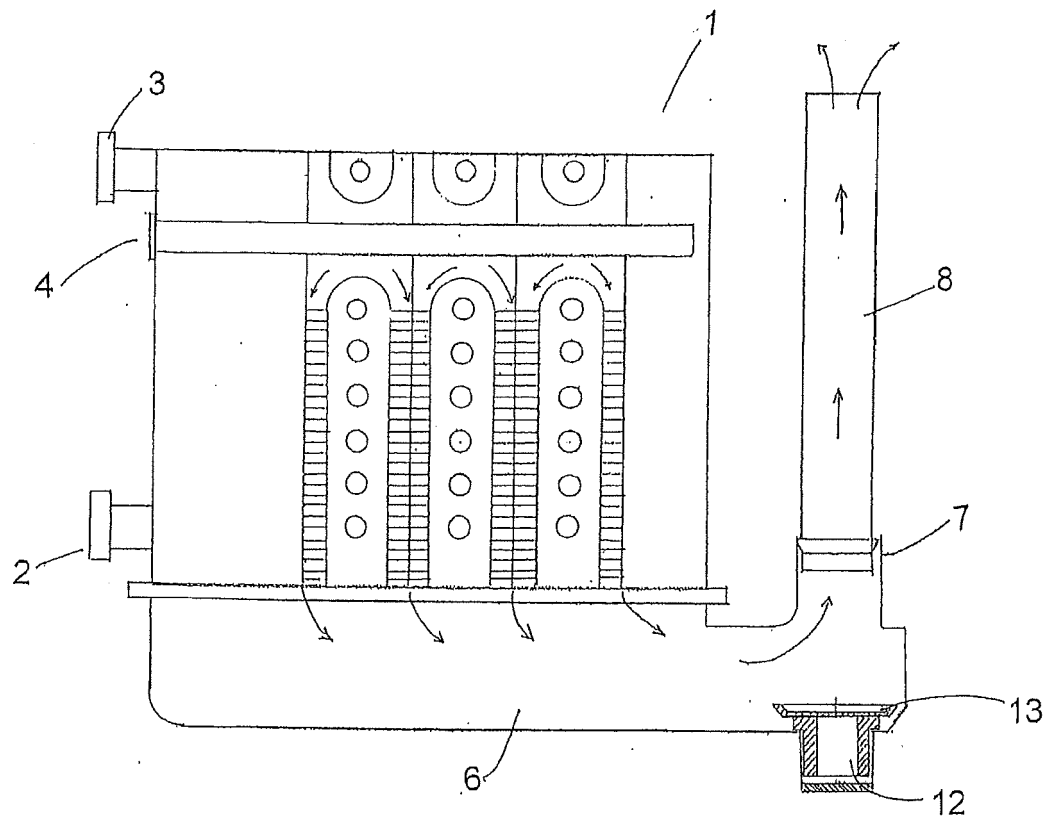


Fig. 2

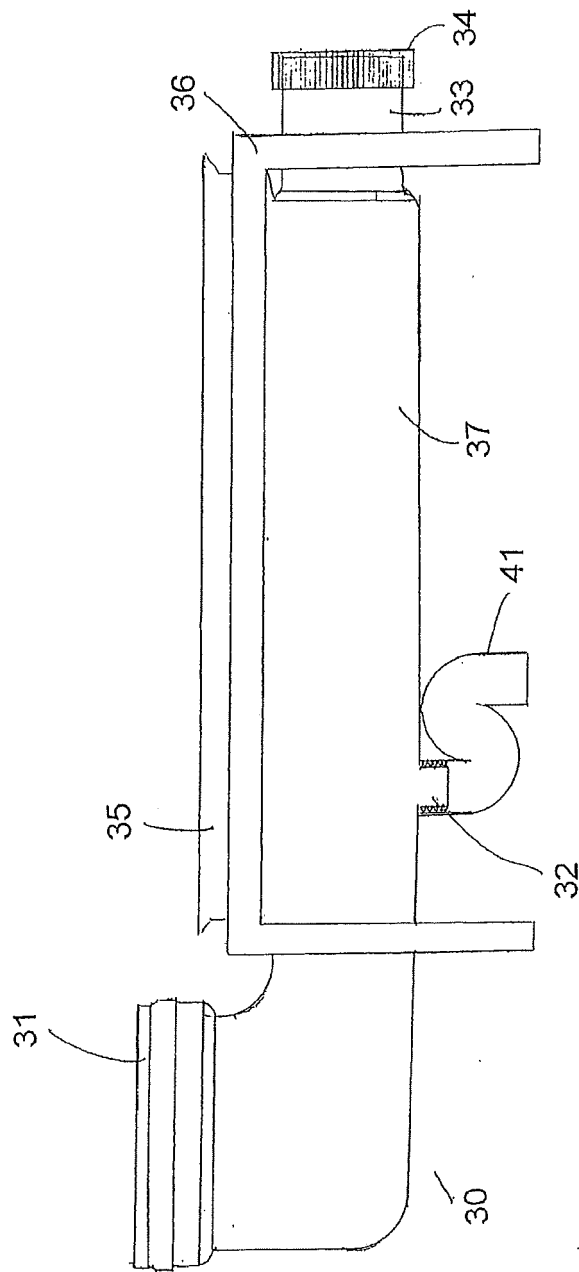


Fig. 3

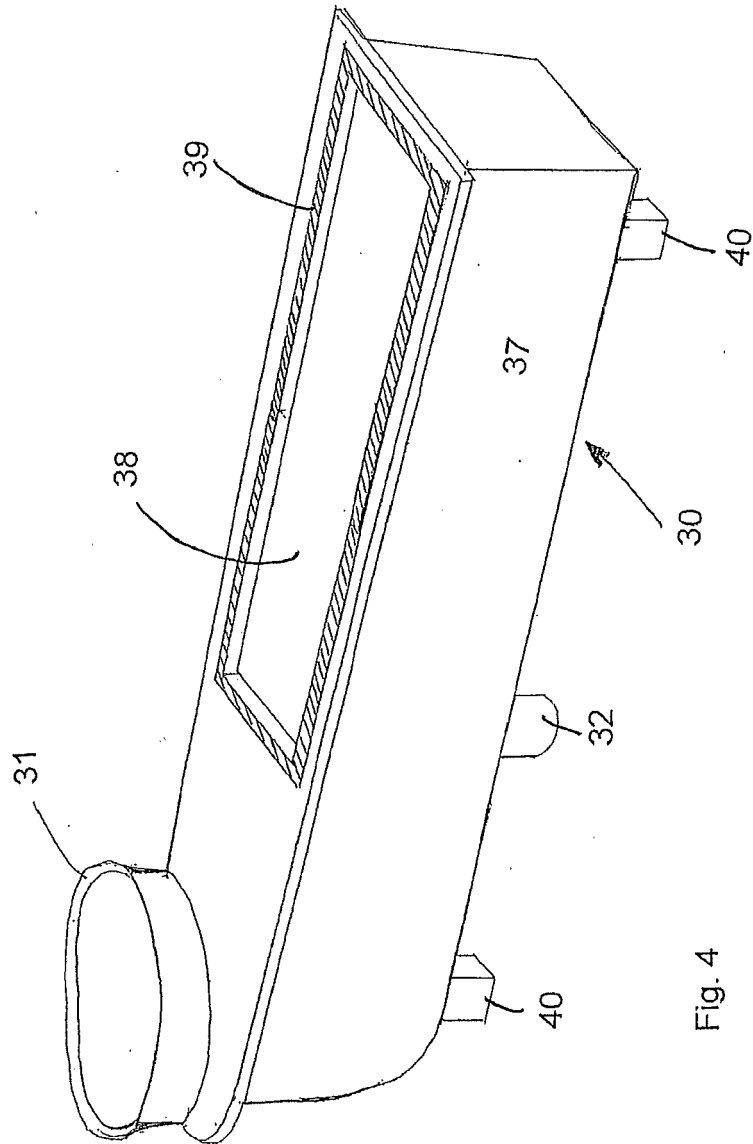


Fig. 4

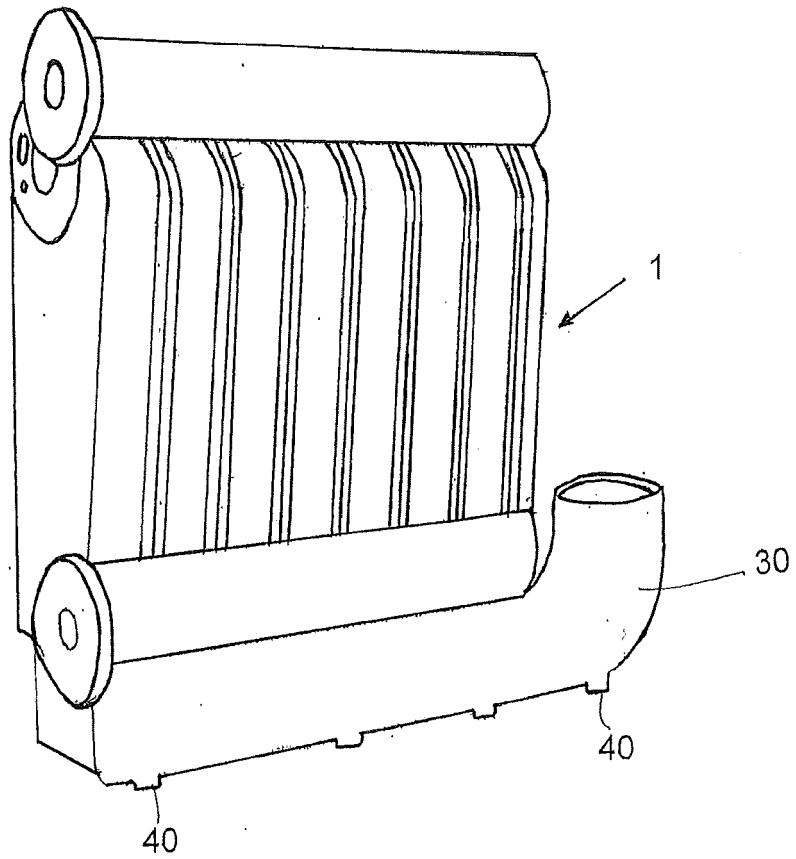


Fig. 5

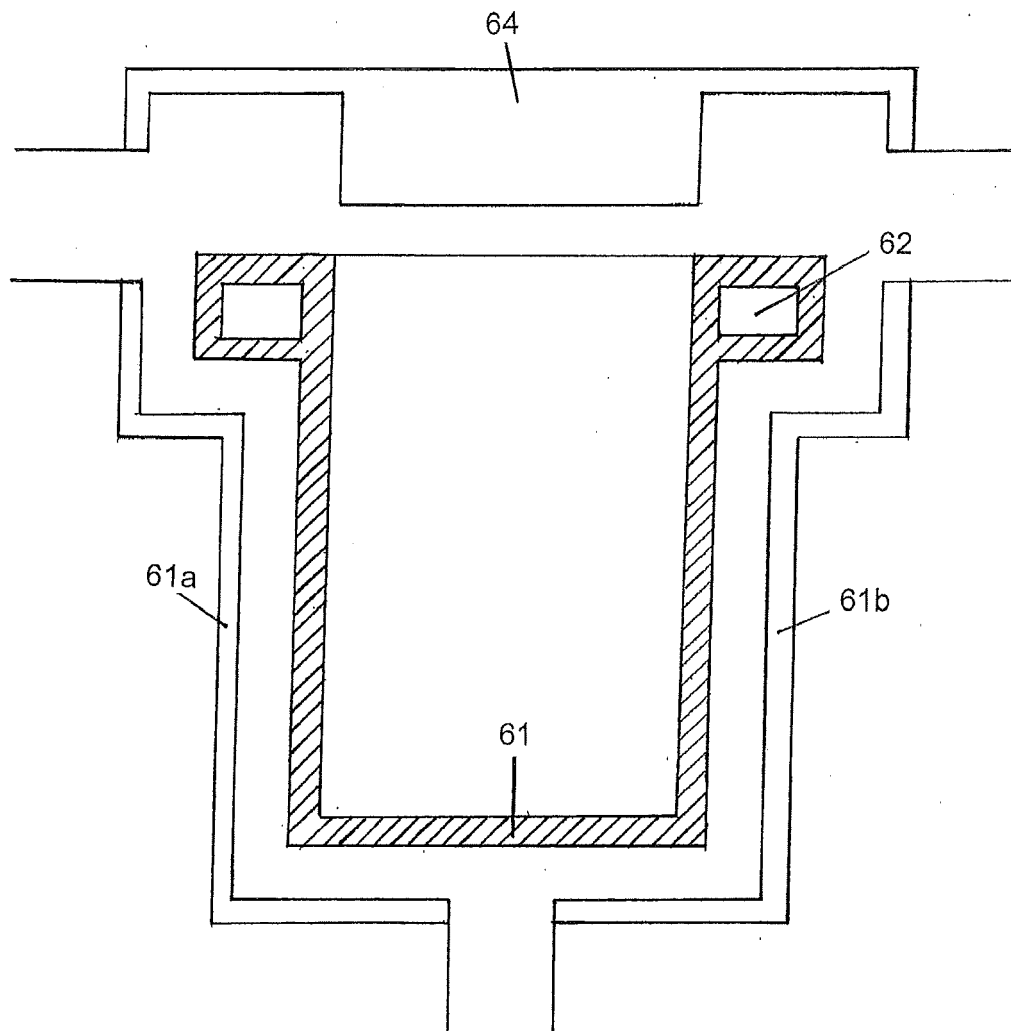


Fig. 6

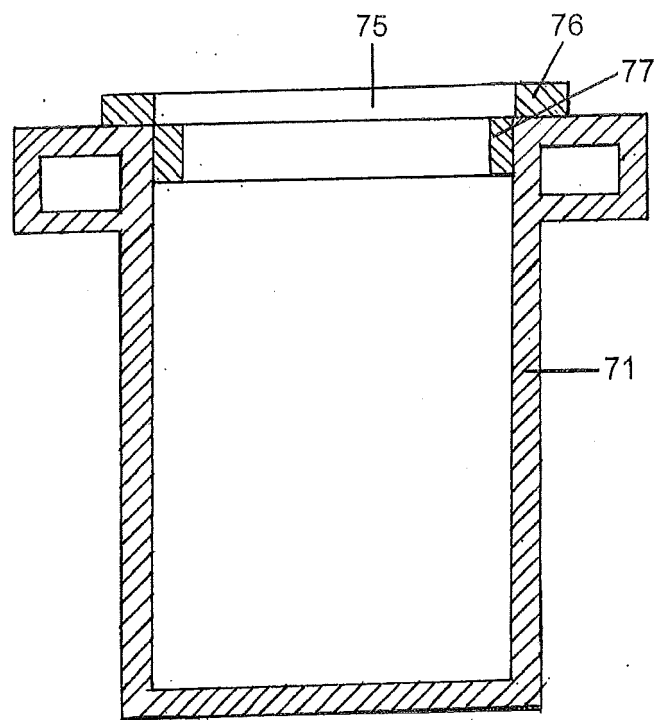


Fig. 7

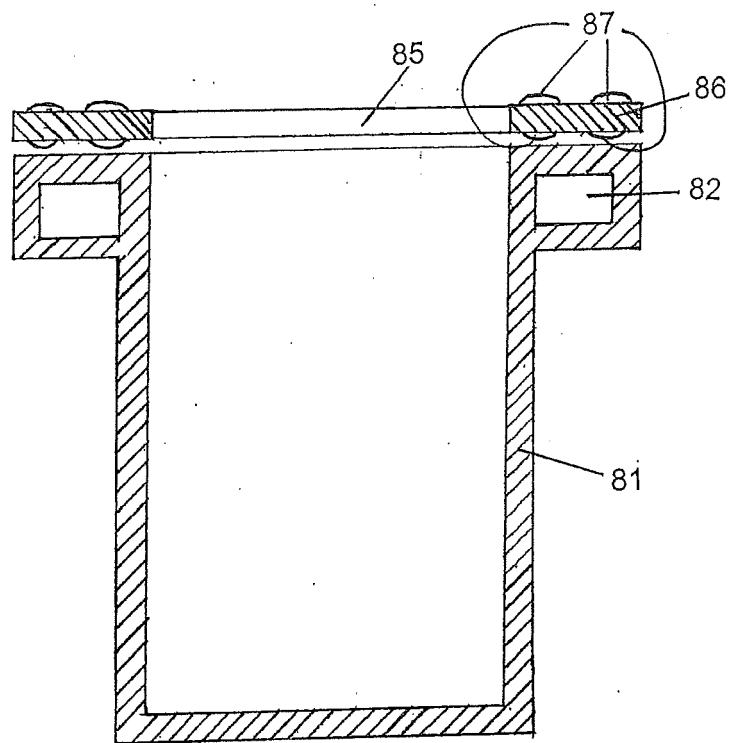


Fig. 8

REFERENCES CITED IN THE DESCRIPTION

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