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(54) DIRECT FLAME BOILER FOR THERMAL ABSORPTION MACHINES AND VAPOUR GENERATOR INCLUDING SUCH A BOILER

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Description

[0001] The present invention relates to a direct flame boiler, in particular for a generator of coolant vapor for thermal absorption machines, and to a vapour generator comprising such a boiler.

[0002] The boiler according to the invention is especially suitable for use in a coolant vapor generator for thermal absorption machines, and will be described with particular reference being made to this application, without however intending to thereby limit the possible areas of use thereof for other applications.

[0003] As is known, absorption machines, typically chillers or heat pumps, are thermal machines that exploit the ability of a substance, whether liquid or solid, to "absorb" a second chemical species in a gaseous state; for example, an unsaturated solution of water and ammonia can absorb ammonia vapor.

[0004] This property makes it possible to produce a refrigeration cycle with a thermochemical compressor: the low pressure coolant vapor is not compressed with an electrically powered mechanical compressor, but absorbed by the absorbent solution, which is then pumped at high pressure, with a reduced level of power consumption, and sent to a generator.

[0005] In the generator, the solution is heated up to the point of boiling, resulting in the production of high pressure coolant vapor necessary to produce the refrigeration cycle.

[0006] The high pressure vapor, that is rich of coolant, is sent into a condenser and then returns through an evaporator to an absorber.

[0007] The hot solution, depleted of coolant, which leaves the generator flows into a solution heat exchanger (or SHX), which serves the purpose of recovering the heat from the depleted solution by pre-heating the solution rich of coolant pumped towards the generator, and then, passing through a lamination valve, this solution also returns to the absorber, where it absorbs the coolant vapor.

[0008] In particular, in the generator, the generation of coolant vapor takes place in the boiler, commonly referred to in the practice also as desorber. In the case of direct-flame boilers, the solution rich of coolant is kept boiling by the heat supplied by a burner, hence by exposure to the flame and via the heat exchange with the hot flue gases (fumes) produced therefrom.

[0009] During operation, the generator of an absorption thermal machine, in particular of an absorption heat pump, must manage significant variations in the input power to the burner, significant variations in flow rate and level of the solution in the various sections, and significant variations in internal pressure and temperature. All of the foregoing are to occur while ensuring complete safety against leaks to the exterior, especially if ammonia is used, with total absence of maintenance for tens of thousands of hours of work, and without negative impact on the efficiency of heat and mass exchanges in the various components. These drawbacks are even more problematic with respect to the application of thermal machines to the residential sector where the reduction in overall dimensions and the industrialization of the product play a fundamental role.

[0010] Clearly, the boiler has an important role to play in obtaining satisfactory results, in particular when used in generators of heat absorption machines.

[0011] In the current state of the art, the direct flame boilers used in a generator are made according to two different types of construction:

- a first type in which both the burner and the fins for exchanging heat with the fumes are external to the generator; and
- a second type in which both the burner and the fins for exchanging heat with the fumes are internal to the generator. This type of generator includes some variants: the most common one is constituted by a fire-tube with internal fins, other variants that are more sophisticated provide a flue gas circuit within the interior of the generator implemented by complex systems of multiple tubes that are smooth or finned.

[0012] These solutions, while making it possible to obtain relatively satisfactory results, still have some drawbacks and can thus be further improved.

[0013] In particular, in the case of direct combustion generators with external burner, the heat dispersion losses due to the extremely high temperatures of the burner are difficult to manage with thermal insulation.

[0014] In case of installation within the interior of a building, this heat dispersion while participating in the heating of the environment does not contribute to feeding the thermodynamic cycle, consequently leading to a decrease in efficiency of the heat pump.

[0015] In the case of external installation, that is to say, in an unheated environment, the negative weight of these dispersions on the overall efficiency becomes critical.

[0016] If the burner is positioned under the boiler, the major part of the radiative heat is supplied directly to the bottom of the same, and if the burner is installed alongside the boiler the heat transfer is not symmetrical in relation to the axis of the insulating jacket of the boiler.

[0017] The external burner therefore includes respectively concentrated or asymmetrical heat flows, which generate local tensions and related stresses in the walls of the boiler, and which can induce localized corrosion during the normal on/ off cycles of the machine.

[0018] With regard to the generators with internal burner and internally finned fire-tube, for example the correct positioning and durability of the fin attachment system are crucial and closely correlated aspects: the direct welding of the internal fins is extremely difficult, while the brazing thereof results in a lower resistance to temperature peaks, due to the limited melting temperature of the brazing material, even though the so-called hard brazing reaches high operating temperatures (> 450°C).

[0019] In addition, systems with fumes circulating within the interior of pipe bundles, while they allow for flexibility in sizing and enable advanced recovery systems, prove to be complex, heavy and expensive, and thus not at all suitable for mass production.

[0020] The relevant prior art documents are US1729355A, US5617737A and US5791158A.

[0021] The main scope of the present invention is to provide a direct flame boiler, in particular for a coolant vapor generator for absorption thermal machines, as well as a related generator, which allows mitigating, at least partially, one or more of the aforementioned drawbacks.

[0022] In particular, within this scope, one object of the present invention is to provide a direct flame boiler, as well as a related generator, that are highly efficient from the thermal standpoint, and in particular in which the heat dispersion losses are reduced or almost completely eliminated as compared to known solutions.

[0023] Another object of the present invention is to provide a direct flame boiler, as well as a related generator, in which the local tensions and related stresses in particular in the walls of the boiler, are at least reduced as compared to known solutions, thus decreasing the possibility of inducing localized corrosion, for example during normal ignition cycles.

[0024] Not the last object of the present invention is that of realizing a direct flame boiler, as well as a related generator, that present a structure which is simple and can be realized at relatively modest costs.

[0025] The present invention is disclosed in the independent claim 1.

[0026] Further embodiments are disclosed in the dependent claims.

[0027] Further characteristics and advantages of the invention will become apparent from the detailed description that follows, provided purely by way of non-limiting example, with reference to the attached drawings, in which:

- Figure 1 is a perspective cross-section view that illustrates a possible embodiment of a boiler according to the invention;
- Figure 2 is a perspective view that illustrates a possible embodiment of a cross-flow distributor used in the boiler according to the invention;
- Figure 3 is a cross-section view that illustrates a second possible embodiment of a boiler according to the invention;
- Figure 4 is a perspective cross-section view that illustrates a second possible embodiment of a cross-flow distributor used in the boiler according to the invention;
- Figure 5 is a cross-section view that schematically illustrates a coolant vapor generator for thermal absorption machines using the boiler shown in Figure 1 according to the invention.

[0028] It should be noted that in the detailed description that follows, components that are identical or similar, from a structural and/or functional standpoint, may have the same or different reference numerals, regardless of whether they are shown in different embodiments of the present invention or in distinct parts.

[0029] It should also be noted that in order to clearly and concisely describe the present invention, the drawings may not necessarily be to scale and some characteristic features of the description may be shown in a form that is schematic in some way.

[0030] In addition, when the term "adapted" or "arranged or organized" or "configured" or "shaped" or a similar term is used in the present document, with reference to any component as a whole, or to any part of a component, or to a combination of components, it is to be understood that it refers to and correspondingly includes the structure and/or configuration and/or shape-form and/or positioning.

[0031] In addition, when the term "substantial" or "substantially" is used herein, it is to be understood as including an actual variation by plus or minus 5% relative to that which is indicated as a value, position, or axis of reference.

[0032] Furthermore, when the terms "transversal" or "transversally" are used herein they are to be understood as including a direction that is not parallel to the reference part or parts or direction(s)/axis to which they refer; and perpendicularity is to be considered one specific case of transversal direction.

[0033] Finally, in the description and in the following claims, the ordinal numerals first, second, et cetera, are used purely for reasons of illustrative clarity and therefore should in no way be construed to be limiting for any reason whatsoever; in particular, the indication, for example, of "a third cavity" does not necessarily imply the presence or the stringent requirement that there be "a first and a second cavity", or vice versa, unless such presence is clearly evident for the correct operation of the embodiments described, nor that the order is to be exactly as in the sequence described with reference to the exemplary embodiments illustrated. Figures 1 and 3 illustrate two possible embodiments of a direct flame boiler according to claim 1, indicated as a whole by the reference number 100, which is adapted to be used in particular in a generator 200 of coolant vapor for thermal absorption machines, of which a possible exemplary embodiment, suitable for working fluids in which the absorbent is relatively volatile, is illustrated in Figure 5.

[0034] As schematically illustrated in Figure 5, the generator 200 comprises a casing 201, that can be fabricated as one single metal piece or in multiple metal pieces connected to each other, for example in a cylindrical shaped form, which extends as a whole vertically along a substantially vertical reference axis Y.

[0035] As illustrated in Figure 5, when installed in the generator 200, the boiler 100 according to claim 1 substantially constitutes the base thereof and, as will become apparent in greater detail from the following description, is suitable to ensure that an initial solution containing a coolant substance is kept boiling so as to generate streams or flows of vapor containing this coolant.

[0036] For example, a solution comprising water and ammonia can be introduced into the boiler 100 through the duct 52 and/or the duct 53.

[0037] The generated vapor streams that contain the coolant, indicated in Figure 5 by the letter V, rise towards the top of the generator 200, which depending on the working fluids can act as a distillation column, as in the example of Figure 5. In this case, the vapor streams first pass through, for example a stripping or analyzer section, schematically represented by the reference number 205 and then subsequently a dephlegmator, schematically represented by reference number 210.

[0038] Taken together as a whole, the stripping section 205 and the dephlegmator 210 are capable of altering the concentration of coolant in the vapors produced, in the event that a portion of these is constituted by the absorbent substance. This, in particular, can be obtained by cooling at least the vapor streams V coming from the boiler 100 according to claim 1 so as to obtain a partial condensation of the absorbent, for example water, and thus increase the mass fraction of coolant, that is to say ammonia.

[0039] In practice, this alteration occurs through the exchange of matter and/or heat between the vapors and the cooling fluids and/or materials used in the stripper and in the dephlegmator. The embodiments and modes of operation of both the stripping section 205 and the dephlegmator 210 may be of any type that is known in the art and/or easy to realize for a person skilled in the art; however, these embodiments and modalities are not relevant for the purposes of the description of the boiler 100 according to claim 1 and for these reasons they are not described herein in greater detail.

[0040] As illustrated in the exemplary embodiments in the attached figures, the boiler 100 according to claim 1 comprises at least:

- a first body 1 which extends along a substantially vertical reference axis X and at least partially encloses a first internal cavity 2 suitable for receiving for example a liquid solution;
- a second body 10 which, with reference to said substantially vertical axis X, is arranged below and substantially aligned with the first body 1 and at least partially encloses an own internal cavity 12, hereinafter for clarity of description referred to as a second cavity 12;
- a third body 10B which is arranged for at least a part thereof, around the second body 10, said second and third bodies 10 and 10B delimiting between them an internal cavity 13 (hereinafter referred to as a third cavity 13) which is arranged, for at least a part thereof, laterally around said second cavity 12; and
- a fourth body 20 which is interposed between said first body 1 and said second body 10 and is at least integrally connected to them.

[0041] In the second cavity 12 there is placed a burner 11 capable of generating the heat necessary to ensure that the liquid solution present in the first internal cavity 2 and in the second internal cavity 13 is kept boiling, as will become apparent in greater detail from the following description.

[0042] The fourth body 20 is interposed between the first body 1 and the second body 10, and is integrally connected to them, for example by means of welding.

[0043] In the embodiment of Figure 1, the fourth body 20 is also integrally connected to the top part of the third body 10B.

[0044] Conveniently, the fourth body 20 is a cross-flow distributor, and in particular it is configured in a manner such that at least hot fumes produced by the burner 11, indicated in Figures 1, 2 and 5 by the letters F_c, flow through it flowing from the second internal cavity 12 towards the outer surfaces 6 of the first body 1, while streams of the boiling liquid solution, indicated in Figures 2, 3 and 5 by the letter L, flow through it by flowing from the first internal cavity 2 of the body 1 down into the third internal cavity 13.

[0045] When the boiler 100 is installed in the generator 200, its vertical reference axis X preferably coincides substantially with the axis Y along which the generator 200 as a whole is extended vertically.

[0046] As illustrated graphically only in Figure 1 for simplicity of description, the first internal cavity 2 has an internal extension D1 measured in a transversal direction, and in particular perpendicular, to the vertical reference axis X, which is smaller than the maximum internal extension D2 of the second internal cavity 12, also measured in a transversal direction, and in particular perpendicular, to the vertical reference axis X.

[0047] In one possible embodiment of the boiler 100 according to claim 1, the streams L flow out from the boiler 100 through at least one duct 14 (illustrated for simplicity only in Figures 1 and 5) provided at the base of the third internal cavity 13 and which connects this cavity 13 to the exterior.

[0048] In their turn, the exiting hot fumes F_C flow out for example from an exhaust duct 54, illustrated for simplicity only in Figure 5.

[0049] In the embodiments illustrated in Figures 1 and 3, the second body 10 comprises a first internal cylindrical body which laterally delimits said second internal cavity 12 and develops vertically around the substantially vertical reference axis X; this first internal cylindrical body 10 therefore has an internal diameter equal to D2.

[0050] In turn, the third body 10B comprises a second external cylindrical body which is arranged externally to and substantially concentric with the first internal cylindrical body 10 relative to said substantially vertical axis X.

[0051] In practice, the two cylindrical bodies 10 and 10B are arranged coaxially to each other around the vertical reference axis X which therefore actually constitutes the axis of structural symmetry, and they delimit there-between an interspace which forms the third internal cavity 13.

[0052] In the embodiment of Figure 1, the external cylindrical body 10B extends along the axis X, only for a short part beyond the first internal cylindrical body 10, and the third cavity 13 is closed at the bottom, for example by means of a metal plate 16 of the second body 10 welded to the two coaxial cylindrical bodies 10 and 10B, and at the top by means of the structure of the fourth body 20 welded to the same coaxial cylindrical bodies 10 and 10B.

[0053] As illustrated in the exemplary embodiments shown in Figures 1 and 3, the burner 11 preferably has a substantially cylindrical shape and is arranged in the second cavity 12 in a central position extending along said vertical reference axis X which in fact also constitutes the axis of structural symmetry thereof.

[0054] In its turn, as illustrated in the exemplary embodiments shown in Figures 1 and 3, the first body 1 also comprises a substantially cylindrical body which develops vertically around the vertical reference axis X which in fact also constitutes the axis of structural symmetry thereof.

[0055] In this case, the cylinder of the first body 1 has an internal diameter D1 smaller than the internal diameter D2 of the first cylindrical body 10.

[0056] For illustrative clarity, in Figure 1 the internal extensions D1 and D2, and in particular the diameters, are graphically represented forward in relation to the axis of symmetry X since in Figure 1 the boiler is shown cut in a plane not passing through this axis X.

[0057] According to one possible embodiment, for example as shown schematically only in Figure 5 for simplicity of illustration, the first body 1 comprises at least a plurality of metal plates 9 which are suitably arranged in sequence with each other along the substantially vertical axis X inside the first cavity 2.

[0058] As illustrated, the metal plates 9 are positioned mutually among them, in particular staggered, in a manner so as to form a passage pathway for the descending liquid solution (arrows L) or for the ascending vapors (arrows V) produced by boiling, and promote exchanges of mass and/or heat between the flows of liquid streams L and vapor streams V.

[0059] Conveniently, the boiler 100 according to claim 1 further comprises a plurality of fins 5 which are fixed on the outer surface 6 of the first hollow body 1.

[0060] In particular according to one possible embodiment illustrated in Figure 1, there is a helical fin, constituted of a segmented or notched metal strip 7 which is fixed on the outer surface 6 of the first hollow body 1 along substantially all or a predominant portion of the vertical extension thereof.

[0061] Clearly, it is possible to use one single continuous strip or a plurality of metal strips 7 fixed individually to the outer surface 6.

[0062] In practice, the or each strip 7 protrudes from the outer surface 6 in a transversal direction, in particular perpendicular, relative to the vertical reference axis X, with its teeth that form the fins 5; advantageously, with respect to a direction parallel to the vertical reference axis X, the fins 5 are for example staggered between adjacent turns of the fins, in order to facilitate the through- passage of fumes.

[0063] For example, each metal strip 7 is high frequency resistance welded to the outer surface 6 of the first body 1, before the latter is welded to the fourth body or cross-flow distributor 20. In one possible embodiment, the fins 5 may have a shorter length in the lower part of the body 1 where the temperatures, and therefore the heat exchanges, are greater.

[0064] In practice, according to this embodiment, the length of the fins 5, measured along a transversal direction relative to the vertical reference axis X, increases in the ascending direction along the first body 1, that is to say in the direction moving away from the fourth body 20.

[0065] In one other possible embodiment, as schematically illustrated in Figure 3, each fin 5 comprises, seen in a plane perpendicular to the reference axis X, a shaped body having a U- shaped or C- shaped section; the U- or C-shaped body is fixed on the external surface 6 of the first body 1 and extends longitudinally along a direction parallel to the vertical reference axis X with the concavity facing outwards relative to the first body 1, that is to say in the direction opposite to the first internal cavity 2.

[0066] As well in this case, the fins 5 are welded to the external wall 6 of the first hollow body 1 before the latter is welded to the fourth body 20.

[0067] In the embodiment illustrated in Figure 1, the boiler 100 according to claim 1 comprises moreover, an insulating jacket 30 comprising at least one layer of thermal insulating material, for example glass wool, which is arranged laterally around the first body 1, and contained for example in a rigid cylindrical casing, for example made of metal.

[0068] In the illustrated embodiment, the insulating jacket 30 as a whole preferably has also a cylindrical shape that develops around the vertical axis X, which therefore constitutes the axis of symmetry thereof.

[0069] As illustrated, the insulating jacket 30 extends above and upwards from the fourth body 20 along the vertical reference axis X, and is arranged laterally around the outer surface 6 of the first hollow body 1 and is spaced apart there-from so as to form with the first hollow body 1 an interspace 31 within which the fins 5 are housed and within which the hot fumes Fc flow.

[0070] The rigid casing of the insulating jacket 30 is for example fixed below the cross- flow diffuser 20.

[0071] In one possible embodiment, illustrated in Figure 3, the boiler 100 according to claim 1 comprises a further metallic hollow cylindrical body 32 which is fixed at its bottom/lower part to the fourth body 20 and extends above and upwards along the substantially vertical reference axis X.

[0072] In particular, said further metallic cylindrical body 32 is arranged laterally around and spaced apart from the first body 1 in a manner so as to delimit with it, at least in part, an interspace 31.

[0073] In this embodiment, the third external cylindrical body 10B is disposed externally to and extends further along the substantially vertical axis X also around the fourth body 20 and up to the further metallic hollow cylindrical body 32.

[0074] In this manner, the external cylindrical body 10B delimits with the first cylindrical body 10, the fourth body 20, and the further hollow insulating body 32, a further interspace or cavity 35 which, in the lower part, includes in fact also the second internal cavity 13.

[0075] Conveniently, a heat exchanger 36 is housed within the interspace 35, for example a coil which extends for instance over the entire vertical length of the boiler 100 according to claim 1.

[0076] Such a coil 36 for example makes it possible to drain the solution poor of coolant from the bottom of the boiler 100 and to release heat to the solution rich of coolant which instead travels in a countercurrent flow in the downward direction.

[0077] Furthermore, there is conveniently an exchange of heat between the cavity 31 (containing hot flue gases/fumes) and the interspace or cavity 35 (containing the boiling solution).

[0078] In this embodiment, on the exterior of the third body 10B an appropriate insulation may be used.

[0079] In its turn, as illustrated in greater detail in the exemplary embodiments shown in Figures 2 and 4, the fourth hollow body 20 comprises one or more first through holes 21 which extend in a transversal direction, in particular perpendicular to the substantially vertical reference axis X.

[0080] These first through holes 21 are configured to cause streams of solution L to flow out from the first internal cavity 2 conveying them towards the second body 10, and introducing them into the third cavity 13.

[0081] Furthermore, the fourth body 20 conveniently comprises one or more second through holes 22 which extend in a direction substantially parallel to the vertical reference axis X.

[0082] These second through holes 22 are configured in a manner such as to cause hot fumes Fc to flow out from the second internal cavity 12 making them rise upwards and directing them towards the exterior of the external lateral walls 6 of the first body 1.

[0083] Furthermore, by flowing through the first holes 21, the streams of vapor, which form in the third internal cavity 13, are also able to rise upwards.

[0084] In the boiler 100 according to claim 1, the fourth body 20 also preferably presents a substantially symmetrical structure in relation to the reference axis X, and is for example made of steel.

[0085] In particular, as illustrated in the exemplary embodiments shown in Figures 2 and 4, the fourth body 20 has a hollowed or flared central portion 23, shaped for example like a cup or glass, having the cavity facing towards the first body 1; along the lateral surface of the hollowed portion 23 is defined the inlet of said one or more first through holes 21 which then lead into the third internal cavity 13.

[0086] Furthermore, the fourth body 20 comprises a lateral portion 24 which is arranged around the central portion 23 along which said one or more second through holes 22 are defined. In the embodiment illustrated in Figure 2, the lateral portion 24 of the fourth body 20 has, for example, a ring shape in which the bottom part 25, for instance is welded to the first cylindrical body 10, and the top part has a laterally protruding flange 26 which is welded below the second cylinder body 10B and above the first body 1 and the metal cylinder which forms the insulating jacket 30.

[0087] Clearly, these connections may be implemented differently; for example, the protruding flange 26 may be welded laterally to the second cylinder body 10B.

[0088] In the embodiment illustrated in Figure 4, the lateral portion 24 has at the top a raised inner edge 27 arranged around the hollowed central portion 23 that is adapted so as to be fixed, in particular welded, to the first body 1, and an outer edge 28 raised at the top and adapted so as to be fixed, for example welded, to the further body 32.

[0089] Furthermore, the lateral portion 24 has at the bottom a further lower edge 29 adapted so as to be fixed, for example welded, to the first cylindrical body 10.

[0090] Clearly, with respect to the previously described configuration, which represents a preferred form of realization, the fourth body 20 in accordance with claim 1 can be differently configured and have any shape suitable for performing the tasks assigned to it, namely configured so that hot fumes Fc produced by the burner 11 flows through it flowing from said second internal cavity 12 towards the outer surface 6 of the first body 1, and flows of said liquid solution flow through it flowing from said first internal cavity 2 into said third internal cavity 13.

[0091] As previously indicated, once assembled, the boiler 100 according to claim 1 may be conveniently installed for example at the base of a generator 200 for a thermal absorption machine.

[0092] During the operation of the generator 200, and with reference to Figure 5, the vapor generated by the boiler 100 according to claim 1 by boiling the starting solution, for example water and ammonia, indicated by the arrows V, rises from the internal cavity 13, passes through the distributor 20, rises from the internal cavity 2 passing among the metal plates 9, then rising through the stripping section 205, and subsequently the dephlegmator 210. Over the course of this route, the mass and/or heat exchanges serve to enable at least partial condensation of the water contained in the vapor, thus going to increase the percentage of coolant obtained.

[0093] The rectified coolant vapor (indicated in Figure 5 by the arrow V_R) is released from the generator head to be used, for example, in the refrigeration cycle of the thermal machine of which the generator 200 forms a part.

[0094] The condensed vapor V flows downwards travelling along the pathway in the opposite direction and mixes with the liquid solution L entering into the generator.

[0095] In practice, it has been found that the boiler 100 according to claim 1 and the generator 200 according to the invention fulfil the intended scope and objects in that they allow realizing a very efficient solution from the thermal standpoint, and in particular wherein the heat dispersion or losses are reduced as compared to known solutions, the local tensions and related stresses in particular in the walls of the boiler, are at least reduced thanks also to the structure being substantially symmetrical, and the heat exchanges are optimized. For example, in particular in the configuration of Figure 1, the fins 5 serve to maximize heat transfer from the hot fumes Fc which rise and flow parallel to the axis X of the first hollow body 1 rather than perpendicularly thereto; therefore these fumes are forced to constantly change direction in order to pass through the interstices of the fins, consequently providing substantial improvement in respect of the turbulence and heat transfer coefficient.

[0096] All of the foregoing is obtained with a simple structure that can be implemented at relatively low costs, and is mechanically robust; for example, the positioning of the fins located externally to the first hollow body 1 provides the ability to effectively execute the welds with the consequent benefit thereof in terms of resistance to mechanical stresses and thermal stresses.

[0097] Furthermore, both the boiler 100 according to claim 1 and the generator 200 may be advantageously used for the fabrication of a thermal absorption machine, and in particular a heat pump or a chiller;

[0098] therefore a further aspect of the present invention constitutes a thermal absorption machine comprising a boiler 100 according to claim 1 or such a generator 20C according to claim 14 Naturally, the principle of the invention remaining the same, there may be wide variation in the embodiments and the particular details of implementation as compared to what has been described and illustrated purely by way of non-limiting example, without thereby intending to depart from the scope of protection of the present invention as defined in the attached claims. The components described could be made from a material that is different from that mentioned in the description and/or they could be configured differently from the manner described above as long as compatibility thereof is ensured with respect to the scope of the following claims, for example, the fins 5 may easily be bent or twisted, in order to modify the area of throughpassage of the flue gases.

Claims

1. Direct flame boiler (100), wherein it comprises at least:

   - a first body (1) which extends along a substantially vertical reference axis (X) and at least partially encloses a first internal cavity (2) suitable for receiving a liquid solution;
   - a second body (10) which, with reference to said substantially vertical axis (X), is arranged below said first body (2) and at least partially encloses a second internal cavity (12) in which there is placed a burner (11) capable of generating heat to keep the liquid solution in the first internal cavity (2) boiling;
   - a third body (10B) which is arranged for at least a part thereof around the second body (10), said second and third bodies (10, 10B) delimiting between them a third internal cavity (13) which is arranged, for at least a part thereof, laterally around said second cavity (12); and
   - a fourth body (20) which is interposed between said first body (1) and said second body (10) and is at least integrally connected to them, said fourth body (20) being configured so that hot fumes (Fc) produced by the burner (11) flows through it flowing from said second internal cavity (12) towards the outer surface (6) of the first body (1) and **characterized in that** the fourth body (20) is configured so that flows of said liquid solution flow through it flowing from said first internal cavity (2) into said third internal cavity (13), wherein said fourth body (20) comprises one or more first through holes (21) which extend in a direction transverse to said substantially vertical reference axis (X) and are configured to put said first internal cavity (2) in communication with said third internal cavity (13).

2. Boiler (100) according to claim 1, wherein said fourth body (20) comprises one or more second through holes (22) which extend in a direction substantially parallel to said substantially vertical reference axis (X) and are configured to put said second internal cavity (2) in communication with an external area around said first body (1).

3. Boiler (100) according to claim 2, wherein said fourth body (20) comprises a central portion (23) hollowed with the cavity facing towards said first body (1) and along whose lateral surface the inlet of said one or more first through holes (21) are defined, and a side portion (24) arranged around said central portion (23) along which said one or more second through holes (22) are defined.

4. Boiler (100) according to one or more of the preceding claims, wherein said second body (10) comprises a first internal cylindrical body which laterally delimits said second internal cavity (12), and said third body (10B) comprises a second external cylindrical body which is arranged externally to and substantially

concentric with said first internal cylindrical body with respect to said substantially vertical axis (X), said third internal cavity (13) being defined, at least in part, between said first internal cylindrical body and second external cylindrical body.

5. Boiler (100) according to one or more of the preceding claims, wherein said burner (11) has a substantially cylindrical shape and is arranged in said second cavity (12) in a central position extending from a base plate (16) along said substantially vertical reference axis (X).

6. Boiler (100) according to one or more of the preceding claims, wherein said first body (1) comprises a substantially cylindrical body which develops vertically around said substantially vertical reference axis (X) and having an internal diameter (D1) smaller than or equal to the internal diameter (D2) of said second internal cavity (12).

7. Boiler (100) according to one or more of the preceding claims, comprising a plurality of metal plates (9) which are arranged inside said first internal cavity (2), in sequence with each other along said substantially vertical axis (X).

8. Boiler (100) according to one or more of the preceding claims, comprising a plurality of fins (5) which are fixed on the outer surface (6) of the first body (1).

9. Boiler (100) according to claim 8, wherein said plurality of fins (5) is formed by at least one segmented metal strip which is helically fixed on the outer surface (6) of the first hollow body (1) and protrudes from said outer surface in a transverse direction with respect to the substantially vertical reference axis (X).

10. Boiler (100) according to claim 8, wherein each of said fins (5) comprises a U or C-shaped body which is fixed on the external surface (6) of the first body (1) and extends longitudinally along said substantially vertical reference axis (X) with the concavity facing outwards with respect to said first body (1).

11. Boiler (100) according to one or more of the preceding claims, comprising an insulating jacket (30) arranged laterally around and spaced from said first body (1) so as to delimit together with it, at least in part, an interspace (31).

12. Boiler (100) according to one or more of claims 1 to 10, comprising a further hollow cylindrical body (32) which is fixed in its lower part to said fourth body (20) and extends above along said reference axis substantially vertical (X), said further cylindrical body (30) being arranged laterally around and spaced apart from said first body (1) so as to delimit with it, at least in part, an interspace (31).

13. Boiler (100) according to claim 12 when dependent on claim 4, wherein said second external cylindrical body (10B) is disposed externally to and extends further along said substantially vertical axis (X) around said fourth body (20) and further hollow cylindrical body (32), said second external cylindrical body (10B) delimiting with said first cylindrical body (10), fourth body (20) and further hollow body (32), an interspace (35) suitable for housing a heat exchanger (36).

14. Coolant vapor generator (200) for thermal absorption machines, **characterized in that** it comprises at least one direct flame boiler (100) according to one or more of the preceding claims.

15. Thermal absorption machine **characterized in that** it comprises a coolant vapor generator (200) according to claim 14 or a direct flame boiler (100) according to one or more of claims 1 to 13.

Patentansprüche

1. Direktflammkessel (100), wobei

er mindestens Folgendes umfasst:

- einen ersten Körper (1), der sich entlang einer im Wesentlichen vertikalen Bezugsachse (X) erstreckt und zumindest teilweise einen ersten inneren Hohlraum (2) umschließt, der zum Aufnehmen einer flüssigen Lösung geeignet ist;
- einen zweiten Körper (10), der in Bezug auf die im Wesentlichen vertikale Achse (X) unter dem ersten Körper (2) angeordnet ist und zumindest teilweise einen zweiten inneren Hohlraum (12) umschließt, in dem ein Brenner (11) platziert ist, der in der Lage ist, Wärme zu erzeugen, um die flüssige Lösung in dem ersten inneren Hohlraum (2) am Sieden zu halten;
- einen dritten Körper (10B), der zumindest teilweise um den zweiten Körper (10) herum angeordnet ist, wobei der zweite und der dritte Körper (10, 10B) untereinander einen dritten inneren Hohlraum (13) begrenzen, der zumindest teilweise seitlich um den zweiten Hohlraum (12) herum angeordnet ist; und
- einen vierten Körper (20), der zwischen dem ersten Körper (1) und dem zweiten Körper (10) angeordnet und zumindest einstückig damit verbunden ist, wobei der vier-

te Körper (20) konfiguriert ist, sodass heiße Rauchgase (Fc), die von dem Brenner (11) erzeugt werden, durch ihn strömen und von dem zweiten inneren Hohlraum (12) zu der äußeren Oberfläche (6) des ersten Körpers (1) strömen, und **dadurch gekennzeichnet, dass** der vierte Körper (20) konfiguriert ist, sodass

Ströme der flüssigen Lösung durch ihn strömen und von dem ersten inneren Hohlraum (2) in den dritten inneren Hohlraum (13) strömen, wobei der vierte Körper (20) ein oder mehrere erste Durchgangslöcher (21) umfasst, die sich in einer Richtung quer zu der im Wesentlichen vertikalen Bezugsachse (X) erstrecken und konfiguriert sind, um den ersten inneren Hohlraum (2) mit dem dritten inneren Hohlraum (13) in Verbindung bringen.

2. Kessel (100) nach Anspruch 1, wobei der vierte Körper (20) ein oder mehrere zweite Durchgangslöcher (22) umfasst, die sich in einer Richtung im Wesentlichen parallel zu der im Wesentlichen vertikalen Bezugsachse (X) erstrecken und konfiguriert sind, um den zweiten inneren Hohlraum (2) mit einem Außenbereich um den ersten Körper (1) herum in Verbindung bringen.

3. Kessel (100) nach Anspruch 2, wobei der vierte Körper (20) einen mittleren Abschnitt (23), der mit dem Hohlraum zu dem ersten Körper (1) hin hohl ist und entlang dessen Seitenfläche der Einlass des einen oder der mehreren ersten Durchgangslöcher (21) definiert ist, und einen seitlichen Abschnitt (24), der um den mittleren Abschnitt (23) herum angeordnet ist, entlang dessen das eine oder die mehreren zweiten Durchgangslöcher (22) definiert sind, umfasst.

4. Kessel (100) nach einem oder mehreren der vorherigen Ansprüche, wobei der zweite Körper (10) einen ersten inneren zylindrischen Körper umfasst, der den zweiten inneren Hohlraum (12) seitlich begrenzt, und der dritte Körper (10B) einen zweiten äußeren zylindrischen Körper umfasst, der außerhalb des ersten inneren zylindrischen Körpers und im Wesentlichen konzentrisch zu diesem in Bezug auf die im Wesentlichen vertikale Achse (X) angeordnet ist, wobei der dritte innere Hohlraum (13) zumindest teilweise zwischen dem ersten inneren zylindrischen Körper und dem zweiten äußeren zylindrischen Körper definiert ist.

5. Kessel (100) nach einem oder mehreren der vorherigen Ansprüche, wobei der Brenner (11) eine im Wesentlichen zylindrische Form aufweist und in dem zweiten Hohlraum (12) an einer mittleren Position angeordnet ist, die sich von einer Grundplatte (16) entlang der im Wesentlichen vertikalen Bezugsachse (X) erstreckt.

6. Kessel (100) nach einem oder mehreren der vorherigen Ansprüche, wobei der erste Körper (1) einen im Wesentlichen zylindrischen Körper umfasst, der sich vertikal um die im Wesentlichen vertikale Bezugsachse (X) erstreckt und einen Innendurchmesser (D1) aufweist, der kleiner als oder gleich wie der Innendurchmesser (D2) des zweiten inneren Hohlraums (12) ist.

7. Kessel (100) nach einem oder mehreren der vorherigen Ansprüche, umfassend eine Vielzahl von Metallplatten (9), die im Inneren des ersten inneren Hohlraums (2) hintereinander entlang der im Wesentlichen vertikalen Achse (X) angeordnet sind.

8. Kessel (100) nach einem oder mehreren der vorherigen Ansprüche, umfassend eine Vielzahl von Rippen (5), die an der Außenfläche (6) des ersten Körpers (1) befestigt sind.

9. Kessel (100) nach Anspruch 8, wobei die Vielzahl von Rippen (5) durch mindestens einen segmentierten Metallstreifen gebildet ist, der schraubenförmig an der Außenfläche (6) des ersten Hohlkörpers (1) befestigt ist und von der Außenfläche in einer Querrichtung in Bezug auf die im Wesentlichen vertikale Bezugsachse (X) hervorsteht.

10. Kessel (100) nach Anspruch 8, wobei jede der Rippen (5) einen U- oder C-förmigen Körper umfasst, der an der Außenfläche (6) des ersten Körpers (1) befestigt ist und sich in Längsrichtung entlang der im Wesentlichen vertikalen Bezugsachse (X) erstreckt, wobei die Konkavität in Bezug auf den ersten Körper (1) nach außen gerichtet ist.

11. Kessel (100) nach einem oder mehreren der vorherigen Ansprüche, umfassend einen Isoliermantel (30), der seitlich um den ersten Körper (1) herum und in einem Abstand davon angeordnet ist, um zusammen damit zumindest teilweise einen Zwischenraum (31) abzugrenzen.

12. Kessel (100) nach einem oder mehreren der Ansprüche 1 bis 10, umfassend einen weiteren hohlen zylindrischen Körper (32), der in seinem unteren Teil an dem vierten Körper (20) befestigt ist und sich entlang der im Wesentlichen vertikalen Bezugsachse (X) nach oben erstreckt, wobei der weitere zylindrische Körper (30) seitlich um den ersten Körper (1) herum und davon beabstandet angeordnet ist, sodass er damit zumindest teilweise einen Zwischenraum (31) begrenzt.

13. Kessel (100) nach Anspruch 12, wenn abhängig von Anspruch 4, wobei der zweite äußere zylindrische Körper (10B) außerhalb der im Wesentlichen vertikalen Achse (X) um den vierten Körper (20) und den weiteren hohlen zylindrischen Körper (32) angeordnet ist und sich weiter entlang dieser Achse erstreckt, wobei der zweite äußere zylindrische Körper (10B) mit dem ersten zylindrischen Körper (10), dem vierten Körper (20) und dem weiteren hohlen Körper (32) einen Zwischenraum (35) begrenzt, der zum Aufnehmen eines Wärmetauschers (36) geeignet ist.

14. Kältemitteldampferzeuger (200) für Wärmeabsorptionsmaschinen, **dadurch gekennzeichnet, dass** er mindestens einen Direktflammkessel (100) nach einem oder mehreren der vorherigen Ansprüche umfasst.

15. Wärmeabsorptionsmaschine, **dadurch gekennzeichnet, dass** sie einen Kältemitteldampferzeuger (200)

nach Anspruch 14 oder einen Direktflammkessel
(100) nach einem oder mehreren der Ansprüche 1-13 umfasst.

Revendications

1. Chaudière à flamme directe (100), dans laquelle

elle comprend au moins :

- un premier corps (1) qui s'étend le long d'un axe de référence sensiblement vertical (X) et qui renferme au moins partiellement une première cavité interne (2) apte à recevoir une solution liquide ;
- un deuxième corps (10) qui, par rapport à l'axe sensiblement vertical (X), est disposé sous le premier corps (2) et renferme au moins partiellement une deuxième cavité interne (12) dans laquelle est placé un brûleur (11) capable de générer de la chaleur pour maintenir en ébullition la solution liquide contenue dans la première cavité interne (2) ;
- un troisième corps (10B) disposé au moins en partie autour du deuxième corps (10), lesdits deuxième et troisième corps (10, 10B) délimitant entre eux une troisième cavité interne (13) disposée, au moins en partie, latéralement autour de ladite deuxième cavité (12) et
- un quatrième corps (20) qui est interposé entre ledit premier corps (1) et ledit deuxième corps (10) et qui leur est au moins intégralement relié, ledit quatrième corps (20) est configuré de sorte que des fumées chaudes (Fc) produites par le brûleur (11) le traversent en s'écoulant de ladite deuxième cavité interne (12) vers la surface extérieure (6) du premier corps (1) et **caractérisé en ce que** le quatrième corps (20) est configuré de sorte que

les flux de ladite solution liquide le traversent en s'écoulant de ladite première cavité interne (2) dans ladite troisième cavité interne (13), dans lequel ledit quatrième corps (20) comprend un ou plusieurs premiers trous traversants (21) qui s'étendent dans une direction transversale à l'axe de référence sensiblement vertical (X) et sont configurés pour mettre ladite première cavité interne (2) en communication avec ladite troisième cavité interne (13).

2. Chaudière (100) selon la revendication 1, dans laquelle ledit quatrième corps (20) comprend un ou plusieurs seconds trous traversants (22) qui s'étendent dans une direction sensiblement parallèle audit axe de référence sensiblement vertical (X) et sont configurés pour mettre ladite seconde cavité interne (2) en communication avec une zone externe autour dudit premier corps (1).

3. Chaudière (100) selon la revendication 2, dans laquelle ledit quatrième corps (20) comprend une partie centrale (23) creusée avec la cavité orientée vers ledit premier corps (1) et le long de la surface latérale de laquelle l'entrée desdits un ou plusieurs premiers trous traversants (21) sont définis, et une partie latérale
(24) disposée autour de ladite partie centrale (23) le long de laquelle sont définis lesdits un ou plusieurs seconds trous traversants (22).

4. Chaudière (100) selon l'une ou plusieurs des revendications précédentes, dans laquelle ledit deuxième corps (10) comprend un premier corps cylindrique interne qui délimite latéralement ladite deuxième cavité interne (12), et ledit troisième corps (10B) comprend un deuxième corps cylindrique externe qui est disposé à l'extérieur et sensiblement concentrique avec ledit premier corps cylindrique interne par rapport audit axe sensiblement vertical (X), ladite troisième cavité interne (13) étant définie, au moins en partie, entre ledit premier corps cylindrique interne et ledit deuxième corps cylindrique externe.

5. Chaudière (100) selon l'une ou plusieurs des revendications précédentes, dans laquelle ledit brûleur

(11) présente une forme sensiblement cylindrique et est disposé dans ladite seconde cavité (12) dans une position centrale s'étendant à partir d'une plaque de base (16) le long dudit axe de référence sensiblement vertical (X).

6. Chaudière (100) selon l'une ou plusieurs des revendications précédentes, dans laquelle ledit premier corps (1) comprend un corps sensiblement cylindrique qui se développe verticalement autour dudit axe de référence sensiblement vertical (X) et présentant un diamètre interne (D1) inférieur ou égal au diamètre interne (D2) de ladite seconde cavité interne (12).

7. Chaudière (100) selon l'une ou plusieurs des revendications précédentes, comprenant une pluralité de plaques métalliques (9) qui sont disposées à l'intérieur de ladite première cavité interne (2), en séquence les unes avec les autres le long dudit axe sensiblement vertical (X).

8. Chaudière (100) selon l'une ou plusieurs des revendications précédentes, comprenant une pluralité d'ailettes (5) qui sont fixées sur la surface extérieure (6) du premier corps (1).

9. Chaudière (100) selon la revendication 8, dans laquelle ladite pluralité d'ailettes (5) est formée par au moins une bande métallique segmentée qui est fixée de manière hélicoïdale sur la surface extérieure (6) du premier corps creux (1) et qui fait saillie par rapport à ladite surface extérieure

dans le sens transversal
par rapport à l'axe de référence sensiblement vertical (X).

10. Chaudière (100) selon la revendication 8, dans laquelle chacune desdites ailettes (5) comprend un corps en forme de U ou de C qui est fixé sur la surface externe (6) du premier corps (1) et s'étend longitudinalement le long dudit axe de référence sensiblement vertical (X) avec la concavité
tournée vers l'extérieur par rapport au premier corps (1).

11. Chaudière (100) selon l'une ou plusieurs des revendications précédentes, comprenant une enveloppe isolante (30) disposée latéralement autour et à distance dudit premier corps (1) de manière à délimiter avec lui, au moins en partie, un espace intermédiaire (31).

12. Chaudière (100) selon une ou plusieurs des revendications 1 à 10, comprenant un autre corps cylindrique creux (32) qui est fixé dans sa partie inférieure audit quatrième corps (20) et s'étend au-dessus le long dudit axe de référence sensiblement vertical (X), ledit autre corps cylindrique (30) étant disposé latéralement autour et à distance dudit premier corps (1) de manière à délimiter avec lui, au moins en partie, un espace intercalaire (31).

13. Chaudière (100) selon la revendication 12 lorsqu'elle dépend de la revendication 4, dans laquelle ledit deuxième corps cylindrique externe (10B) est disposé à l'extérieur et s'étend plus loin le long dudit axe sensiblement vertical (X) autour dudit quatrième corps (20) et dudit autre corps cylindrique creux (32), ledit deuxième corps cylindrique externe (10B) délimitant avec ledit premier corps cylindrique (10), le quatrième corps (20) et l'autre corps creux (32), un espace intermédiaire (35) convenant au logement d'un échangeur de chaleur (36).

14. Générateur de vapeur de refroidissement (200) pour machines d'absorption thermique, **caractérisé par le fait qu'**il comprend au moins une chaudière à flamme directe
(100) selon l'une quelconque des revendications précédentes.

15. Machine d'absorption thermique **caractérisée par le fait qu'**elle comprend un générateur de vapeur de liquide de refroidissement (200)

selon la revendication 14 ou une chaudière à flamme directe
(100) selon une ou plusieurs des revendications 1 à 13.

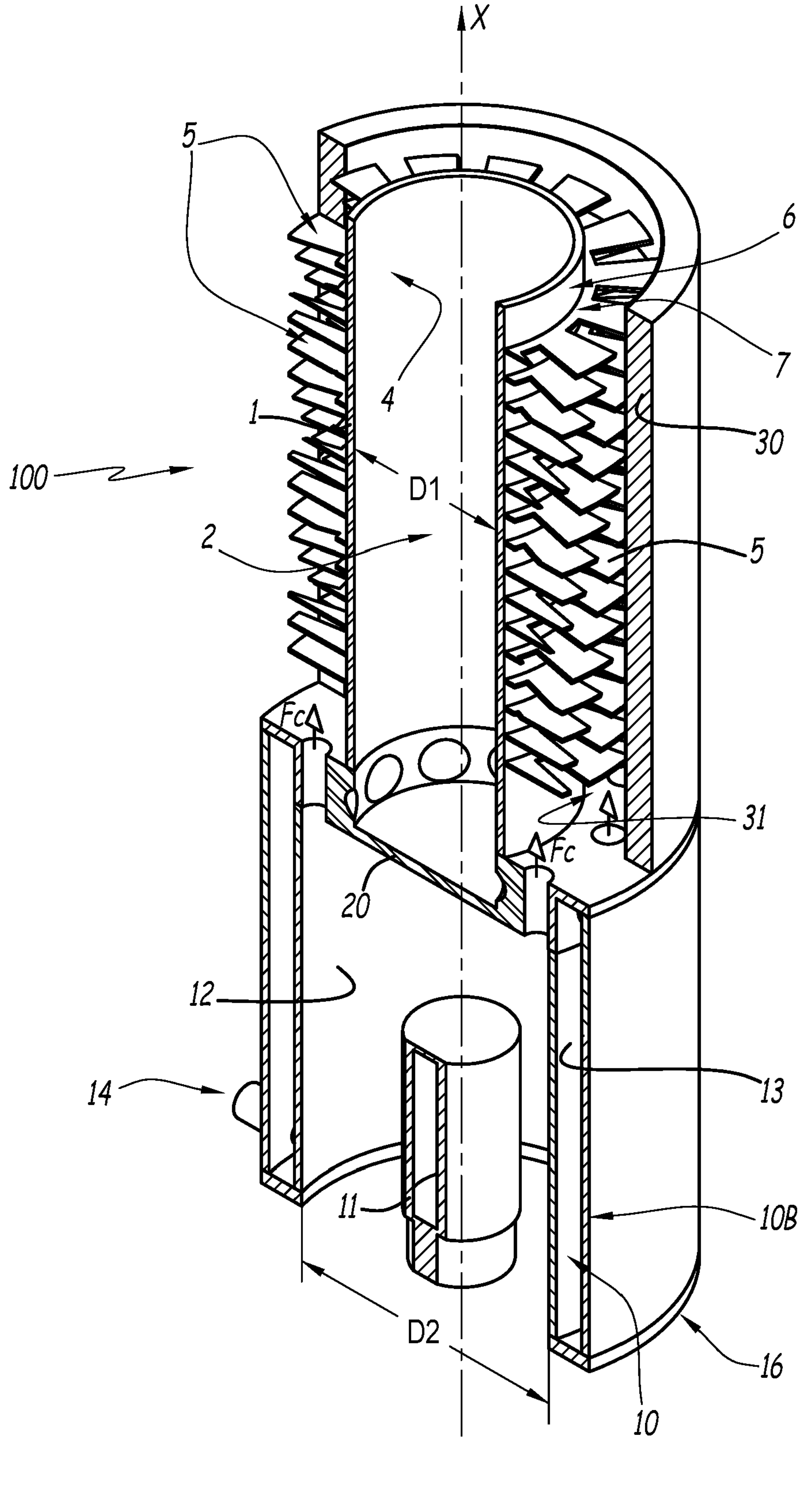


FIG.1

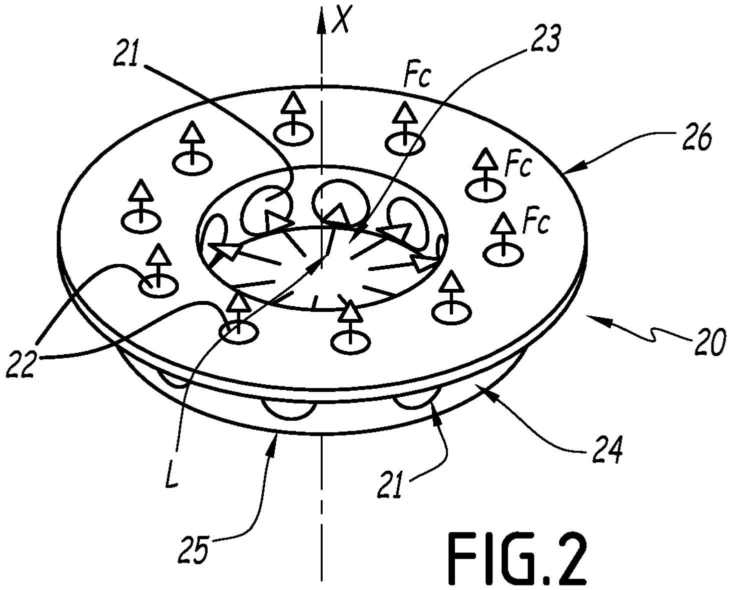


FIG.2

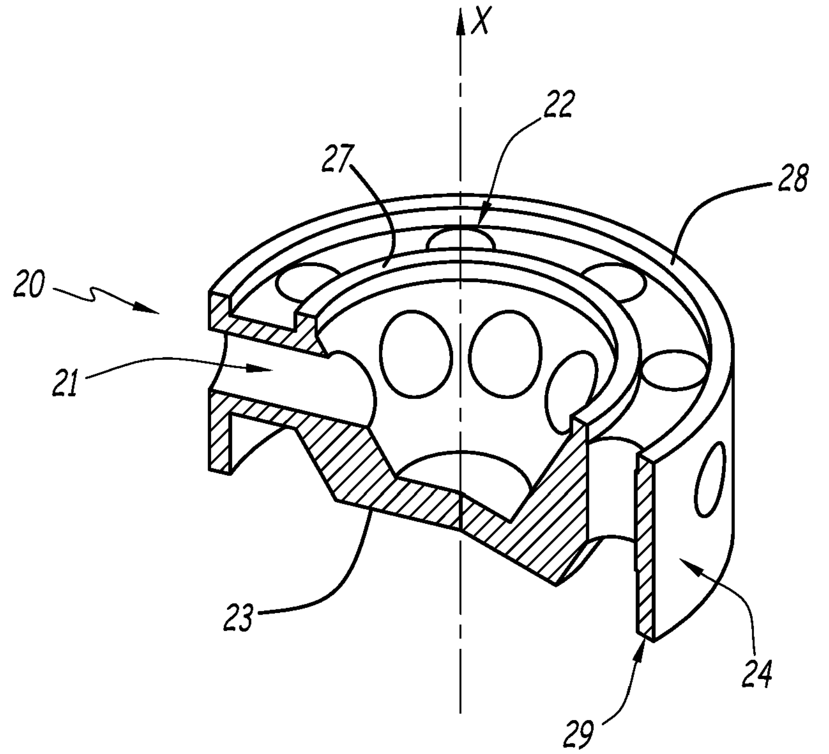
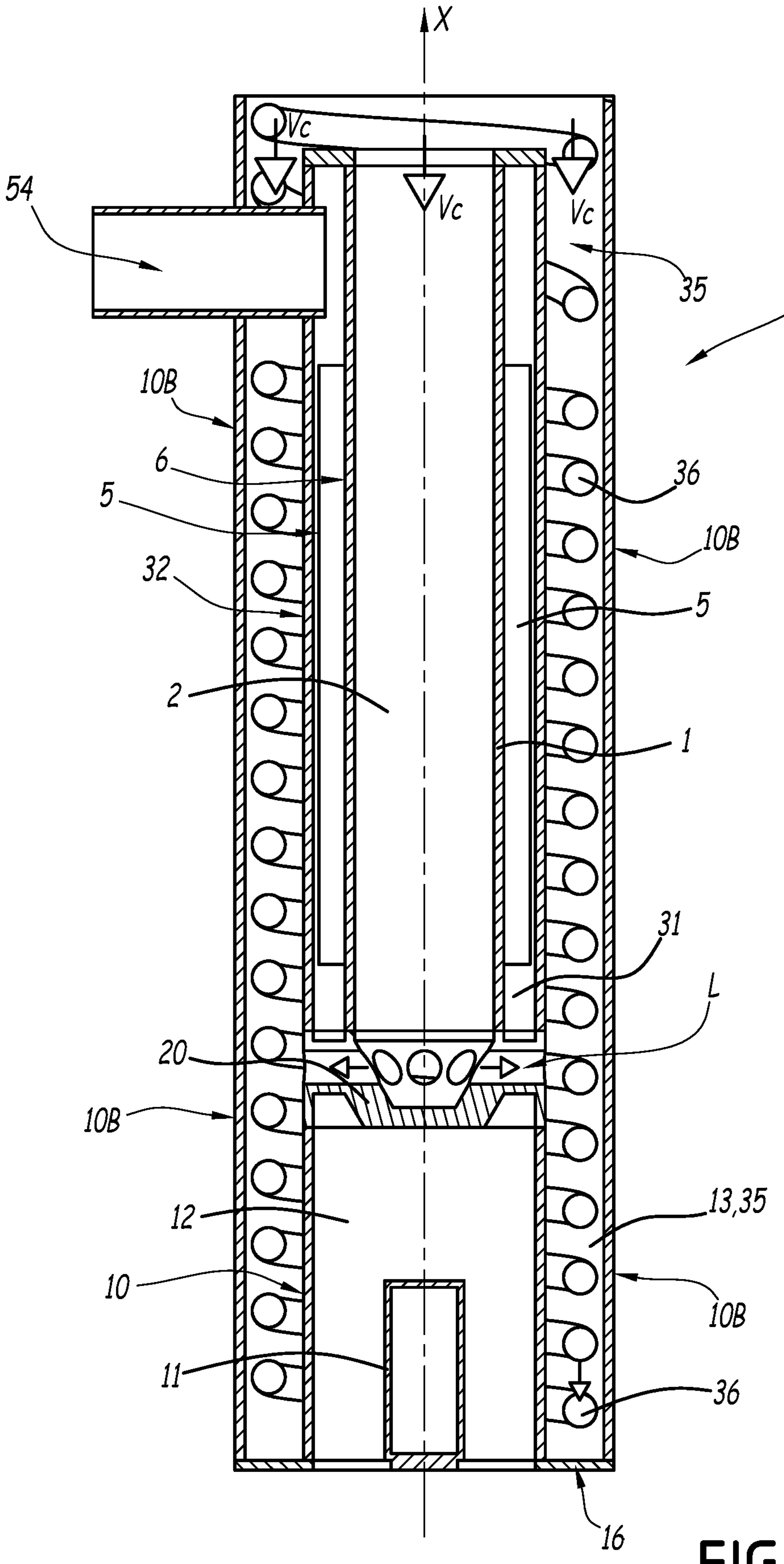


FIG.4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Vc
Vc
54
100
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10B
6
36
5
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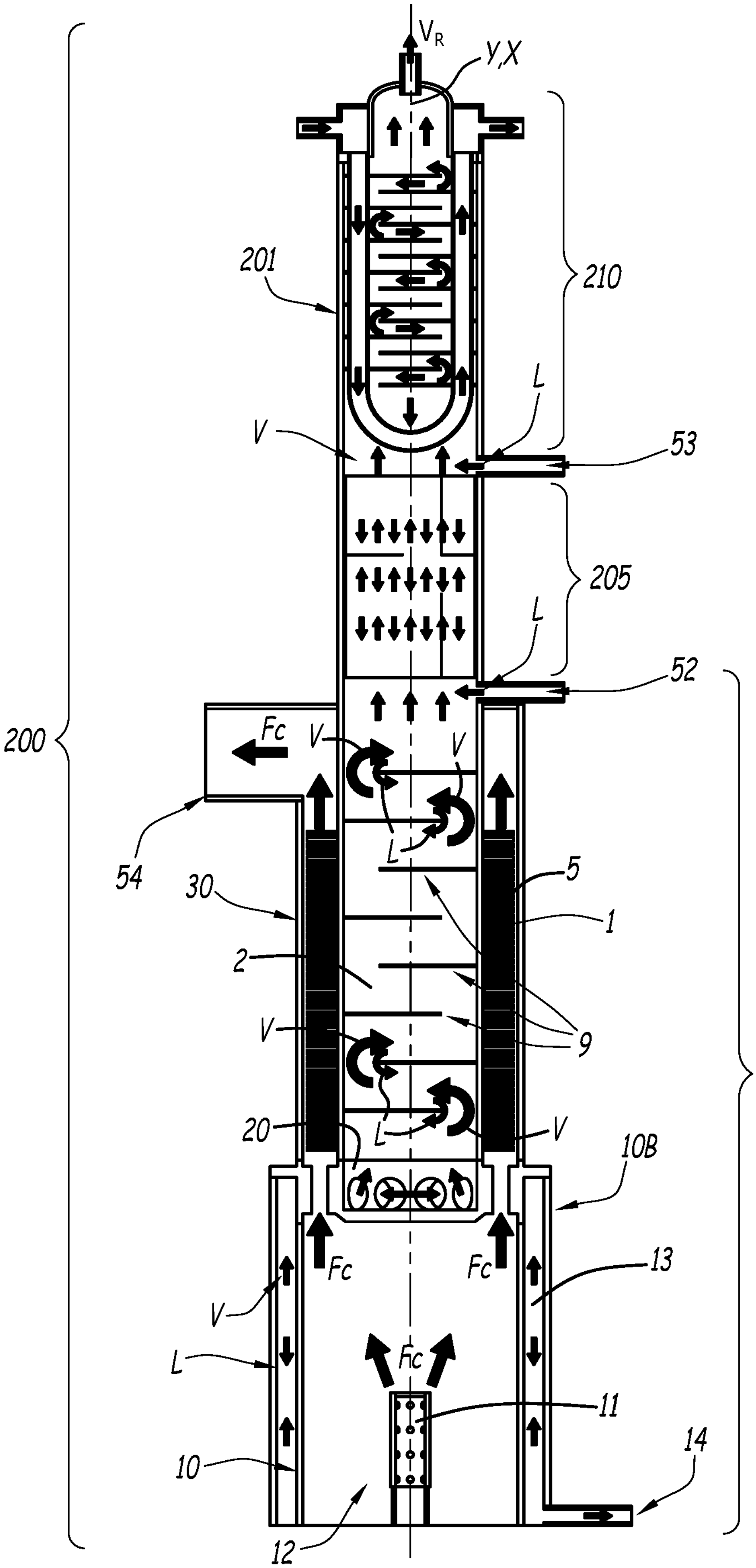
12
13,35
10
10B
11
36
16

FIG.3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210
L
V
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205
L
52
200
Fc
V
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5
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2
9
V
9
100
L
20
V
10B
Fc
Fc
13
V
L
Fc
11
10
14
12

FIG.5

REFERENCES CITED IN THE DESCRIPTION

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