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(54) COOLED WALL OF COMBUSTION CHAMBER AND COMBUSTION CHAMBER COMPRISING SAID WALL

GEKÜHLTE WAND EINER BRENNKAMMER UND BRENNKAMMER MIT DER BESAGTEN WAND

PAROI REFROIDIE DE CHAMBRE DE COMBUSTION ET CHAMBRE DE COMBUSTION COMPRENANT LADITE PAROI

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a new type of cooled wall for producing combustion chambers of the type used in industrial boilers for transforming thermal energy produced through combustion into high pressure steam.

[0002] The subject of the present invention is therefore both the cooled wall and the combustion chamber comprising said cooled wall.

[0003] The applications of the present invention are many, although it is particularly advantageous when used on boilers that produce steam by incinerating waste (solid urban waste, industrial waste, hazardous toxic waste and so on) and related derivatives.

[0004] In fact, in all these cases, the combined action of the high temperatures reached in the combustion process and consistent concentrations of chlorine and derivatives, with the related corrosive effects, cause devastating deteriorations of the membrane tubes with which the walls of the combustion chamber of this type are conventionally produced.

[0005] These corrosive phenomena drastically reduce the reliability of the boiler, and, consequently, of the plant as a whole, also resulting in frequent stops for maintenance/replacement of the tubes of the corroded membrane walls, with related costs linked not only to the actual maintenance costs, but also and above all to the downtime costs due to lack of production.

STATE OF THE ART

[0006] As is known, the containing walls of a conventional steam boiler are formed of membrane walls, i.e. of walls formed by parallel membrane tubes inside which the fluid (water/steam) flows.

[0007] In particular, in modern plants that use waste as fuel, rapid deterioration of the tubes (in general made of carbon steel), which form the membrane wall of the combustion chamber and which are therefore exposed to the corrosive action of the fumes, is slowed down by covering the surface of the membrane tubes that form the inner wall (lapped by fumes) of the combustion chamber with a layer or facing of precious corrosion-resistant material.

[0008] In general, this facing material is formed by Inconel 625, a very expensive material, which is applied with a minimum thickness of 2 mm to all parts of the membrane wall by means of complex welding processes.

[0009] The product applied, as stated generally formed by Inconel 625, is based on nickel and has very high costs. To provide an indication of the costs, a common carbon steel rarely exceeds the price of 1 Euro/kg, while the Inconel 625 facing material has a cost in the order of 30 Euro/kg. Moreover, when considering that to ensure a thickness of at least 2 mm in all parts of the inner surface of the membrane wall, especially in the joining points between the tube and the membrane for connection to the adjacent tube in which the deposition process for welding the cladding material is most difficult, it is often necessary for the thickness of the material to be thicker, it is understandable that the cost of the cladding for protecting the membrane wall from corrosive agents is extremely high, in excess of the production cost of the combustion chamber itself.

[0010] Due to this, it is understood that any solution that enables a reduction in the production and operating costs of the membrane walls of the boilers of the type concerned by the present invention has a very significant impact on the industrial value of the combustion chamber and of the plant as a whole, and would therefore be greatly appreciated in the field.

[0011] Therefore, in conventional boilers the membrane walls have high costs and are difficult to produce even in fields in which the fumes are not corrosive.

[0012] Instead, in boilers for waste incineration furnaces, taken as an example of plants in which the fumes are extremely corrosive, the problem of production and maintenance costs of boilers produced with membrane tube walls is amplified by the need to protect the inner surface of the walls of the combustion chamber, in contact with the fumes, from corrosion. To date, this need has been met through the deposition of precious corrosion-resistant materials, such as Inconel 625, with further increase in the costs and complication of the production process of the boiler.

[0013] As is known, conventional membrane walls are formed by carbon steel tubes aligned parallel to each other, between which there is interposed a plate (called membrane), also made of steel of appropriate thickness and width, continuously welded along one edge of the tubes.

[0014] The membrane wall of the boiler is therefore formed by an alternation of tube/plate/tube repeated N times.

[0015] To tackle phenomena of corrosion, to which tubes and plates are subject when the combustion fumes are particularly aggressive, as they contain chlorine and derivatives, a solution has been found consisting of welding a facing, made of precious material resistant to corrosion by chlorine, sulphur and the like, to the surface of the tubes lapped by the combustion gases.

[0016] This solution has involved radically changing the production cycles of conventional membrane walls. To better clarify this aspect, the main steps of the two processes are considered.

Conventional membrane wall:

[0017]

- welding tubes/plates with automatic system using tubes of at least 12 m in length. The tubes are welded in pairs, then in groups of four and subsequently in

groups of eight.

- assembling the groups of eight thus obtained by welding of the various panels formed by 8 tubes, both in width and in length, to obtain transportable walls or modules;
- transporting to the site, assembly by means of welding the walls or modules to form the combustion chamber.

Membrane wall with Inconel facing:

[0018]

- welding tubes/plates with automatic system using tubes not exceeding 6 m in length, as the usual technologies do not allow the application of Inconel by automatic welding on panels exceeding 6 m in length;
- applying the Inconel facing to the face of the panel exposed to corrosive fumes. This takes place with automatic welding systems that follow the profile of the panel (half tube-plate-half tube). The fact that facing material is not applied to a flat surface complicates the operation considerably. Moreover, to maintain a standard minimum thickness of 2 mm in all points it is necessary to overlap the weld seams, taking the average thickness to values of around 3/4 mm, resulting in considerable waste of valuable material.

- to apply the Inconel facing it is necessary to apply a cooling system to the walls by means of water made to circulate in the tubes, either naturally or with the aid of pumps;
- straightening the panels after facing, necessary as welding on only one side bends them;
- heat treatment of the panels to reduce the stresses produced by the Inconel facing on the membrane tubes;
- assembling the panels, with double the tube/tube welds due to their shorter length;
- transporting to the site, assembly by means of welding the walls or modules until the combustion chamber has been formed;
- touching up to be performed both in the construction and in the assembly step. In fact, each time two clad panels are to be joined, it is first necessary to perform the weld on the carbon steel and then weld the facing, this time with a manual process, which is therefore much slower.

[0019] Therefore, in addition to the aforesaid costs of the precious cladding material, it is immediately clear how the deposition process of the cladding material is also characterized by complex, and therefore costly, steps, which require special measures to prevent compromising the integrity of the membrane wall.

[0020] The limits of the clad membrane walls in terms of reliability also derive from the complexity of their construction process, as imprecise execution of any one of the production steps described can considerably compromise the tightness of this wall and, consequently, the reliability of the whole plant.

[0021] Document DE1526933 describes an example of a flat cooled wall as known in the art.

SUMMARY OF THE INVENTION

[0022] The main aim of the present invention is thus to provide a new type of wall for combustion chambers of boilers in general, and in particular for combustion chambers used in environments in which the combustion fumes are particularly aggressive, as they contain chlorine, sulphur and similar corrosive chemical agents.

[0023] In particular, within this aim, the object of the present invention is to provide a new type of wall for combustion chambers of boilers that have considerably lower production and maintenance costs with respect to the production and maintenance costs of current clad membrane walls.

[0024] Moreover, the object of the present invention is to provide a new type of wall for combustion chambers of boilers that allows a reduced and simpler facing of anti-corrosion cladding material.

[0025] Further, the object of the present invention is to provide a new type of wall for combustion chambers of boilers that form an autonomous element from the point of view of fluid circulation and which can be assembled together simply by joining two manifolds. The proposed system forms a modular system in which portions of flat cooled walls are welded to each other at connecting manifolds between the "riser" and the "downcomer" manifolds.

[0026] These and other objects, which will be more apparent from the detailed description of a preferred embodiment of the present invention, are achieved by a wall for combustion chambers of boilers in general, and in particular for combustion chambers used in environments in which the combustion fumes are particularly aggressive as they contain chlorine, sulphur and similar chemical agents, having the characteristics set forth in the appended claims, which form an integral part of the present description.

LIST OF FIGURES

[0027] The technical characteristics of the present invention, as well as its advantages, will be more apparent from the description below with reference to the accompanying figures, wherein:

Fig. 1 schematically shows a wall produced with membrane tubes currently known in the state of the art;

Fig. 2 schematically shows a flat wall according to the present invention;

Fig. 3 shows a top sectional view with a horizontal plane of the membrane wall currently known in the state of the art shown in Fig. 1;
Fig. 4 shows a top sectional view with a horizontal plane of the flat wall forming the subject of the present invention shown in Fig. 2;
Figs. 5 and 6 show the different application of a protective cladding respectively to a membrane wall of the type known in the state of the art and to a flat wall forming the subject of the present invention;
Fig. 7 shows the weld spots of a membrane wall of the type known in the state of the art;
Fig. 8 shows the joining means of the flat sheets that form the membrane wall forming the subject of the present invention;
Figs. 9 and 10 show the execution of an opening, for example to produce an inspection door, respectively in a membrane wall of the type known in the state of the art and in a flat wall of the type forming the subject of the present invention;
Figs. 11 and 12 show the use of anchors for applying a refractory material respectively to a membrane wall and to a flat wall;
Figs. 13 and 14 show the execution of a repair respectively in the case of a membrane wall of known type and of a flat wall according to the present invention;
Figs. 15 and 16 show connection of the wall to the feeding manifolds respectively in the case of a membrane wall of known type and of a flat wall according to the present invention;
Fig. 17 shows the joining of two modules of flat wall according to the present invention, each module comprising vertical manifolds that convey the fluid to/from the horizontal feeding/recovery manifolds;
Fig. 17A schematically shows the welding of two adjacent vertical manifolds to join two contiguous vertical flat wall modules;
Fig. 18 shows a cross-sectional view along the plane with section A-A indicated in
Fig. 19 of a boiler of conventional type comprising a flat wall according to the present invention;
Fig. 19 is a plan view of a boiler of conventional type comprising a flat wall according to the present invention;
Fig. 20 is a front view of the boiler of conventional type of Fig. 19;
Fig. 21 is a sectional side view with a vertical plane of a waste boiler, typically affected by the need to apply a cladding.

DETAILED DESCRIPTION

[0028] Both the present description and the aforementioned figures are to be regarded purely for illustrative purposes and therefore are not limiting; consequently, the present invention can be implemented according to other and different embodiments, all falling within the scope of protection defined by the appended claims.

[0029] With particular reference to Fig. 1, as mentioned, in the state of the art the walls of the boiler of the type considered herein are formed by tubes parallel to each other and joined with a welded plate. The wall is therefore a membrane wall, in which the tube/plate/tube sequence is repeated N times, as visible in the section A-A of Fig. 1.

[0030] The vertical tubes of the membrane wall are connected to a lower feeding manifold, called *"downcomer"*, and to an upper manifold, called *"riser"*.

[0031] According to what can be seen in Fig. 1, each tube thus forms a separate circuit in which the water flows in through the lower manifold, passes through the tube towards the upper manifold, and flows out from this upper manifold, completely transformed into steam or in a mixture of water and steam.

[0032] One of the main reasons for breakages of the tubes of boilers, especially in the combustion chamber, is the possibility that one or more of these tubes is required to produce more steam that the circuit can withstand. In other words, the flow rate of water entering each single tube from the feeding manifold is also proportional to the diameter of the manifold hole. This means that if the boiler were to heat the water in the tubes to the point that all the water is transformed into steam, the circuit would be unable to carry other water to the high temperature area.

[0033] This causes an increase of the quantity of steam in the mixture flowing through the tube and increases the losses of load. The feed deteriorates further and the temperature of the tube increases until it causes a collapse in the material.

[0034] The proposed solution, shown in Fig. 2, in place of a membrane wall formed by a plurality of tubes joined by a plate, provides for a wall **1** produced with a pair of parallel flat sheets **2** inside which the fluid flows.

[0035] In relation to the situation illustrated above in which a high temperature area is created in the boiler, in the case in which the wall is produced with a double sheet in place of a membrane wall there is a continuous flow of water and, consequently, no accumulation of heat would occur as in the case illustrated above relating to the solution according to the state of the art of Fig. 1, but on the contrary the heat would be dissipated by the flow of water in the wall, which would carry more water to the high temperature area.

[0036] In the diagram of Fig. 2, said parallel sheets **2a**, **2b** are connected by a pair of joining members **3** but in real operating conditions these joining members can be formed by feeding or collecting manifolds according the example shown in Figs. 17 and 17A.

[0037] With particular reference to the diagram of Fig. 2, therefore, in the solution according to the present invention there is a "downcomer" feeding manifold, indicated with the reference number **4b**, and a "riser" collecting manifold, indicated with the reference number **5b**.

[0038] Joining of the two flat sheets **2a**, **2b** that form

the wall **1** is obtained through joining means comprising a plurality of pins or pegs **6** welded at the outer **6a** and inner **6b** ends at the sheets in the weld spots respectively external and internal with respect to the combustion chamber, and widely distributed on the surface, as shown in Fig. 8. The pins behave as tie rods opposing the pressure of the fluid that flows inside the wall 1.

[0039] According to what can be seen in the details shown in Figs. 12 and 14, the wall **1** has conical holes on the flat sheet **2a** outside the combustion chamber, having a larger diameter outwards and tapering toward the inside of the wall. In this way, the pins or pegs **6** can have an end with a head with a larger diameter that tapers conically towards a shank. The pin or peg is therefore inserted from the sheet facing outwards causing the cylindrical end of the shank to be inserted in the hole produced in the inner sheet **2b**.

[0040] The other flat sheet **2b**, inside the combustion chamber, instead has a circular hole suitable to accommodate the diameter of the end **6b** of the shank of the peg **6**, if necessary the hole can be slightly conical to accommodate the weld material. The inner end of the connection member indicated with the reference number **8b** in Fig. 12 (which in the example is again in the form of a peg) can also extend beyond the inner sheet **2b** and, according to the embodiment of Fig. 12, act as connection member for the refractory material **9b**, as will be seen in more detail below. In this case the connection member **8b** preferably also has a conical outer end so as to be inserted in the identically shaped holes of the outer sheet **2a**. With particular reference to the appended figures, the flat wall according to the present invention comprises, in addition to the inner sheet **2b** and to the outer sheet **2a**, two manifolds, a feeding manifold called "downcomer" and indicated with the reference number **4b**, and a collecting manifold called "riser" and indicated with the reference number **5b**.

[0041] Each section of flat wall ends with a further manifold substantially perpendicular to the feeding **4b** and collecting **5b** manifolds.

[0042] With particular reference to the aforesaid figures, said vertical manifolds are indicated with the reference numbers **7a**, for the first vertical manifolds through which there flows the fluid in liquid state, generally water, which is conveyed to the feeding manifolds **4b**, and with **7b** for the second vertical manifolds that convey the fluid, generally liquid and steam or only steam, exiting from the collecting manifolds **5**.

[0043] As shown in Figs. 17 and 17A, thanks to the system of manifolds proposed for joining the flat walls that form the cooled wall forming the subject of the present invention, each wall is autonomous from the viewpoint of circulation of the fluid, and the walls are then assembled together to form a combustion chamber, simply by welding together two adjacent vertical manifolds **7a**, **7b**, according to what is shown in Fig. 17.

[0044] In substance, the flat wall according to the present invention forms a modular system as the vertical manifolds can be easily connected to each other to form a flat wall of the required dimensions.

[0045] As the fluid flows through the inside of the vertical manifolds, the joint of adjacent vertical manifolds to join two flat wall modules does not have to ensure a fluid-tight seal, and therefore is a very simple and inexpensive weld to produce, see Fig. 17A.

[0046] Therefore, according to the above, the manifolds **4b**, **5b**, **7a** and **7b** have both the function of "risers" and "downcomers", and of forming a framework of the flat wall which at this point is easily joined to other walls simply by connected two adjacent manifolds to each other with a simple sealing weld.

[0047] With particular reference to Figs. 3 and 4, Fig. 3 shows a sectional view of a membrane wall of the type known in the state of the art, while Fig. 4 shows the same sectional view with reference to the flat sheet wall according to the present invention.

[0048] Currently, with membrane walls according to the state of the art, in a membrane wall the temperature of the tubes is different from the temperature of the plate interposed between the tubes. In particular, in fact, the cooling fluid removes heat from the plate through the tube in the areas of the plate adjacent to this same tube, while in the areas farther from the tubes, for example in a point **P** equidistant from the two tubes, the temperature $\mathbf{T_2}$ of the plate is higher with respect to the temperature $\mathbf{T_1}$ of the tube.

[0049] It is known that this difference in temperature can lead to deformation of the wall, and consequently to faults in the operation of the boiler.

[0050] With the solution forming the subject of the present invention shown, for example, in Fig. 4, the temperatures of the two points $\mathbf{P_1}$ and $\mathbf{P_2}$ are the same regardless of their position, as they are equidistant from the cooling source, i.e. from the fluid that contacts the whole of the wall. This completely eliminates any differential stress, thereby creating an ideal situation of points having the same temperature in all points of the wall.

[0051] With reference to Figs. 5 and 6, the different application condition of the nickel-based anti-corrosion material can be noted, making the structure of the flat sheet wall according to the present invention much simpler and consequently much more economically advantageous, both in terms of the operations required and in terms of quantity of cladding material to be applied.

[0052] In the first place, the extension of the surface to be clad is around 40% less in the case of the flat wall according to the present invention with respect to the membrane wall of the type known in the state of the art. The difference between the surfaces to be clad is evident in Figs. 5 and 6.

[0053] Besides this, applying the material to a flat surface rather than to a curved one is much easier and reduces overlaps of material, which are instead essential in the configuration of the membrane wall of the type known in the state of the art to maintain a minimum thickness of cladding material over the whole of the surface.

[0054] It must also be remembered that cooling of the base material (tube/ membrane/tube) is essential while the cladding is being applied. Currently, the production process provides for positioning of the wall so that the tubes are vertical and the heat produced during welding of the cladding can be removed by filling these tubes with cooling water that circulates with convective motion in each circuit, as shown in Fig. 1 considered above.

[0055] With the flat sheet wall forming the subject of the present invention, it is instead possible to position the part to be clad in the best position to execute the cladding and not in a position dictated by the need to cool it correctly.

[0056] With the flat wall forming the subject of the present invention it is also possible to maintain an even thickness of the cladding layer, thereby obtaining improved temperature distribution, eliminating stresses caused by differential dilations and saving a considerable quantity of anti-corrosion material.

[0057] Further advantages obtainable with the cooled flat wall according to the present invention can be identified, with reference to Figs. 7 and 8, in greater resistance to mechanical stresses with respect to membrane walls of the type known in the state of the art.

[0058] More in particular, joining of the two flat sheets **2** that form the wall 1 through joining means formed by pins or pegs **6** welded at the two walls in the inner **6a** and outer **6b** weld spots with respect to the combustion chamber and widely distributed on the surface make the structure similar, from the viewpoint of distribution of stresses, to a framework in which the pins are subjected to tensional stress, and therefore act as tie rods.

[0059] In the currently known solutions formed by membrane wall, the mechanical stresses caused by the pressure of the fluid inside the tubes are offset by the rigidity of this same tube, according to what is known in the state of the art. However, on the contrary, points in which stresses are concentrated are found in the weld spots between the flat sheets and the tubes, both due to the stresses caused by the temperature variation mentioned previously, and due to the buckling load resistance.

[0060] With particular reference to Figs. 9 and 10, the flat wall **1** forming the subject of the present invention has numerous advantages also in terms of construction with respect to the currently known solution formed by the use of membrane walls.

[0061] It is always necessary to produce openings in a wall of the boiler to allow direct access to the combustion chamber of the boiler (manhole), visual inspection (inspection windows, insertion of instruments (openings for thermometers or other measurement instruments) and/or insertion of auxiliary components (such as burners). This need to produce openings in the wall of the combustion chamber has always caused considerable complications, as, in the current state of the art in which the wall is made of membrane tubes, it is necessary to divert the tubes of the wall as shown in Fig. 9 to be able to create any opening.

[0062] The flat wall **1** forming the subject of the present invention greatly simplifies the production of openings in the new wall as the continuous structure no longer makes it necessary to divert the tubes of the wall. Advantages are obtained both from the simpler construction and from the reduction in sheets and refractory necessary to restore the gas seal.

[0063] With the flat wall forming the subject of the present invention it is in fact possible to produce openings of any shape and dimension in the wall using conveyors to equalize the internal flow, as shown schematically in Fig. 10.

[0064] Moreover, with reference to Figs. 11 and 12, considerable advantages can be obtained with respect to the state of the art by the flat wall forming the subject of the present invention with reference to the application of refractory linings.

[0065] In fact, the inner walls of combustion chambers are normally lined with refractory material. Figs. 11 and 12 schematically show the application differences in the two solutions.

[0066] In fact, in the case of flat wall according to the present invention:

- the quantity of refractory material **9b**, with equal useful thickness, decreases by around 50% with respect to the refractory material indicated with 9a in the diagram relating to the membrane wall;
- the preformed bricks of refractory material are much more simple to make and install as they are flat and not shaped to follow the contour of the tubes;
- the anchors to the wall **8b** are, in the new design, cooled by the fluid that flows inside the wall, contrary to the case of the anchors, indicated with the reference number **8a**, in membrane walls of the type known in the state of the art, eliminating the risk of overtemperatures and/or corrosion and improving the reliability of the cladding.

[0067] Further advantages of the flat wall forming the subject of the present invention can be appreciated with reference to Figs. 13 and 14, which show, once again schematically, the difference in complexity of the maintenance operations in the case of fluid leakage from the wall.

[0068] Even if, after operating for a long time, combustion chambers are subject to wear and consequently to leaks, with the flat wall forming the subject of the present invention, repairing the seal of the circuits is greatly simplified. In particular, if the damage is extended, as is often the case, to several tubes, the repair is particularly complex in the case of membrane wall as it is necessary to:

- detach the plates from the tubes;
- cut the tubes;
- carry out preparation for the new welds on the existing tubes;

- weld the new lengths to the remaining tubes in very awkward positions;
- weld the new plates to the new tubes;
- perform non-destructive tests on the welds to check their integrity;
- it is not possible to carry out NDT (non-destructive testing) except on tube-to-tube welds;
- it is necessary to re-weld the plate to the tubes where it was welded during construction, producing a weld of lower quality.

[0069] With the flat wall forming the subject of the present invention, the operation to replace a damaged part instead involves the following steps:

- removal of the damaged portion of sheet (inner and outer) and pegs;
- linear preparation of the edges;
- positioning of two sheets already prepared for the weld;
- welding of the new sheets with the old sheets and of the new pegs;
- performance of simple NDT (non destructive testing) on the flat surface of all the welds made.

[0070] Therefore, as can be appreciated, also in terms of simplicity and consequently of lower maintenance costs, the solution forming the subject of the present invention offers considerable advantages with respect to the current state of the art. Moreover, Figs. 15 and 16 schematically show the structure of the feeding manifold (also called "downcomer") and collecting manifold ("riser"); in the case of membrane wall of the type known in the state of the art the manifold is indicated with the reference number **4a**, Fig. 15, and in the case of the flat wall according to the present invention the feeding manifold is indicated with the reference number **4b**, Fig. 16.

[0071] In particular, the feeding manifold **4b** is welded to the flat wall **2** by means of flat welds indicated with the reference number **41**, and both the feeding manifold **4b** and the collecting manifold **5b** are provided at the portion of manifold that borders on the flat wall respectively with a plurality of feeding **40** and/or collecting holes. Both solutions require a system that feeds water to the wall and collects the water/steam mixture that forms during operation. This takes place in the collecting manifolds, or "risers", not indicated in Figs. 15 and 16 but visible, for example, in Figs. 1 and 2 and indicated respectively with **5a** and **5b**.

[0072] In the membrane wall of the type known in the state of the art, each tube of the wall is connected to a manifold by means of a circumferential weld.

[0073] In the flat wall solution forming the subject of the present invention, the two sheets **2** forming the wall **1** are welded longitudinally along the manifold.

[0074] With equal wall surface, with the wall according to the present invention there is a saving of around 30% on the length of the weld.

[0075] Moreover, in the case of the flat wall according to the present invention, the welds are linear, much more simple to perform and test.

[0076] The holes **40** that connect the manifold to the walls are, in the case of the flat wall forming the subject of the present invention, greater in number with respect to those currently used with the membrane walls, but nonetheless do not require any special preparation.

[0077] It has thus been shown how the solution proposed makes it possible to obtain numerous advantages in terms of simple production and reduction of costs that cannot be obtained with solutions currently known in the state of the art.

[0078] The cooled wall according to the present invention, as described and illustrated, may be subject to various modifications and variants, all of which fall within the scope of the invention; furthermore, all the details may be replaced with other technically equivalent elements.

[0079] In practice, the materials used and the contingent dimensions and forms can be any, according to requirements and to the state of the art.

Claims

1. A flat cooled wall (1) for combustion chambers, comprising at least two flat sheets (2a, 2b) parallel to each other and connected to each other at the lower edges by at least one feeding manifold (4b), at the upper edges by at least one collecting manifold (5b), and at the side edges by vertical manifolds (7a, 7b) adapted to convey the fluid entering in said feeding manifold (4b) or exiting from said collecting manifold (5b).

2. A flat cooled wall (1) according to claim 1, **characterized in that** it further comprises a plurality of joining means (6) for joining said flat sheets (2a, 2b).

3. A flat cooled wall (1) according to claim 2, **characterized in that** said joining means comprise a plurality of pegs (6), each having an outer end (6a) and an inner end (6b), said ends (6a, 6b) being welded at corresponding holes (8) obtained in said flat sheets (2a, 2b), outside and inside the combustion chamber respectively, one of said ends (6b) of said pegs (6) having a conical head with a larger diameter outwards and tapering towards the shank of the peg (6).

4. A flat cooled wall (1) according to claim 3, **characterized in that** said flat sheets (2a, 2b) comprise a plurality of holes adapted to accommodate said pegs (6).

5. A flat cooled wall (1) according to claim 4, **characterized in that** said plurality of holes adapted to accommodate said pegs (6) on at least one of said flat

walls (2a, 2b) also have a conical profile, in crosswise section with a plane orthogonal to said flat wall, adapted to accommodate the end with conical head (6b) of said pegs (6).

6. A flat cooled wall (1) according to claim 5, **characterized in that** said holes having a conical profile are made on the flat sheet (2a) which, in use, faces the outside of the combustion chamber.

7. A flat cooled wall (1) according to one or more of the preceding claims, **characterized in that** it further comprises one or more shank- or peg-shaped, through connection members (8b) longer than the distance between said two sheets (2a, 2b).

8. A flat cooled wall (1) according to claim 7, **characterized in that** one or more connection members (8b) all have one end with conical head having a larger diameter towards the end and tapering towards the shank of the peg so as to be welded to the outer sheet (2a) at the corresponding conical holes, and the other through end which crosses the inner sheet (2b) so as to form an anchor for a refractory material possibly placed on the face of said inner sheet (2b) which faces the combustion chamber.

9. A flat cooled wall (1) according to one or more of the preceding claims, **characterized in that** adjacent vertical manifolds (7a, 7b) are connected to said feeding manifold (4b) and collecting manifold (5b) so that every segment of the flat wall, delimited by said manifolds (4b, 5b, 7a, 7b), forms a module easily connectable to another module by welding two adjacent vertical manifolds belonging to different modules.

10. A flat cooled wall (1) according to one or more of the preceding claims, **characterized in that** each of said feeding manifold (4b) and collecting manifold (5b) is welded to the flat sheets (2a, 2b) which form the flat cooled wall by means of flat weld joints (41) along the edge of said flat sheets, and **in that** each said feeding manifold (4b) or collecting manifold (5b) comprises a plurality of feeding holes (40) or collecting holes for conveying the fluid either from the manifold to the wall or from the wall to the manifold.

11. A combustion chamber comprising a flat cooled wall according to one or more of the preceding claims.

Patentansprüche

1. Flache, gekühlte Wand (1) für Brennkammern, aufweisend mindestens zwei flache zueinander parallele Platten (2a, 2b), die an den Unterkanten durch mindestens ein Speisungsrohr (4b), an den Oberkanten durch mindestens ein Sammelrohr (5b) und an den Seiten durch vertikale Rohre (7a, 7b) miteinander verbunden sind, die geeignet sind, das in das Speisungsrohr (4b) eintretende Fluid oder das von dem Sammelrohr (5b) austretende Fluid zu leiten.

2. Flache, gekühlte Wand (1) gemäß Anspruch 1, **dadurch gekennzeichnet, dass** sie zudem eine Vielzahl von Verbindungsmitteln (6) zur Verbindung der flachen Platten (2a, 2b) aufweist.

3. Flache, gekühlte Wand (1) gemäß Anspruch 2, **dadurch gekennzeichnet, dass** die Verbindungsmittel eine Vielzahl von Stutzen (6) aufweisen, die jeweils ein äußeres Ende (6a) und ein inneres Ende (6b) haben, wobei diese Enden (6a, 6b) an zugehörigen an den flachen Platten (2a, 2b) bereitgestellten Löchern (8) jeweils außerhalb und innerhalb der Brennkammer angeschweißt sind, wobei ein Ende (6b) der Stutzen (6) einen konischen Kopf hat, dessen Außendurchmesser grösser ist und sich zum Schaft des Stutzens (6) hin verjüngt.

4. Flache, gekühlte Wand (1) gemäß Anspruch 3, **dadurch gekennzeichnet, dass** die flachen Platten (2a, 2b) eine Vielzahl von Löchern aufweisen, die geeignet sind, die Stutzen (6) aufzunehmen.

5. Flache, gekühlte Wand (1) gemäß Anspruch 4, **dadurch gekennzeichnet, dass** die Vielzahl von Löchern geeignet sind, die Stutzen (6) an mindestens einer der Wände (2a, 2b) aufzunehmen, auch ein im Querschnitt konisches Profil in einer Ebene senkrecht zu der flachen Wand aufweisen, das geeignet ist, das Ende mit dem konischen Kopf (6b) der Stutzen (6) aufzunehmen.

6. Flache, gekühlte Wand (1) gemäß Anspruch 5, **dadurch gekennzeichnet, dass** die Löcher mit dem konischen Profil in der flachen Platte (2a) ausgeführt sind, die im Gebrauch zur Außenseite der Brennkammer zeigt.

7. Flache, gekühlte Wand (1) gemäß einem oder mehreren der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** sie zudem eine oder mehrere schaft- oder stutzenförmige Durchführteile (8b) aufweist, die länger sind, als der Abstand zwischen den beiden Platten (2a, 2b).

8. Flache, gekühlte Wand (1) gemäß Anspruch 7, **dadurch gekennzeichnet, dass** bei einem oder mehreren Verbindungsteilen (8b) alle ein Ende mit konischem Kopf aufweisen, dessen Durchmesser zum Ende hin grösser ist und sich zum Schaft des Stutzens hin verjüngt, so dass es mit der äußeren Platte (2a) an den zugehörigen konischen Löchern verschweißt werden kann, und das andere Durchfüh-

rende, das die innere Platte (2b) durchquert, einen Fixpunkt für ein hitzebeständiges Material bildet, das auf der Seite der inneren Platte (2b) platziert werden kann, die zur Brennkammer zeigt.

9. Flache, gekühlte Wand (1) gemäß einem oder mehreren der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** benachbarte vertikale Rohre (7a, 7b) mit dem Speisungsrohr (4b) und dem Sammelrohr (5b) verbunden sind, so dass jedes Segment der flachen Wand, abgesteckt durch die Rohre (4b, 5b, 7a, 7b), ein Modul bildet, das leicht mit einem anderen Modul verbunden werden kann, indem zwei benachbarte vertikale Rohre, die zu verschiedenen Modulen gehören, miteinander verschweißt werden.

10. Flache, gekühlte Wand (1) gemäß einem oder mehreren der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** jedes der Speisungsrohre (4b) und Sammelrohre (5b) mit den flachen Platten (2a, 2b), die die flache gekühlte Wand bilden, durch flache Schweißverbindungen (41) entlang der Kanten der flachen Platten verschweißt sind, und wobei jedes Speisungsrohr (4b) oder Sammelrohr (5b) eine Vielzahl von Speisungslöchern (40) oder Sammellöchern bereitstellt, um das Fluid entweder vom Rohr zur Wand oder von der Wand zum Rohr zu leiten.

11. Brennkammer, die eine flache, gekühlte Wand gemäß einem oder mehreren der vorstehenden Ansprüche, aufweist.

Revendications

1. Paroi refroidie plate (1) pour des chambres de combustion, comprenant au moins deux tôles plates (2a, 2b) parallèles l'une à l'autre et raccordées l'une à l'autre au niveau de bords inférieurs par au moins une tubulure d'alimentation (4b), au niveau des bords supérieurs par au moins une tubulure de collecte (5b), et au niveau des bords latéraux par des tubulures verticales (7a, 7b) adaptées pour acheminer le fluide entrant dans ladite tubulure d'alimentation (4b) ou sortant de ladite tubulure de collecte (5b).

2. Paroi refroidie plate (1) selon la revendication 1, **caractérisée en ce qu'**elle comprend en outre une pluralité de moyens de jonction (6) permettant de joindre lesdites tôles plates (2a, 2b).

3. Paroi refroidie plate (1) selon la revendication 2, **caractérisée en ce que** lesdits moyens de jonction comprennent une pluralité de chevilles (6), ayant chacune une extrémité externe (6a) et une extrémité interne (6b), lesdites extrémités (6a, 6b) étant soudées au niveau de trous correspondants (8) obtenus dans lesdites tôles plates (2a, 2b), à l'extérieur et à l'intérieur de la chambre de combustion respectivement, l'une desdites extrémités (6b) desdites chevilles (6) ayant une tête conique de diamètre plus grand vers l'extérieur et s'effilant vers la queue de la cheville (6).

4. Paroi refroidie plate (1) selon la revendication 3, **caractérisée en ce que** lesdites tôles plates (2a, 2b) comprennent une pluralité de trous adaptés pour accueillir lesdites chevilles (6).

5. Paroi refroidie plate (1) selon la revendication 4, **caractérisée en ce que** ladite pluralité de trous adaptés pour accueillir lesdites chevilles (6) sur au moins l'une desdites parois plates (2a, 2b) présentent également un profil conique, dans une section dans la direction de la largeur avec un plan orthogonal à ladite paroi plate, adapté pour accueillir l'extrémité à tête conique (6b) desdites chevilles (6).

6. Paroi refroidie plate (1) selon la revendication 5, **caractérisée en ce que** lesdits trous présentant un profil conique sont réalisés sur la tôle plate (2a) qui, en utilisation, fait face à l'extérieur de la chambre de combustion.

7. Paroi refroidie plate (1) selon une ou plusieurs des revendications précédentes, **caractérisée en ce qu'**elle comprend en outre un ou plusieurs organes de raccordement traversants en forme de queue ou de cheville (8b) plus longs que la distance entre lesdites deux tôles (2a, 2b).

8. Paroi refroidie plate (1) selon la revendication 7, **caractérisée en ce qu'**un ou plusieurs organes de raccordement (8b) ont tous une extrémité à tête conique ayant un diamètre plus important vers l'extérieur et s'effilant vers la queue de la cheville de sorte à être soudés sur la tôle externe (2a) au niveau de trous coniques correspondants, et l'autre extrémité traversante qui traverse la tôle interne (2b) de façon à former une ancre pour un matériau réfractaire placé éventuellement sur la face de ladite tôle interne (2b) qui fait face à la chambre de combustion.

9. Paroi refroidie plate (1) selon une ou plusieurs des revendications précédentes, **caractérisée en ce que** des tubulures verticales adjacentes (7a, 7b) sont raccordées à ladite tubulure d'alimentation (4b) et à ladite tubulure de collecte (5b) de sorte que chaque segment de la paroi plate, délimitée par lesdites tubulures (4b, 5b, 7a, 7b), forme un module aisément raccordable à un autre module par soudage de deux tubulures verticales adjacentes appartenant à différents modules.

10. Paroi refroidie plate (1) selon une ou plusieurs des revendications précédentes, **caractérisée en ce**

que chacune de ladite tubulure d'alimentation (4b) et de ladite tubulure de collecte (5b) est soudée aux tôles plates (2a, 2b) qui forment la paroi refroidie plate au moyen de joints de soudure plats (41) le long du bord desdites tôles plates, et **en ce que** chaque dite tubulure d'alimentation (4b) et tubulure de collecte (5b) comprend une pluralité de trous d'alimentation (40) ou de trous de collecte permettant d'acheminer le fluide soit de la tubulure vers la paroi, soit de la paroi vers la tubulure.

11. Chambre de combustion comprenant une paroi refroidie plate selon une ou plusieurs des revendications précédentes.

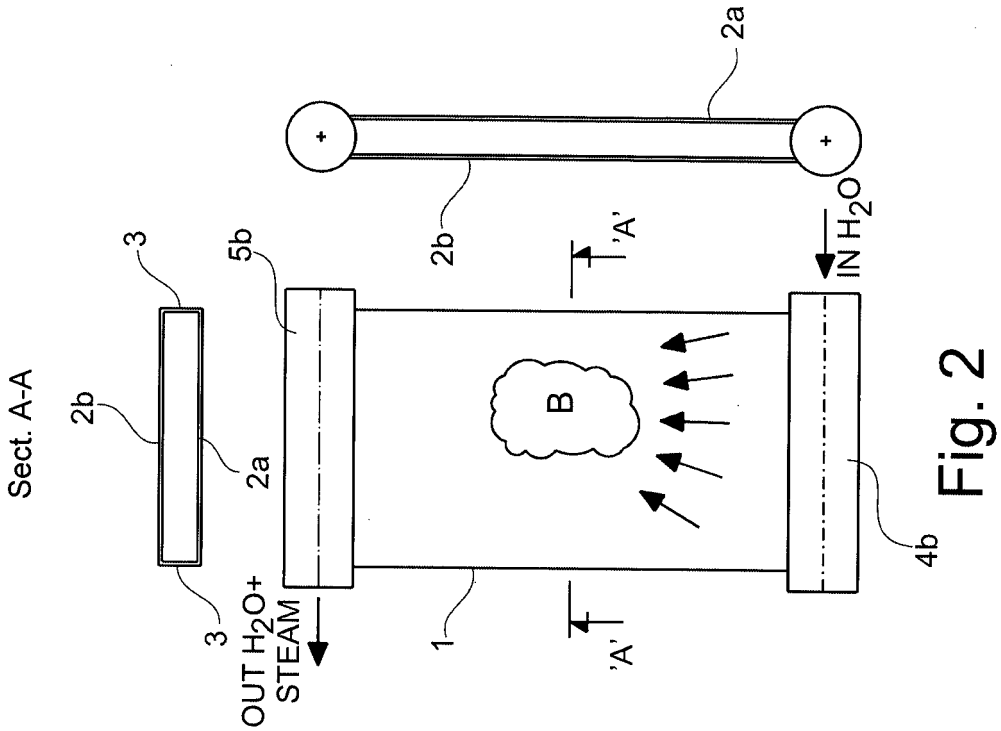


Fig. 2

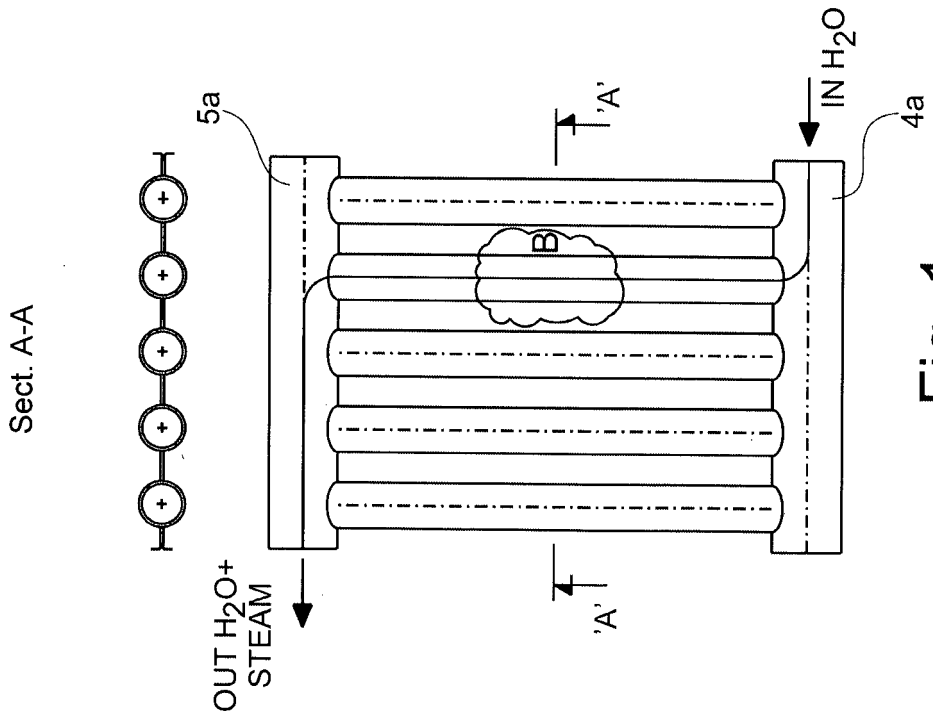


Fig. 1

STATE OF THE ART

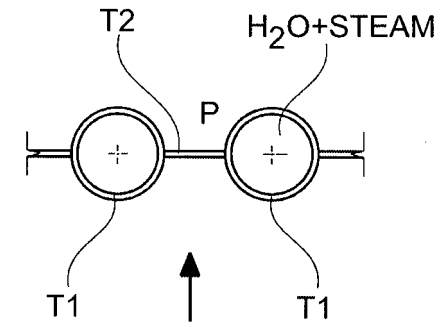


Fig. 3

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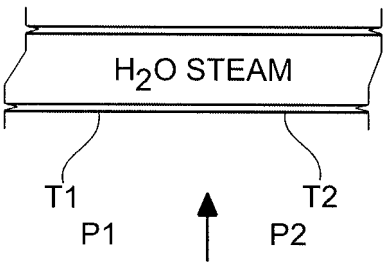


Fig. 4

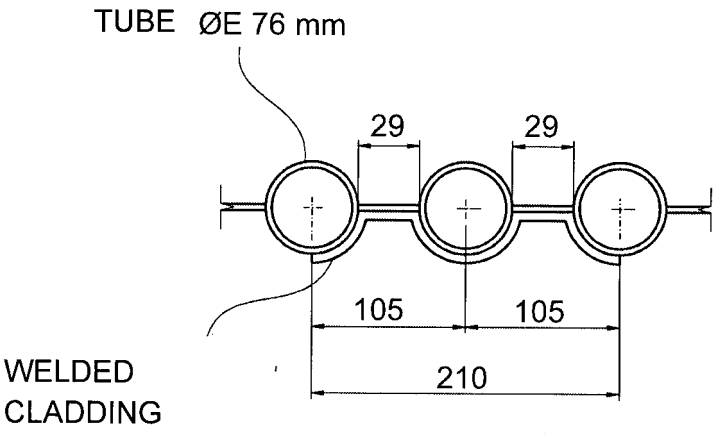


Fig. 5

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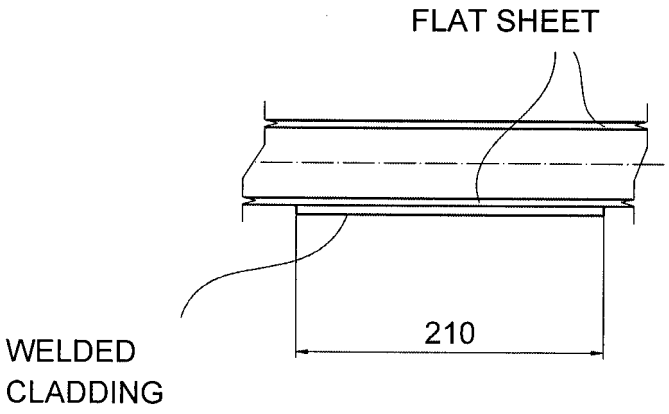


Fig. 6

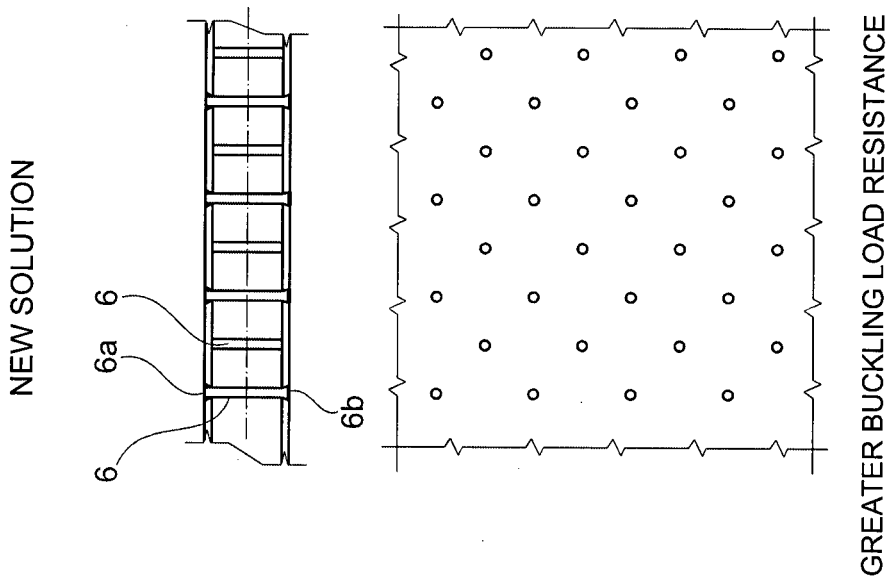


Fig. 8

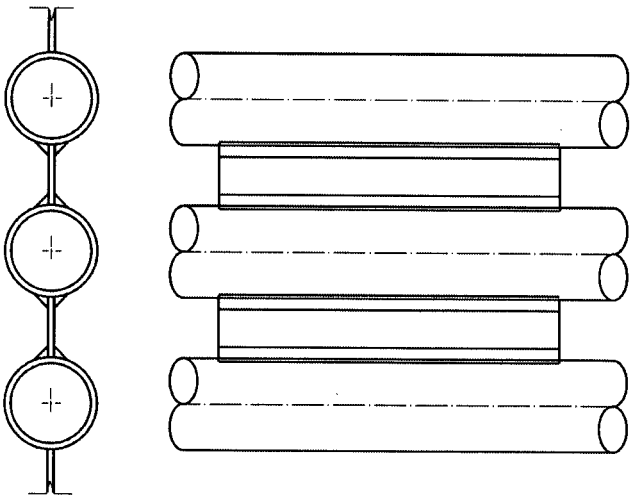


Fig. 7

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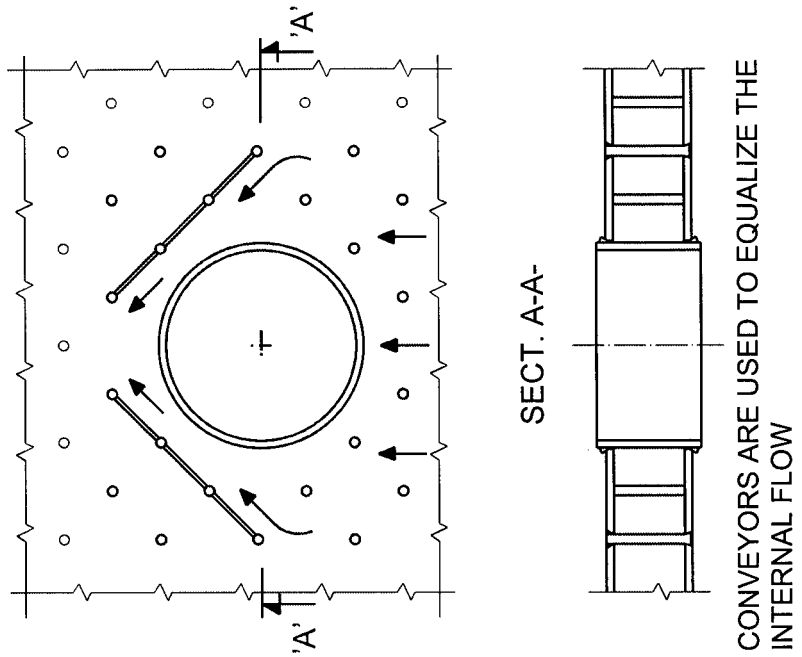


Fig. 10

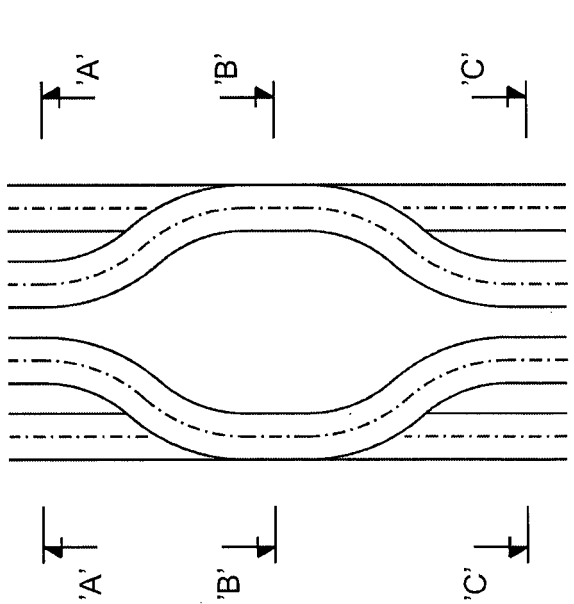


Fig. 9

STATE OF THE ART

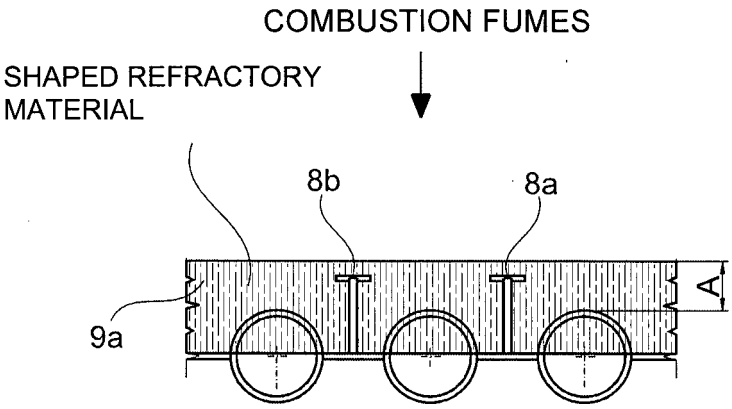


Fig. 11

STATE OF THE ART

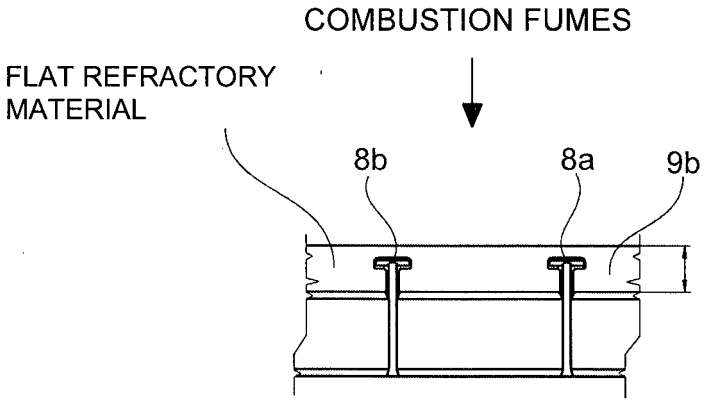


Fig. 12

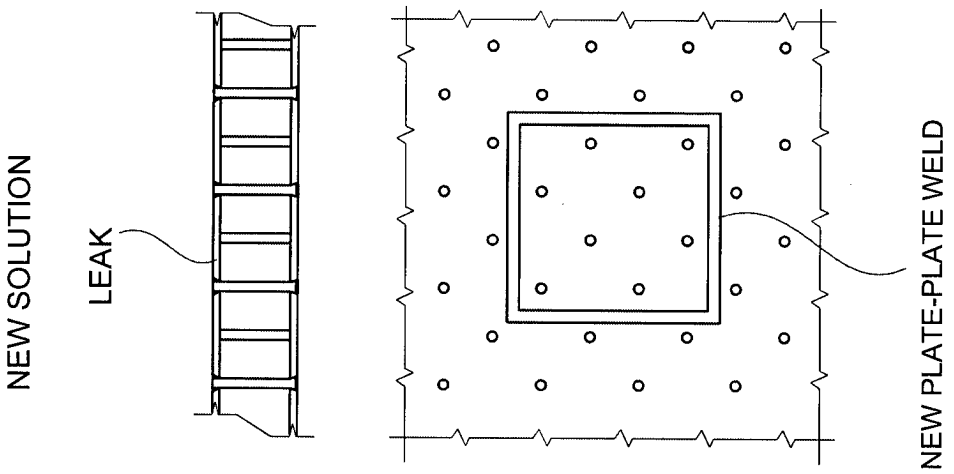


Fig. 14

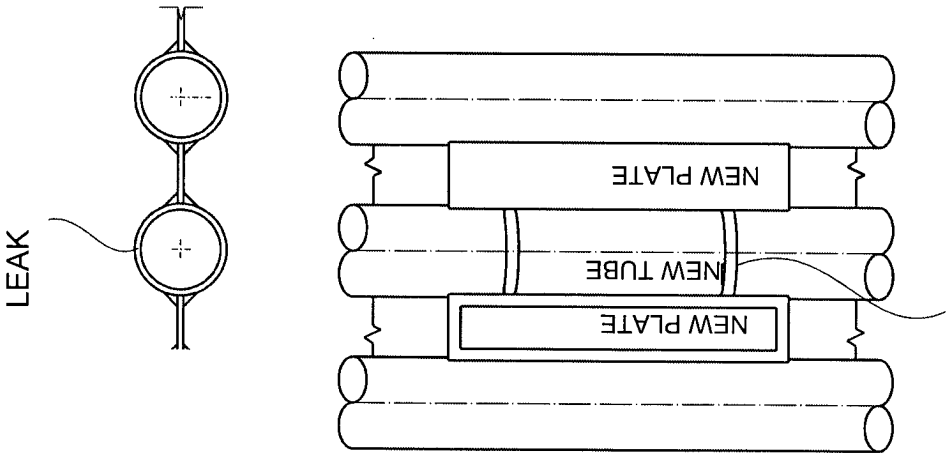


Fig. 13
STATE OF THE ART

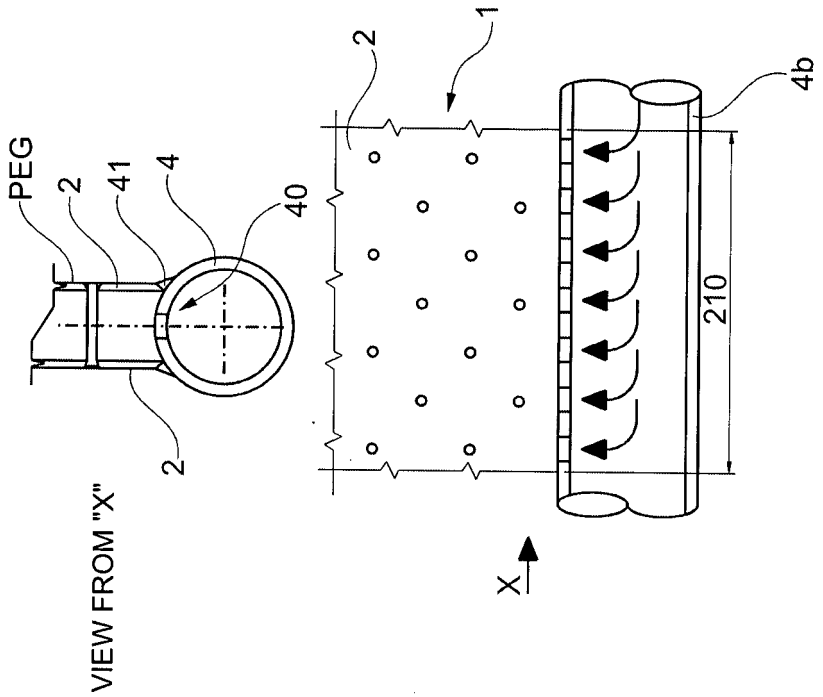


Fig. 16

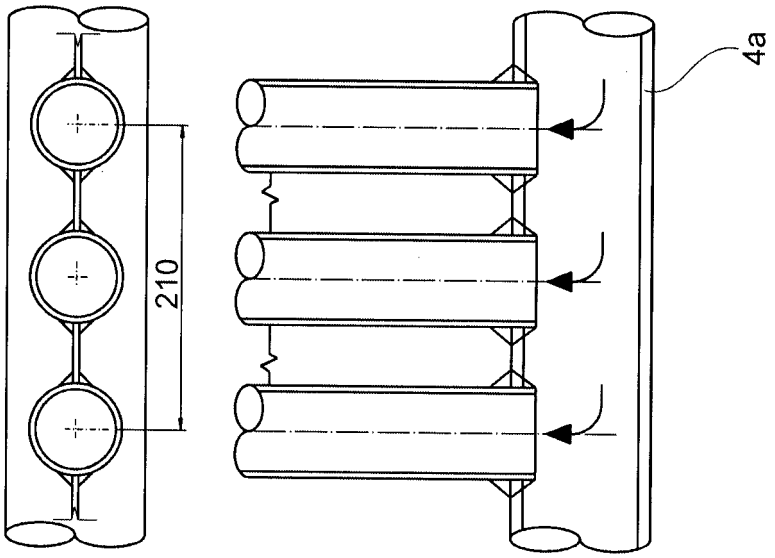


Fig. 15
STATE OF THE ART

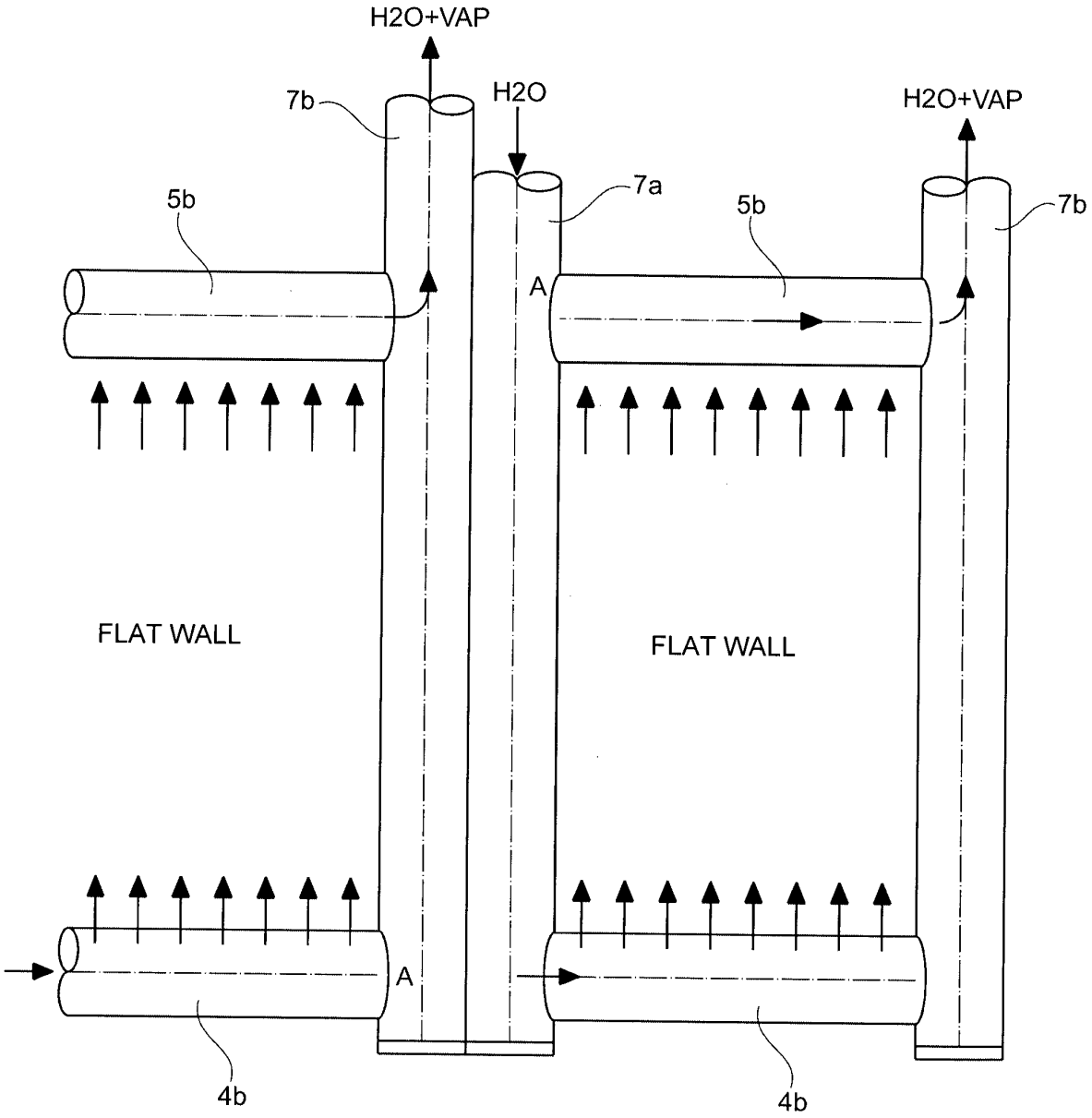


Fig. 17

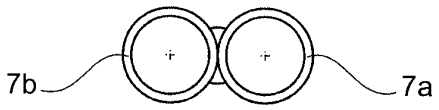
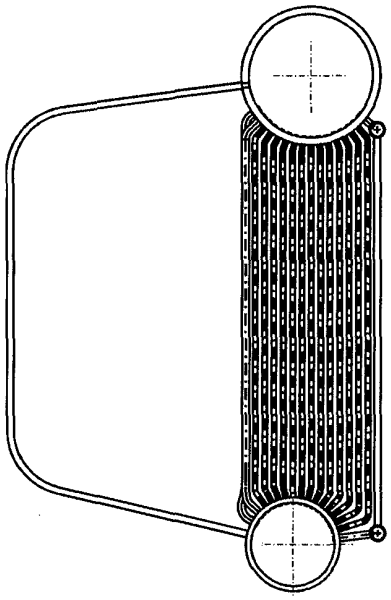
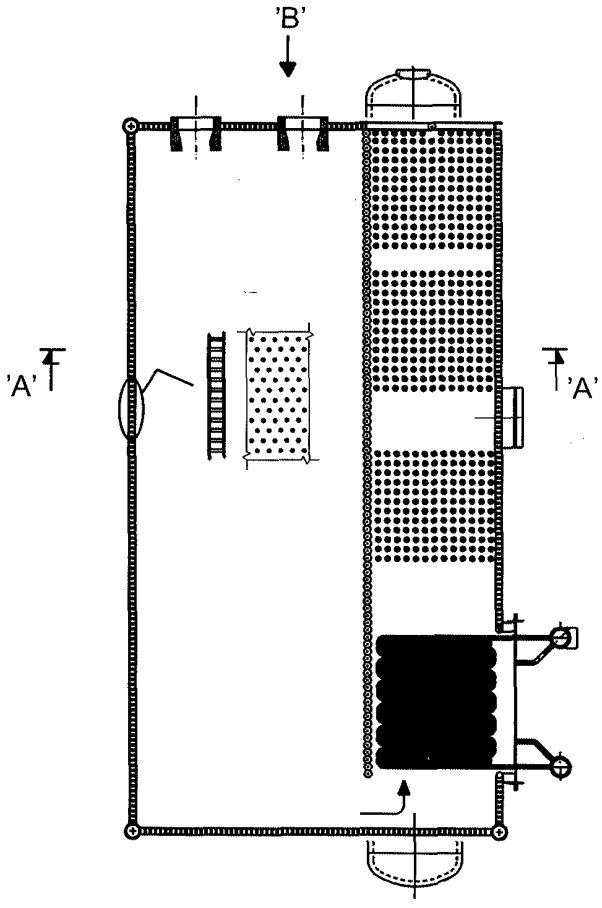


Fig. 17a



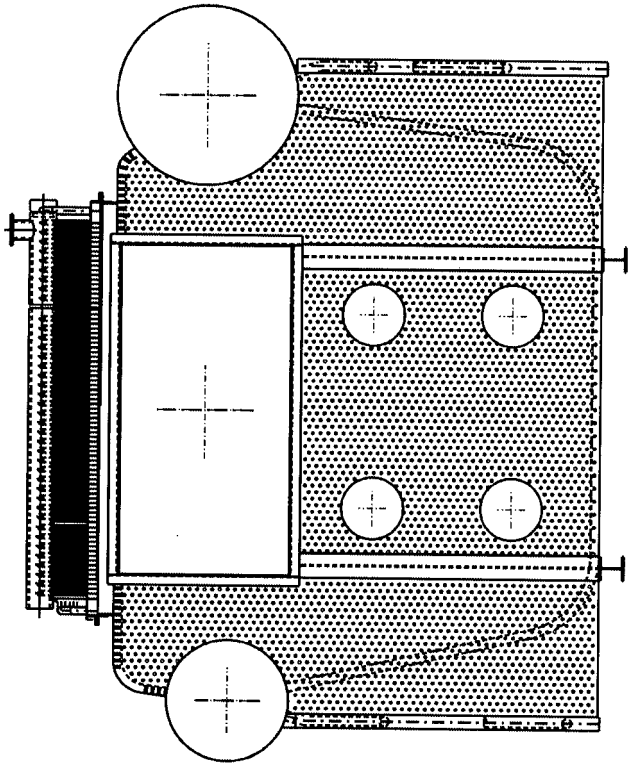
TRANSVERSAL CROSS-SECTION

Fig. 18



PLANT CROSS-SECTION

Fig. 19



FRONT VIEW

Fig. 20

LONGITUDINAL CROSS-SECTION

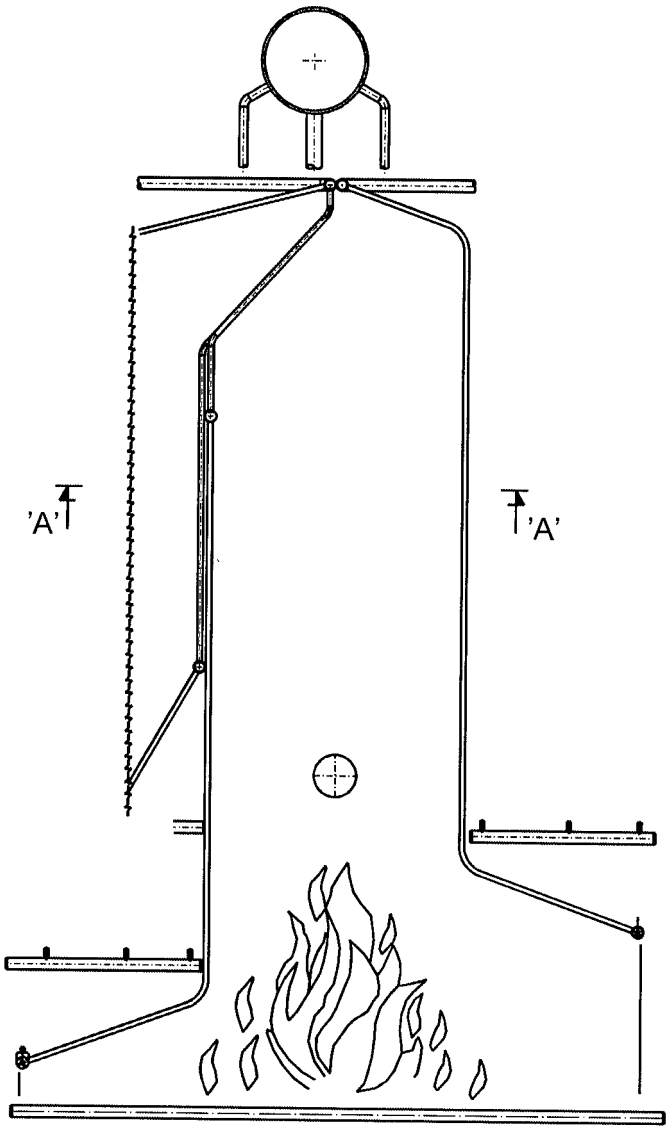


Fig. 21

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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