BOILER FOR THE HEATING OR VAPORIZATION OF A LIQUID MEDIUM

Filed Sept. 23, 1963 3 Sheets-Sheet 1

Fig. 1

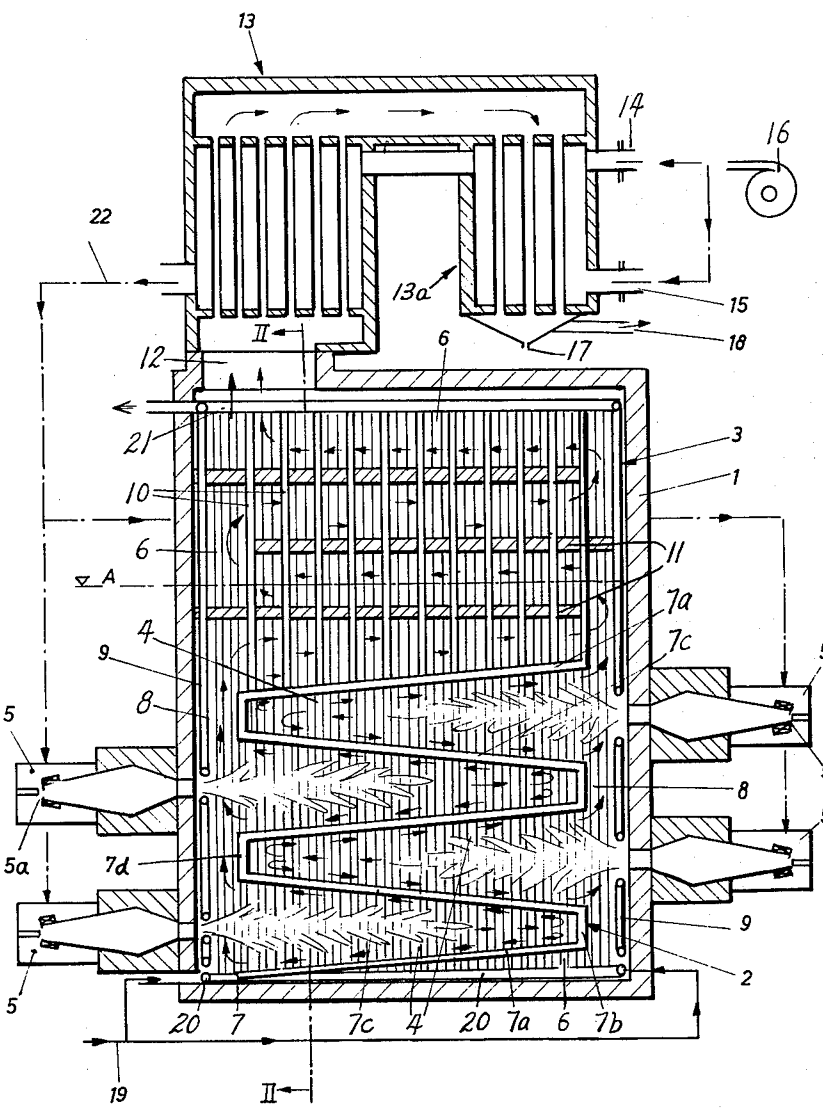

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Fig.2

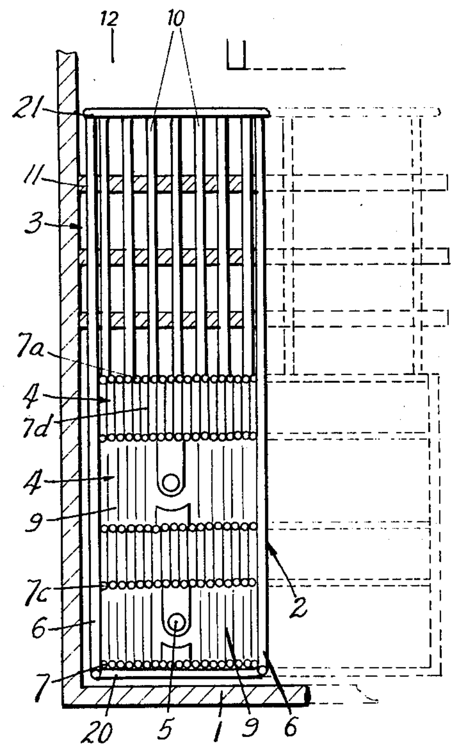

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Fig. 3

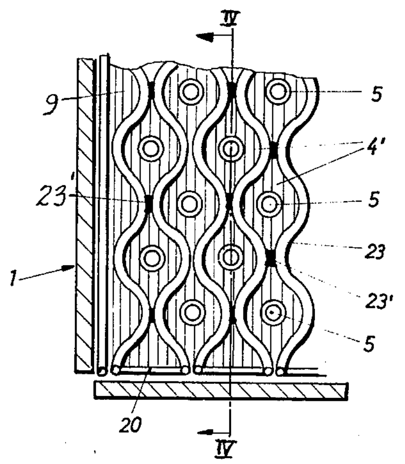


Fig. 4

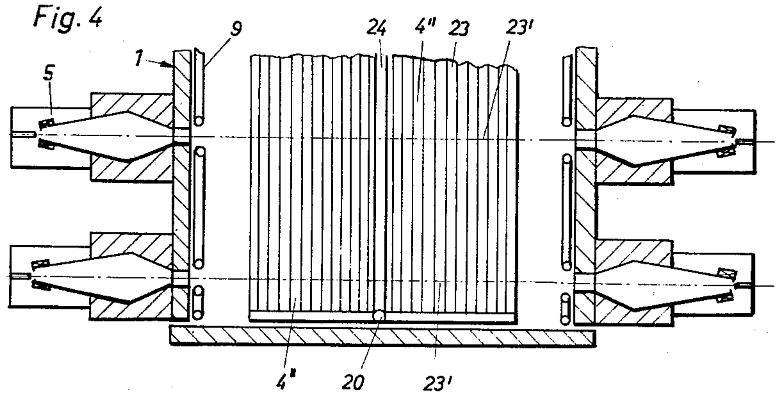
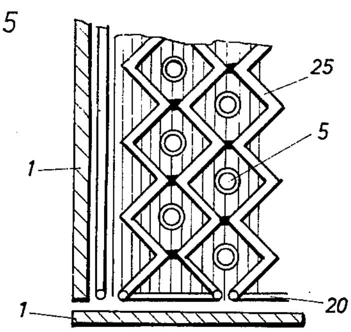


Fig. 5



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3,254,635
BOILER FOR THE HEATING OR VAPORIZATION OF A LIQUID MEDIUM

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5 Claims. (Cl. 122—240)

This invention relates to a boiler for the heating or vaporization of a liquid medium, especially water, and having a gas-flame heated radiation chamber, the walls of which are traversed by the medium.

Boilers of this kind known at the present time have a connected radiation chamber into which the flames are directed from one or more burners. The radiation chamber, into whose walls the heat is transferred mainly by radiation, is as a rule connected to a convection section in which heat transmission is effected by contact between the hot gases and the walls traversed by the medium to be heated. Normally the radiation chamber is made larger as the desired output of the boiler is increased. Since the rate of heat transfer is proportional to the transverse section, i.e. the second power of the dimensions of the chamber, while the space need increases in proportion to the third power of the dimensions of the chamber, the volume of a radiation chamber required for an increased output increases considerably more than the output itself does. The enclosed space of the radiation part of the known boilers with connected radiation space is disproportionately much larger in the case of boilers with a high output, in terms of performance units, than it is in the case of boilers with a low output. Thus, the construction costs of the known boilers increase more with an increase in output than does the output itself.

It is the purpose of the present invention to construct a high-output boiler having very small dimensions. The present invention accomplishes this mainly by subdividing the radiation space into a number of radiation cells heated individually, which are separated from each other by walls traversed by the medium.

The total of the volumes of the radiation cells is considerably smaller than the volume of a connected unified radiation space with equal boiler output. The enclosed space of the boiler according to the present invention can therefore remain very small with a corresponding reduction in the costs of construction. Also the boiler constructed according to the present invention can be regulated easily and particularly effectively because heating of the individual radiation cells can be stopped or started as desired.

In order to make use of the natural convection, the radiation cells are preferably arranged horizontally and provided with upper and lower walls that are inclined with respect to the horizontal and are traversed by the medium to be heated.

The radiation cells preferably end at a distance from the vertical boiler casing with the remaining intermediate space forming combustion gas collecting passages. This means that the combustion gas coming out of the individual cells can be conducted away together, which fact also results in a reduction of the dimensions of the boiler.

Again with regard to the natural convection it is advisable to arrange two or more radiation cells above each other. It is advantageous to incline the upper and the lower wall of each radiation cell with respect to the horizontal at opposite equally large angles and to place the radiation cells lying above each other at 180° angles to each other. When the radiation cells are constructed and arranged in this manner they can be "boxed" or sandwiched into each other so that it is possible to house them in an extremely small space.

It is advisable to construct the radiation cells lying above each other so that they have parallel vertical sidewalls which are connected by means of inclined intermediate walls so that they form a somewhat serpentine or sinuous, vertically stepped arrangement with a burner being mounted in front of the open side of each cell. Thus, the intermediate wall forms the boundary between adjacent radiation cells and acts simultaneously as the upper wall of the lower and the lower wall of the upper radiation cell. This has not only a favorable effect upon space requirements because of the wall savings, but has the additional advantage of bringing radiation to bear upon both sides of the wall with maximum use of the heating surface being the result. In boilers known at the present time the walls are usually constructed of pipes traversed by the medium, which walls are arranged parallel to the boiler casing with the walls either lying tightly side by side so that the heat radiation is effected from only one side, or else being arranged at intervals so that the boiler casing radiates back. The latter method, however, requires expensive casing material and does not use space efficiently.

Because of the above-described construction of the radiation cells it is possible to construct any desired number of side and intermediary walls in the form of standardized parts depending on the boiler output wanted. Boilers already in use can thus be enlarged or reduced in size. Also individual boiler sections can be disengaged for the purpose of making repairs. In addition the side-by-side arrangement of groups of radiation cells lying above each other has the advantage that the sidewalls can be common to cells lying alongside one another, which fact again results in an economic space utilization and a maximum use of the heating surface. The radiation space of the high output boiler of the present invention can be connected to a convection section wherein heat transmission is effected by conduction, into which each combustion gas collecting passage extends. The convection section is best formed by pipes traversed by the medium and arranged vertically or slanting upwards. The convection section is best formed as a superheater where steam is being produced.

In the known boilers the liquid medium is partly carried in the direction of the gas and partly against it. Only Benson boilers, economic only for high outputs, are an exception. The counter-current flow requires an expensive drum for the separation of the liquid phase of the medium from the gaseous phase.

In the boiler according to the present invention the medium and the combustion gases flow mainly in the same direction. This means that the drum is eliminated and thus a reduction in the size of the boiler is effected.

In the place of the drum the boiler according to the present invention utilizes merely a level regulator which would be needed and used anyhow and which can also be used for controlling the temperature in the superheater. An additional reduction of the boiler size with the same output is possible by providing burners of a known construction with a high flame gas velocity (impulse burners), and by working the boiler at a superatmospheric pressure in the firing space, preferably at a pressure of between 50 and 150 mm. water column. The high gas velocity improves the heat transmission so that the heating surface can be smaller.

The combustion gas, which, because of its conduction in the same direction as the medium, is emitted at a relatively high temperature, is preferably supplied to a known air preheater whose preheating temperature is considerably higher than usual and perhaps runs between 350–450° C. This means, to be sure, that a larger air preheater is required. The additional costs are proportional to its space requirements. However, with the strong air preheating, the flame temperature also rises. Its heat radiation is proportional to the fourth power of the temperature. The space requirements of the convection section decrease proportionally to the supertemperature so that the boiler surfaces, which are more thick walled because of the steam pressure, are very considerably reduced. Taken as a whole the high temperature air preheating results in savings in the total surface and, thus, in a reduction of the cost of the boiler.

Additional features and details of the invention will be found in the following description and in the attached drawings of preferred embodiments of the invention.

In the drawings:

FIGURE 1 in the drawing shows a central vertical section through a high output boiler according to the invention.

FIGURE 2 shows a sectional view taken along the line II—II in FIGURE 1.

FIGURE 3 shows a sectional view similar to FIGURE 2 of a modified boiler, this view being taken in a direction vertical to the lengthwise axis of the radiation cells.

FIGURE 4 shows a sectional view taken along the line IV—IV in FIGURE 3.

FIGURE 5 is a view similar to FIGURE 3 showing another modification.

Referring to the drawings, **1** indicates the casing of a high-output boiler which contains a radiation space **2** and a convection section **3**. The boiler illustrated is constructed as a water-steam boiler, but the invention could also be used in boilers for the production of warm water or for the heating or vaporization of any desired liquid medium.

According to the invention radiation space **2** is subdivided into a number of radiation cells **4**. Each of these cells is individually heated, here by placing a burner **5** in association with each cell, which burner sends the flame into its associated radiation cell **4**. Cells **4** are separated from each other by walls traversed by water in a manner to be described in greater detail hereinafter.

Radiation cells **4** are delimited at their lateral ends by vertical walls **6** which are parallel to and spaced from each other. An intermediate wall **7** extends between and is connected to the sidewalls **6**. The intermediate wall **7** begins at the foot of sidewalls **6** adjacent one edge thereof, and it comprises an upwardly inclined section **7*a*** which extends close to the opposite edge of the sidewalls **6**. A short section **7*b*** extends vertically upwardly from the upper end of section **7*a***. Section **7*c*** extends from the upper end of section **7*b*** and it slants upward toward the opposite edge of the sidewalls **6**. Vertical section **7*d*** extends upwardly from the upper end of section **7*c***. From the upper end of vertical section **7*d*** on, the described arrangement of the intermediate wall **7** is repeated until the desired number of radiation cells are formed. In the particular embodiment disclosed four radiation cells are provided. Because of the described shape of the intermediate wall **7** it rises between sidewalls **6** essentially in a substantially serpentine or sinuous form. In front of the open side of each of the cells is a burner **5**.

Because of the described arrangement of the walls of the radiation cells the latter are essentially horizontally disposed and are arranged in a vertical stack. The cells have upper and lower walls traversed by the medium, e.g., water, which walls are inclined horizontally in such a manner than the water can continuously rise at it moves through them. Sections **7*a*** and **7*c*** of intermediate wall **7** form in part common walls for two radiation cells lying above each other, which walls are exposed on both sides to the radiation of the flame gases emitted by burners **5**. The radiation cells **4** each have the form of a pocket of rectangular cross-section whose upper and lower walls converge toward a closed bottom. The cells are arranged in a box form and with each cell being set at an angle of 180° with respect to the cells above and below it. As can easily be seen from FIGURE 1 this makes possible the best space utilization, so that radiation space **2** has a relatively small volume.

The vertical sections **7*b*** and **7*d*** of intermediate wall **7** are spaced from boiler casing **1** so that combustion gas collection channels **8** are formed. These channels can also be delimited toward their outsides by water-conducting walls **9**.

As is indicated in FIGURE 2 by broken lines, the vertical sidewall **6**, found at the right of the figure, can be joined by an additional intermediate wall **7** to another sidewall. Thus, the boiler can be assembled from standardized parts so that it can easily be adapted to any desired output. In the particular embodiment of the invention disclosed, all walls traversed by the water consist of contiguous parallel pipes. However, other wall-constructions of a known character could also be employed.

Flue gas collection channels **8** communicate with the convection section **3**. This section is equipped with vertically arranged pipes **10**, which are contacted by the combustion gases as same are conducted back and forth by means of baffles **11**. The sidewalls **6** extend through convection section **3**. Convection section **3** can partly be constructed as a superheater for the production of steam.

As FIGURE 1 shows and as can be derived from the description of the effect of the boiler below, the water and the gases move through the boiler mainly in the same direction. Thus, it is not necessary to provide a drum for the separation of the steam from the water. An ordinary regulator (not shown) suffices to keep the water level constant at a suitable level such as that indicated by line A. This level regulator also permits control of the temperature in the heater part. Through the lowering of the level it is possible to increase the superheater temperature, and vice versa.

In order to prevent the possibility of drops of water from the boiling area of pipes **10** being carried along into the superheater part it is advisable to arrange filling bodies of a known kind (not shown here) in pipes **10** which prevent such a possibility.

The stack gas leaves the boiler at **12**. To achieve high gas velocities and to avoid disadvantages usually connected with the ordinary flue-draft or blowing process, the boiler is operated at a superatmospheric pressure of, say, 50–150 mm. water column. The burners **5** shown in the boiler in the drawing show a burning space which expands conically beginning at the fuel and air supply end **5*a*** and which is supplied with combustion air in a corkscrew manner. The burning space communicates with an acceleration nozzle which in turn communicates with the radiation space of the boiler, which nozzle gives a high velocity to the flame gases. The burners can use liquid, gaseous or solid fuels.

The stack-gas temperature at stack-gas outlet **12**, which temperature is high because the gas flows in the same direction as the water, makes air preheating necessary. For this purpose the apparatus shown has an air preheater **13** into which the stack gases enter directly from outlet **12**. The preheater **13** has two air inlets **14** and **15** through which, by means of blower **16**, air can be fed into the preheater. It is of advantage to provide regulators by which the air admission can be controlled in such a manner that the stack gas temperature remains constant independent from the output of the boiler. Thus, the boiler will have maximum output, no matter what load,—provided a regulator for the air flow is present.

The "cold" end **13*a*** of the air preheater preferably is made of acid-resistant material. The temperature of the stack-gas is determined by the control of air admission in such a manner that the stack-gas temperature falls below the dew point. This means that a considerable part of the sulphur in the fuel can be withdrawn from the stack-gas condensate and can be neutralized. An opening for the withdrawal of this condensate is shown at **17**. The stack-gas leaves the air preheater under pressure through outlet pipe **18** and reaches a flue which can be capped by an acceleration nozzle which ejects the stack-gases very high into the atmosphere so that they do not constitute a nuisance for the environment.

The boiler shown works as follows: Fresh water is admitted through conduit system **19** and reaches elastically suspended feed pipes **20**, which are connected with pipes comprising the sidewalls **6** and the pipes comprising the intermediate wall **7**. Burners **5** fire into the radiation cells bounded by these walls so that the water is heated by radiation and begins to boil.

The gas conduction in the radiation cells is arranged in such a manner that first of all the hot flame gas enters coaxially into the pocket-like radiation cells, is then reversed at the closed ends formed by wall section *7b, 7d,* and finally flows back along sections *7a, 7c*. Because of this flow-back a heat transference by radiation occurs in addition to the transference by contact. In the pipes the water is further heated because of contact with the hot gases and is perhaps even vaporized. Through additional heating in the upper part of pipes **10** it is possible to produce superheated steam. The steam collects in pipes **21** and is then conducted to a consumer (not shown here).

The air entering at **14** and **15** into air preheater **13** and being preheated there is conducted to burners **5** by way of a conduit schematically indicated at **22**.

FIGURES 3 and 4 show a modified construction of radiation cells **4'**. Radiation cells **4'** are constructed and arranged like honeycombs in which the cells are arranged in vertical adjacent rows, in which the cells in each row are vertically offset from and are sandwiched with the cells of the adjacent rows. Cells **4'** are here delimited by walls **23** which are common to several cells **4'** lying above each other in a given row and said walls are wavy or sinuous corresponding to the crosscut of the honeycomb. The walls are formed of pipes as before and are traversed by the medium and are fitted together with adjacent identical walls **23** being mirror images of each other with their maximum points and minimum points **23'** being opposed to each other in the manner shown in FIGURE 3

The honeycomb-like radiation cells **4'** can be open at both ends, in which case burners **5** fire into each of the pipe-like cells **4'** from the two open ends thereof.

It is also possible, as demonstrated in FIGURE 4, to subdivide each radiation cell in the center by a vertical separation wall **24** traversed by the medium, into two symmetrical halves **4'**. Thus, additional heating surface is obtained.

The crosscut form of the honeycomb-like cells can be formed in other ways. Thus, the honeycomb cells, as shown in FIGURE 5, can also be formed by zig-zag shaped walls **25**.

In addition, intermediate forms between sharp cornered walls **25** according to FIGURE 5 and the wavy wall form **23** according to FIGURE 3 are possible, for instance trapeze-like, interrupted waves etc., which leads to the polygonal crosscuts of the honeycombs.

Although a particular embodiment of the invention has been disclosed above in detail for illustrative purposes, it will be recognized that variations or modifications of such disclosure, which lie within the scope of the appended claims, are fully contemplated.

What is claimed is:

1. A boiler for the heating or vaporization of a liquid medium, particularly water, comprising:

a boiler casing;

wall means inside of said casing dividing same into a plurality of separate cells, said wall means being hollow so that the medium to be heated can flow therethrough, said cells being of generally rectangular cross section and each having an upper and a lower wall inclined at substantially the same angle and in opposite directions relative to the horizontal, and in which the cells are arranged one above the other and are placed at an angle of 180° with respect to each other; and

burners for supplying combustion gases to said cells, any two adjacent cells having common intermediate wall means with one cell being on one side of said common wall means and the other cell being on the other side of said common wall means so that said common wall means are contacted on opposite sides thereof by the combustion gases supplied to the respective adjacent cells.

2. A boiler according to claim **1**, in which the burners are arranged on the outside of the boiler casing and wherein each burner is comprised of a combustion chamber of conically enlarging shape followed by a converging nozzle opening into the interior of the boiler casing.

3. A boiler according to claim **1**, in which the cells include vertical side walls parallel to and spaced from each other and said upper and lower walls of each cell are formed by an intermediate transverse wall extending between and connected to said side walls, said intermediate wall being of serpentine shape to define a plurality of cells each of which is open at one end, and including a burner mounted in front of the open end of each cell.

4. A boiler according to claim **3**, in which a plurality of substantially identical, spaced apart, parallel side walls are provided with substantially identical intermediate walls being provided between each pair of side walls.

5. A boiler according to claim **3**, in which the intermediate wall is formed of tubes arranged closely adjacent each other and through which the medium flows, said tubes being arranged in vertical planes which are substantially parallel to the direction in which the combustion gases enter the cells.

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