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## (54) SECTIONAL HEAT EXCHANGER

(57) A sectional heat exchanger comprises a plurality of aluminum cast segments; means clamping the aluminum cast segments to each other, thereby assembling the plurality of aluminium cast segments vertically side by side; and sealing means between neighbouring aluminum cast segments. The sectional heat exchanger comprises a combustion chamber extending through the plurality of aluminum cast segments. The combustion chamber is configured for the installation of a premix burner. The heat exchanger comprises a plurality of flue gas flow channels extending from the combustion chamber. At least part of the flue gas flow channels are provided between each two neighbouring aluminum cast segments. Each aluminum cast segment comprises at least one fluid flow channel for heating fluid by heat transfer from the flue gas flowing through the flue gas channels. The aluminum cast segments comprise a set of lugs, wherein all lugs of the set of lugs are aligned with each other. The clamping means comprise a bolt and nut connection. The bolt extends through lugs of the set of lugs of only two neighbouring aluminium cast segments. The lugs through which the bolt extends contact each other. The bolt and nut connection presses the two neighbouring aluminum cast segments to each other. The clamping means comprise a tie rod extending through lugs of the set of lugs of at least three of the aluminum cast segments thereby pressing the at least three aluminum cast segments to each other.

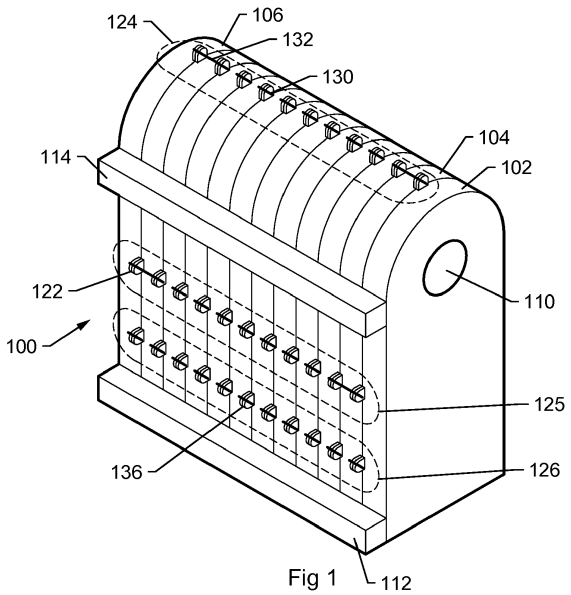


Fig 1

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## Description

### Technical Field

**[0001]** The invention relates to the field of sectional heat exchangers comprising a plurality of cast aluminum segments assembled side to side; and a combustion chamber for mounting a burner. More specifically, the invention relates to the way of assembling the cast aluminum segments into the sectional heat exchanger.

### Background Art

**[0002]** A known type of sectional heat exchangers comprises a plurality of aluminum cast segments; means clamping the aluminum cast segments to each other thereby assembling the plurality of aluminium cast segments vertically side by side; and sealing means - e.g. polymer sealant - between neighbouring aluminum cast segments. Such sectional heat exchangers comprise a combustion chamber extending through the plurality of aluminum cast segments. The combustion chamber is provided for the installation of a premix burner. The sectional heat exchanger comprises a plurality of flue gas flow channels extending from the combustion chamber. At least part of the flue gas flow channels are provided between two neighbouring aluminum cast segments. Each aluminum cast segment comprises a fluid flow channel for heating fluid by heat transfer from the flue gas flowing through the flue gas channels. The aluminum cast segments comprise lugs. The cast segments are clamped against each other by means of tie rods extending through the lugs of all cast segments. Alternatively, each cast segment is bolted to its neighbouring cast segments.

**[0003]** US3,554,167 shows an example of a sectional heat exchanger in which the segments are clamped against each other using tie rods.

**[0004]** As the cast segments become hot when the sectional heat exchanger is in use, the cast segments will expand. The clamping means need to be able to cope with the thermal expansion forces, as the clamping means - which are most of time out of steel - normally have a lower coefficient of thermal expansion than the aluminum cast segments. The clamping means will also heat (and cool) slower than the aluminum cast segments.

### Disclosure of Invention

**[0005]** The objective of the invention is to improve the way of assembling a sectional heat exchanger which comprises a plurality of aluminum cast segments.

**[0006]** The first aspect of the invention is a sectional heat exchanger. The sectional heat exchanger comprises a plurality of aluminum cast segments; means clamping the aluminum cast segments to each other, thereby assembling the plurality of aluminium cast segments vertically side by side; and sealing means - e.g. polymer sealant - between neighbouring aluminum cast segments. The sectional heat exchanger comprises a combustion chamber extending through the plurality of aluminum cast segments. The combustion chamber is configured for the installation of a premix burner. The heat exchanger comprises a plurality of flue gas flow channels extending from the combustion chamber. At least part of the flue gas flow channels are provided between each two neighbouring aluminum cast segments. Each aluminum cast segment comprises at least one fluid flow channel for heating fluid by heat transfer from the flue gas flowing through the flue gas channels. The aluminum cast segments comprise a set of lugs, wherein all lugs of the set of lugs are aligned with each other. With "aligned with each other" is meant that all first lugs are arranged in a straight line. The clamping means comprise a bolt and nut connection. The bolt extends through lugs of the set of lugs of only two neighbouring aluminium cast segments. The lugs through which the bolt extends contact each other. The bolt and nut connection presses the two neighbouring aluminum cast segments to each other. The clamping means comprise a tie rod extending through lugs of the set of lugs of at least three of the aluminum cast segments thereby pressing the at least three aluminum cast segments to each other.

**[0007]** It is a benefit of the invention that better clamping of the segments of the sectional heat exchanger is obtained, especially with respect of the ability to cope with the thermal expansion of the cast segments. This is especially beneficial when manufacturing a sectional heat exchanger with a large number of segments or with big and/or wide segments, as the total thermal expansion will become much larger than with a less big and/or less wide segment. According to the invention, part of the thermal expansion forces are taken up by bolt and nut connections, and another part by the tie rod or tie rods.

**[0008]** The invention is particularly advantageous for sectional heat exchangers of long lengths (sectional heat exchangers comprising a large number of aluminum cast segments or sectional heat exchangers comprising aluminum cast segments having a large width) that would otherwise require long tie rods spanning the full length of the heat exchanger. A tie rod - which is traditionally out of steel - heats slower and expands less than the aluminum cast segments. As a consequence, the forces applied by the long tie rod extending over all the cast segments onto the lugs of the first and last cast aluminum segments could become too big for the lugs to withstand. The lugs might break off or alternatively the lugs need to be made very strong. The aligned use of one or more tie rods in combination with one or more bolt and nut connections according to the invention drastically reduces the thermal expansion forces exerted on the clamping means.

**[0009]** Furthermore, when the sectional heat exchanger cools down, the aluminium cast segment cools quicker than the steel tie-rod. This could result in a situation in which there is no pre-tension in a tie rod anymore; such

situation might result in flue gas leakages between the cast aluminium segments. Such problem is also resolved in sectional heat exchangers according to the invention.

**[0010]** It is a further benefit of the invention that when manufacturing sectional heat exchangers with different numbers of aluminum cast segments, one single length of tie rod can be used (and using one or more than one tie rod of this length); while complementing the clamping means of sets of lugs with bolt and nut connections.

**[0011]** It is a benefit of at least part of the embodiments of the invention that the lugs can be made smaller. The lugs can be made smaller, as lower thermal forces will act on the lugs in sectional heat exchangers according to the invention.

**[0012]** The fluid to be heated can be water.

**[0013]** Preferably, the aluminum cast segments comprise lugs. The lugs are provided in a plurality of sets of lugs. The lugs in each set of lugs are aligned. The clamping means comprise for each set of lugs a bolt and nut connection. Each bolt of a bolt and nut connection extends through contacting lugs of only two neighbouring segments pressing the two neighbouring aluminum cast segments to each other. The clamping means comprise for each set of lugs a tie rod extending through lugs of at least three aluminum cast segments, pressing the at least three aluminum cast segments to each other. More preferably, the alignment of each of the sets of lugs is parallel one to another.

**[0014]** Advantageously, the lugs are integrally cast with the aluminum cast segments.

**[0015]** Advantageously, the bolt and nut connection(s) comprise(s) a helical spring. The bolt extends through the helical spring. The compression forces of the helical spring presses the two neighbouring aluminum cast segments to each other.

**[0016]** Advantageously, the tie rod(s) act(s) in combination with a helical spring. The tie rod extends through the helical spring. The compression forces of the helical spring determines the compressive forces with which the tie rod presses the at least three aluminum cast segments to each other.

**[0017]** Preferably, the at least three - and preferably only three - aluminum cast segments pressed together by the tie rod(s) are provided at one of the ends of the sectional heat exchanger. Such embodiments are beneficial, as the first and the last aluminum cast segments in a sectional heat exchanger heat differently compared to the middle aluminum cast segments of the sectional heat exchanger. Such situation could result in an extra load on the lugs of the first and of the last aluminum cast segment, which is resolved in the embodiments described in this paragraph.

**[0018]** Preferably, at both ends of the sectional heat exchanger at least three - and preferably only three - aluminum cast segments are pressed together by tie rods provided at both ends of the sectional heat exchanger. Such embodiments are beneficial, as the first and the last aluminum cast segments in a sectional heat exchanger heat differently compared to the middle aluminum cast segments of the sectional heat exchanger. Such situation could result in an extra load on the lugs of the first and of the last aluminum cast segment, which is resolved in the embodiments described in this paragraph.

**[0019]** Preferably, at maximum four aluminum cast segments - and preferably three aluminum cast segments - are pressed together by the tie rod(s) provided at one or at both ends of the sectional heat exchanger. Such embodiments are particularly beneficial. The first and the last aluminum cast segments of the sectional heat exchanger have an asymmetrical heat load. The inside of the first and the last aluminum cast segment is hot because of the flow of hot flue gas, but the outside of the first and the last aluminum cast segment is approximately at the temperature of the fluid flowing through the fluid channel of this aluminum cast segment. This difference in temperature creates a difference in thermal expansion of the inside and the outside of the first and of the last aluminum cast segment. Consequently, the first and the last aluminum cast segments want to curve, imposing a bending force on the lugs of these aluminum cast segments. A bolt and nut connection might be insufficient to cope with these forces, resulting in lugs breaking off from the first or the last aluminum cast segment resulting in a dramatic failure of the sectional heat exchanger. According to the embodiment of the invention, the use of a relatively short tie rod - with or without a compression spring - results in it that at its end opposite to the first or last aluminum cast segment, two lugs will carry the force (instead of one lug when using a bolt and nut connection). The lug of the aluminum cast segment neighbouring the first or last aluminum cast segment, lug which is contacting the lug of the end segment is not pressed against the lug of the first or last aluminum cast segment allowing both lugs to cope independently with the forces, which is beneficial for maintaining the integrity of the assembly of the cast segments.

**[0020]** More preferred is when both ends of the sectional heat exchanger a tie rod connection is provided; and the tie rods each extend through lugs of a set of lugs pressing at least three - and preferably only three - cast segments to each other.

**[0021]** In preferred embodiments, the clamping means comprise for each set of lugs a plurality of bolt and nut connections. Each bolt extends through contacting lugs of the set of lugs of only two neighbouring aluminum cast segments pressing the two neighbouring aluminum cast segments to each other.

**[0022]** Advantageously, each aluminum cast segment, except for the aluminum cast segments at both ends of the sectional heat exchanger, comprises in each set of lugs two lugs. Each of the two lugs is provided in the aluminum cast segment such that it makes planar contact with a lug - of the same set of lugs - of the neighbouring aluminum cast segment. More preferably, the aluminum cast segments at both ends of the sectional heat ex-

changer comprise one lug in each set of lugs, configured such that it makes planar contact with a lug from the same set of lugs of the neighbouring aluminum cast segment. Such embodiments provide particular sturdy ways of assembling the sectional heat exchanger.

**[0023]** In preferred embodiments of the invention, the sectional heat exchanger comprises at least 6 aluminum cast segments assembled vertically side by side, more preferably at least 8 aluminum cast segments assembled vertically side by side, more preferably at least 10 aluminum cast segment assembled vertically side by side, more preferably at least 12 aluminum cast segment assembled vertically side by side, more preferably at least 14 aluminum cast segments assembled vertically side by side, more preferably at least 16 aluminum cast segments assembled vertically side by side. Such preferred embodiments facilitate the assembly of the sectional heat exchanger. Placing a large number of aluminum cast segments in contact with each other, with the application of the sealing means in between the cast aluminum segments takes considerable time. The use of long tie rods extending over all aluminum cast segments is problematic, as the sealing means - which normally comprises a reacting (e.g. crosslinking) chemical polymer - would react to a too large extent before the full set of aluminum cast segments is pressed together by a tie rod or by the tie rods extending over all aluminum cast segments. The embodiment of the invention allows to press a small number of aluminum cast segments to each other, with sealing means in between, while the main reaction of the sealing means still has to take place, resulting in efficient sealing and assembly of the sectional heat exchanger.

**[0024]** A preferred sectional heat exchanger comprises a manifold for feeding fluid into the at least one fluid channel of each of the aluminum cast segments. The manifold is configured perpendicularly to the aluminum cast segments assembled vertically side by side. The manifold can be bolted into the sectional heat exchanger. Alternatively, the manifold can be provided by sections of each of the aluminum cast segments, wherein the sections are pressed to each other with sealing means in between the sections of the manifold.

**[0025]** A preferred sectional heat exchanger comprises a manifold for evacuating fluid from the at least one fluid channel of each of the cast segments. The manifold is configured perpendicularly to the aluminum cast segments assembled vertically side by side. The manifold can be bolted into the sectional heat exchanger. Alternatively, the manifold can be provided by sections of each of the aluminum cast segments, wherein the sections are pressed to each other with sealing means in between the sections of the manifold.

**[0026]** A preferred sectional heat exchanger comprises lugs. The lugs are provided in a plurality of sets of lugs. The lugs in each set of lugs are aligned. The sets of lugs comprise first sets of lugs and second sets of lugs. The first sets of lugs are provided in an upper section of the sectional heat exchanger. The second sets of lugs are provided in a lower section of the sectional heat exchanger. The lower section is provided in the sectional heat exchanger below the upper section. The clamping means comprise for each set of the first set of lugs a bolt and nut connection; wherein each bolt of a bolt and nut connection extends through contacting lugs of only two neighbouring aluminum cast segments pressing the two neighbouring cast segments to each other. The clamping means comprise for each set of the first set of lugs a tie rod extending through lugs of at least three aluminum cast segments, pressing the at least three aluminum cast segments to each other. The clamping means comprise for each set of the second set of lugs only bolt and nut connections (optionally, the bolt and nut connections can comprise helical springs, wherein the bolt extends through the helical spring) wherein each bolt of a bolt and nut connection extends through contacting lugs of only two neighbouring aluminum cast segments; or the clamping means comprise for each set of the second set of lugs only one single tie rod (optionally, the one single tie rod extends through a helical spring). Such embodiments are particularly advantageous. The upper section of the sectional heat exchanger will heat more than the lower section of the sectional heat exchanger, as the flue gas in the upper section is at a much higher temperature than the flue gas in the lower section of the sectional heat exchanger, and due to the counter direction of flow of fluid and flue gas, the fluid in the upper part of the sectional heat exchanger is hotter than the fluid in the lower part. The flue gas has already transferred in the upper section an important part of its heat content to fluid flowing through the fluid channels by the time it arrives in the lower section. As a consequence, the upper section will be more prone to thermal expansion when heating and to contraction when cooling down than the bottom section of the sectional heat exchanger. Therefore, it is beneficial to use for sets of lugs in the upper section a combination of nut and bolt connections on the one hand and tie rods on the other hand to cope efficiently with the thermal expansion and contraction. As the thermal expansion and contraction is less of an issue in the lower section, only bolt and nut connections on the one hand or on the other hand only a single tie rod per set of lugs can be used in the lower section, which provide cheaper clamping means than used in the sets of lugs in the upper section.

**[0027]** In preferred embodiments of the invention, the tie rod(s) and/or the bolt(s) are out of steel. The use of tie rod(s) and/or bolt(s) out of steel has the benefit that high strength clamping means are being used, which also have high modulus of elasticity.

**[0028]** Preferably, the tie rod(s) have at one or at both ends threaded ends onto which a nut is provided.

**[0029]** A preferred sectional heat exchanger comprises a sump below the aluminum cast segments. The sump is provided for collecting the flue gas from each of the plurality of flue gas flow channels and for collecting and evacuating fluid condensed from the flue gas.

**[0030]** The second aspect of the invention is a heat

cell, preferably a condensing heat cell. The heat cell comprises a sectional heat exchanger as in any embodiment of the first aspect of the invention; and a premix burner. The premix burner is installed in the combustion chamber for the production of flue gas. Preferably, the premix burner is a surface stabilized premix gas burner.

**Brief Description of Figures in the Drawings**

**[0031]**

Figure 1 shows a sectional heat exchanger according to the invention.

Figure 2 shows a detail of the sectional heat exchanger of figure 1.

Figure 3 shows a detail of another sectional heat exchanger according to the invention.

**Mode(s) for Carrying Out the Invention**

**[0032]** Figure 1 illustrates a sectional heat exchanger 100 according to the invention comprising twelve cast aluminum segments 102, 104, 106. The aluminum cast segments are assembled vertically side by side. Polymer sealant is used between each two neighbouring aluminum cast segments, in order to ensure that the aluminum cast segments are assembled gas tight to each other.

**[0033]** The sectional heat exchanger comprises a combustion chamber 110 extending through the plurality of aluminum cast segments. The combustion chamber is configured for the installation of a premix gas burner for the production of flue gas. The heat exchanger comprises a plurality of flue gas flow channels extending from the combustion chamber. Flue gas flow channels are provided between each two neighbouring aluminum cast segments. Each aluminum cast segment comprises a fluid flow channel for heating fluid by heat transfer from the flue gas flowing through the flue gas channels.

**[0034]** The sectional heat exchanger comprises a manifold 112 for feeding fluid into the fluid channels of each of the aluminum cast segments. The manifold is configured perpendicularly to the aluminum cast segments assembled vertically side by side. The manifold 112 is bolted into the sectional heat exchanger.

**[0035]** The sectional heat exchanger comprises a manifold 114 for evacuating fluid from the fluid channels of each of the cast segments. The manifold is configured perpendicularly to the aluminum cast segments assembled vertically side by side. The manifold 114 is bolted into the sectional heat exchanger.

**[0036]** The sectional heat exchanger comprises lugs 122. The lugs are integrally casted with the aluminum cast segment on which they are provided. The lugs are provided in a plurality of sets of lugs. The lugs in each set of lugs are aligned. Reference numerals 124 and 125 indicate two of the sets of lugs in the upper section of the sectional heat exchanger. Reference numeral 126 indicates a set of lugs in the lower section of the sectional heat exchanger.

**[0037]** Each of the aluminum cast segments 104 - except for the aluminum cast segments 102, 106 at both ends of the sectional heat exchanger - comprises in each set of lugs two lugs. Each of the two lugs is provided in the aluminum cast segment such that it makes planar contact with a lug - of the same set of lugs - of the neighbouring aluminum cast segment. The aluminum cast segments 102, 106 at both ends of the sectional heat exchanger comprise one lug in each set of lugs, such that it makes planar contact with a lug from the same set of lugs of the neighbouring aluminum cast segment.

**[0038]** The aluminum cast segments of the sectional heat exchanger are assembled by clamping means that comprise seven bolt and nut connections 130 and two tie rods 132 for each set of lugs 124, 125 in the upper section of the sectional heat exchanger. The bolts each extend through lugs of the set of lugs of only two neighbouring aluminium cast segments. The lugs through which the bolt extends contact each other. The bolt and nut connection presses the two neighbouring aluminum cast segments to each other. The clamping means for each set of lugs of the upper section comprise two tie rods each extending through lugs of the set of lugs of three aluminum cast segments thereby pressing the three aluminum cast segments to each other. The tie rods have at both ends screw thread onto which nuts are provided. In the exemplary sectional heat exchanger, the tie rods are provided to press the aluminum cast segments at both ends of the sectional heat exchanger to their neighbouring aluminum cast segment. As already explained, bolt and nut connections 130 compress the other aluminum cast segments to each other. Each set of lugs in the upper section of the sectional heat exchanger is provided with the same arrangement with at the one hand the bolt and nut connections; and on the other hand the tie rod connections.

**[0039]** The sets of lugs in the lower section (e.g. the set of lugs indicated with reference numeral 126) only comprise bolt and nut connections 136. The bolts each extend through lugs of the set of lugs of only two neighbouring aluminium cast segments. The lugs through which the bolt extends contact each other. The bolt and nut connection presses the two neighbouring aluminum cast segments to each other. The bolt and nut connections can comprise helical springs, wherein the bolt extends through the helical spring.

**[0040]** Figure 2 shows a detail of the sectional heat exchanger of figure 1. The detail shows the arrangement of the clamping means for one of the sets of lugs, more specifically for the set of lugs indicated by 124 in figure 1. This set of lugs belongs to the upper section of the sectional heat exchanger. The twelve aluminum cast segments 102, 104, 106 are clamped into the sectional heat exchanger by tie rods 132 and bolt and nut connections 130 that extend through lugs 122. The tie rods 132 act in combination with a helical spring 140 wherein the tie rod extends through the helical spring. The compres-

sion force of the helical spring determines the compressive force with which the tie rod presses the three aluminum cast segments to each other.

**[0041]** Figure 3 shows a detail of another example of a sectional heat exchanger according to the invention. The sectional heat exchanger comprises ten aluminum cast segments 302, 304, 306; assembled side by side, with sealing means in between the aluminum cast segments to ensure a gas tight assembly. The figure shows the lugs 322 of one of the sets of lugs of the sectional heat exchanger. In the set of lugs that is shown, two tie rods 332 and three nut and bolt connections 330 are used to press the aluminum cast segments to each other in order to assemble the sectional heat exchanger. The nut and bolt connections comprise a helical spring 344. The bolt extends through the helical spring and the compression force of the helical spring determines the compressive force with which the bolt and nut connection presses the aluminum cast segments to each other. The two tie rods 332 act in combination with a helical spring 340 through which the tie rod extends. The compression force of the helical spring determines the compressive force with which the tie rod presses the three aluminum cast segments to each other. The tie rods have at both ends screw thread onto which a nut is screwed.

**[0042]** Figure 3 illustrates the benefit of the invention that sectional heat exchangers with different number of segments can be assembled using a same length of tie rod, by using one or more than one such tie rod in combination with bolt and nut connections.

## Claims

**1.** Sectional heat exchanger, comprising

- a plurality of aluminum cast segments;
- means clamping the aluminum cast segments to each other, thereby assembling the plurality of aluminium cast segments vertically side by side; and
- sealing means between neighbouring aluminum cast segments;

wherein the sectional heat exchanger comprises a combustion chamber extending through the plurality of aluminum cast segments,
wherein the combustion chamber is configured for the installation of a premix burner;
wherein the heat exchanger comprises a plurality of flue gas flow channels extending from the combustion chamber, wherein at least part of the flue gas flow channels are provided between each two neighbouring aluminum cast segments;
wherein each aluminum cast segment comprises at least one fluid flow channel for heating fluid by heat transfer from the flue gas flowing through the flue gas channels;
wherein the aluminum cast segments comprise a set of lugs, wherein all lugs of the set of lugs are aligned with each other;
wherein the clamping means comprise a bolt and nut connection; wherein the bolt extends through lugs of the set of lugs of only two neighbouring aluminium cast segments; wherein the lugs through which the bolt extends contact each other; wherein the bolt and nut connection presses the two neighbouring aluminum cast segments to each other; and
wherein the clamping means comprise a tie rod extending through lugs of the set of lugs of at least three of the aluminum cast segments thereby pressing the at least three aluminum cast segments to each other.

**2.** Sectional heat exchanger as in claim 1;
wherein the aluminum cast segments comprise lugs, wherein the lugs are provided in a plurality of sets of lugs, wherein the lugs in each set of lugs are aligned;
wherein the clamping means comprise for each set of lugs a bolt and nut connection; wherein each bolt of a bolt and nut connection extends through contacting lugs of only two neighbouring aluminum cast segments pressing the two neighbouring cast segments to each other;
wherein the clamping means comprise for each set of lugs a tie rod extending through lugs of at least three aluminum cast segments, pressing the at least three aluminum cast segments to each other.

**3.** Sectional heat exchanger as in any of the preceding claims; wherein the bolt and nut connection(s) comprise(s) a helical spring, wherein the bolt extends through the helical spring, wherein the compression forces of the helical spring presses the two neighbouring aluminum cast segments to each other.

**4.** Sectional heat exchanger as in any of the preceding claims, wherein the tie rod(s) act(s) in combination with a helical spring, wherein the tie rod extends through the helical spring; and wherein the compression forces of the helical spring determines the compressive forces with which the tie rod presses the at least three aluminum cast segments to each other.

**5.** Sectional heat exchanger as in any of the preceding claims, wherein the at least three - and preferably only three - aluminum cast segments pressed together by the tie rod(s) are provided at one of the ends of the sectional heat exchanger.

**6.** Sectional heat exchanger as in claim 5;
wherein at both ends of the sectional heat exchanger a tie rod connection is provided; wherein the tie rods each extend through lugs of a set of lugs pressing at least three - and preferably only three - aluminum cast segments to each other.

7. Sectional heat exchanger as in any of the preceding claims;
wherein the clamping means comprise for each set of lugs a plurality of bolt and nut connections; wherein each bolt extends through contacting lugs of the set of lugs of only two neighbouring aluminum cast segments pressing the two neighbouring aluminum cast segments to each other.

8. Sectional heat exchanger as in any of the preceding claims, wherein each aluminum cast segment, except for the aluminum segments at both ends of the sectional heat exchanger, comprises in each set of lugs two lugs, wherein each of the two lugs is provided in the aluminum cast segment, such that it makes planar contact with a lug - of the same set of lugs - of the neighbouring aluminum cast segment.

9. Sectional heat exchanger as in any of the preceding claims, wherein the heat exchanger comprises at least six aluminum cast segments vertically assembled side by side.

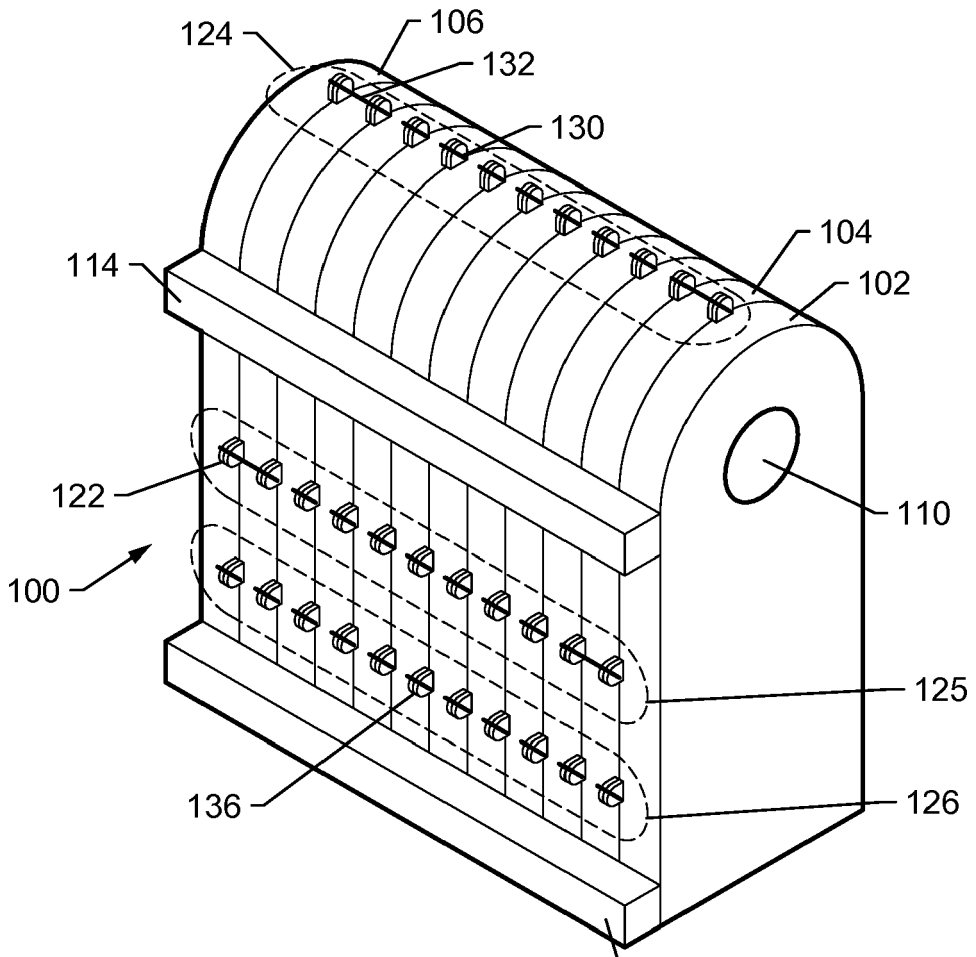
10. Sectional heat exchanger as in any of the preceding claims 2 - 9,
wherein the sets of lugs comprise first sets of lugs and second sets of lugs; wherein first sets of lugs are provided in an upper section of the sectional heat exchanger; and wherein second sets of lugs are provided in a lower section of the sectional heat exchanger, wherein the lower section is provided in the sectional heat exchanger below the upper section;
wherein the clamping means comprise for each set of the first set of lugs a bolt and nut connection; wherein each bolt of a bolt and nut connection extends through contacting lugs of only two neighbouring aluminum cast segments pressing the two neighbouring cast segments to each other;
wherein the clamping means comprise for each set of the first set of lugs a tie rod extending through lugs of at least three aluminum cast segments, pressing the at least three aluminum cast segments to each other;
wherein the clamping means comprise for each set of the second set of lugs only bolt and nut connections wherein each bolt of a bolt and nut connection extends through contacting lugs of only two neighbouring aluminum cast segments; or wherein the clamping means comprise for each set of the second set of lugs only one single tie rod.

11. Sectional heat exchanger as in any of the preceding claims; wherein the tie rod(s) and/or the bolt(s) are out of steel or at out of aluminum.

12. Sectional heat exchanger as in any of the preceding claims, wherein the tie rod(s) have at one or at both ends threaded ends onto which a nut is provided.

13. Sectional heat exchanger as in any of the preceding claims, comprising a sump below the aluminum cast segments, wherein the sump is provided for collecting the flue gas from each of the plurality of flue gas flow channels and for collecting and evacuating fluid condensed from the flue gas.

14. Heat cell, comprising a sectional heat exchanger as in any of the preceding claims and a premix burner, wherein the premix burner is installed in the combustion chamber for the production of flue gas.


124
106
132
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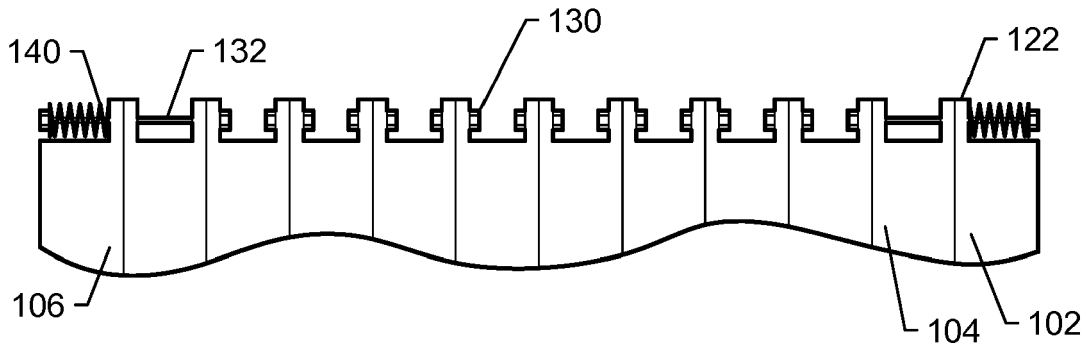
126
112

Fig 1


140
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102

Fig 2

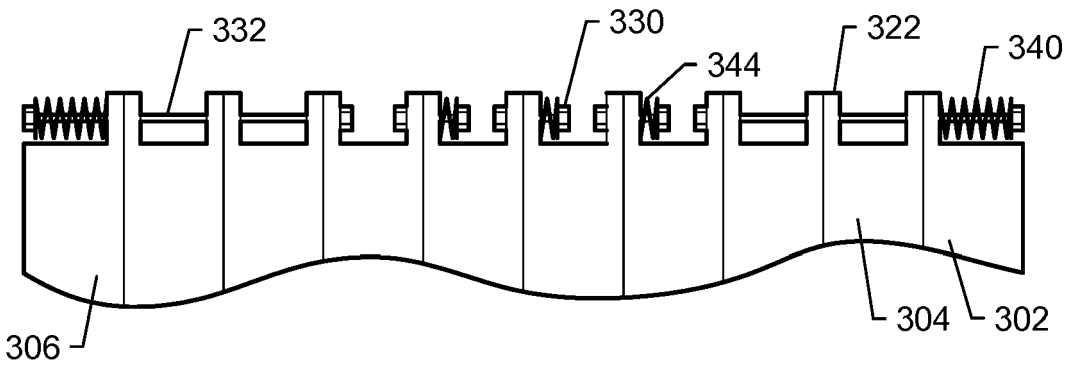


Fig 3

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# EUROPEAN SEARCH REPORT

Application Number
EP 19 18 5384

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
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| A | GB 624 708 A (LESLIE FREDERICK TUNNELL) 15 June 1949 (1949-06-15)<br>* page 8; figures 1-4 * | 1-14 | |
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