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(54) Sectional heating boiler and heating apparatus comprising such boiler

(57) A sectional heating boiler comprising a series of heating sections, each comprising at least a water duct part and heat-exchange elements, wherein burner means are provided for heating in each section, through heat exchange via the heat-exchange elements, water in the relevant water duct, characterized in that the heating boiler (1,101,201) is of modular construction, wherein at least a series of sections and preferably each section is individually provided with a burner (20,120,220), a heat-exchange area (17,117,217) and flue gas discharge means, wherein control means (26) are provided for controlling, individually or batchwise, at least a part of the burners (20,120,220).

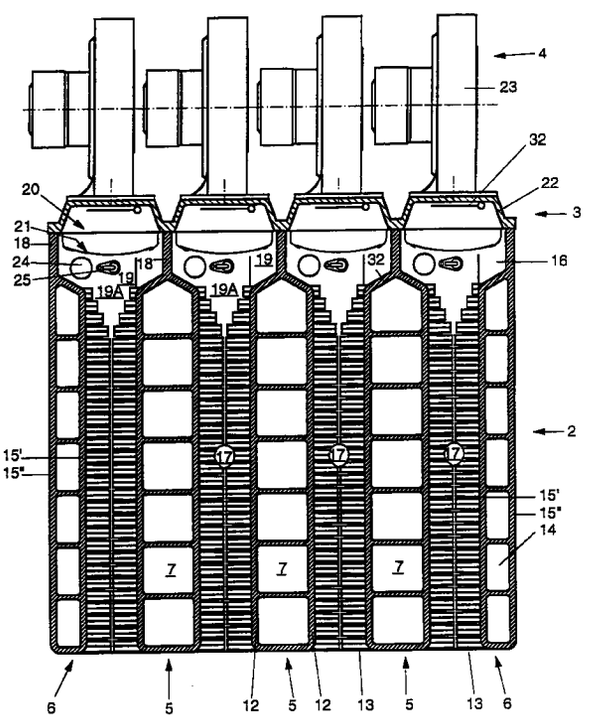

FIG. 2

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Description

The invention relates to a sectional heating boiler as described in the preamble of claim 1. Such apparatus is known from practice.

The known heating boiler comprises a burner bed having a series of sections arranged thereabove. Each section comprises a water duct, wherein the water ducts are fed via a common return duct of a heating circuit and terminate in a common feed duct to the heating circuit. The water duct parts are for instance formed by zigzag extending pipes. During use, the flue gases of flames on the burner bed are forced between the pipes while exchanging heat with water flowing through the pipes.

Such heating boiler has a fixed number of sections, chosen depending on the pre-calculated maximum heat demand of a heating circuit to be connected thereto. This means that a large number of different heating boilers should be available to be able to provide in each case a heating boiler of a suitable capacity for different heating circuits. Moreover, such heating boiler has the drawback that the entire burner bed should be used continuously, regardless of the heat demand in the heating circuit to be fed, while also all sections are in each case involved in the heat exchange. As a consequence, such heating boiler is relatively costly in manufacture and use, is relatively complicated in terms of construction and use, is economically and environmentally little profitable, and provides, especially in the case of highly changing heat demands in the heating circuit to be fed, limited convenience of use. Further, repair of such heating boiler is complicated.

The object of the invention is to provide a sectional heating boiler of the type described in the generic part of the main claim, wherein the drawbacks mentioned have been avoided and the advantages thereof have been retained. To that end, a sectional heating boiler according to the invention is characterized by the features of the characterizing part of claim 1.

The modular construction of a heating boiler according to the invention offers the possibility of selecting the number of sections included in the heating boiler depending on the pre-calculated maximum heat demand, so that with a limited number of different or identical, relatively simple modules a suitable heating boiler can in each case be composed. As there is provided a series of burners, together with control means for controlling the different burners individually or batchwise, a desired load of the burners can in each case be set with such heating boiler, depending on the heat demand measured, also when this demand is considerably lower than the maximum heat requirement for which the heating boiler has been laid out. For instance, one or more burners can be switched on or off or be modulated. It is thus provided that during use, in each heat-exchange area connecting to a switched-on burner, the heat-exchange elements are sufficiently loaded.

Owing to the modular construction of a heating boiler according to the invention, maintenance of the heating boiler can be carried out in a relatively simple manner and the capacity of the heating boiler is readily adaptable, for instance to changed circumstances.

In an advantageous embodiment, a heating boiler according to the invention is characterized by the features of claim 2.

The modules in the central area can be substantially identical, so that with only one type of tool all modules for the central area can be manufactured, regardless of the number of modules. Moreover, the second modules at the two ends of the heating boiler can be identical to each other as well, so that for these second modules, too, only one tool is necessary. In addition, the first modules can also be identical to the second modules.

In a preferred embodiment, a heating boiler according to the invention is characterized by the features of claims 3 and 4.

Positioning a portion of the or each heat-exchange area of a module on one respectively two sides of the water duct part in a module offers the advantage that it is approachable from a side when a module has been removed. Thus, for instance cleaning and inspection thereof are readily possible, while the manufacture of the modules is also simplified considerably thereby. In particular when the heat-exchange areas comprise elements increasing the heat-transferring surface, such as for instance pins or partitions. For instance, they can be of a readily withdrawable design, so that simple casting techniques can be used for manufacturing the modules, without this requiring complicated molds. Also, the elements increasing the heat-transferring surface can for instance be milled and they can moreover be finished in a simple manner.

Of course, the elements increasing the heat-transferring surface can also extend for all modules on only one side of the water duct part of the relevant module, while the opposite side is substantially flat. This has the advantage that the modules can all be identical, while a closing plate need be provided at only one end of a heating boiler, which closing plate can for instance be of a simple, flat design. The maximum width of the heat-exchange areas, i.e. the distance between the water duct parts of adjoining modules, is in each case determined by the length of the elements increasing the heat-transferring surface.

In an advantageous embodiment, a heating boiler is further characterized by the features of claim 7.

Through the provision of a series of burners, each included in a section, heat can directly be fed in each section during use. In this connection, designing the burners as premix burners, wherein for each burner a separate fan is provided, has the advantage that thereby the desired amount of heat can readily be fed to each section, depending on for instance the heat demand observed in a connected heating circuit. In this

regard, section should be understood to mean a unit comprising at least a burner and a space therebelow, included between two juxtaposed modules, in which space, during use, heat can be exchanged between flue gases and water (or another medium) flowing therethrough in the water duct parts provided on either side of the relevant space.

In further elaboration, a heating boiler according to the invention is characterized by the features of claim 9.

During the through-flow of the heat-exchange areas, the combustion gases exchange heat with water in the water duct parts. The shape of the modules, or at least of the heat-exchange areas, that tapers in the direction away from the burners, provides a flow resistance for the combustion gases that increases in that direction, a decreasing heat-exchange area and a greater flow rate of the combustion gases. This means that during use, the best heat exchange is realized where the combustion gases have approximately the highest temperature. Because of the taper of the heat-exchange areas, the flue gas velocity in the direction away from the burner is kept high at a decreasing flue gas volume. As a result, the heat transfer is maintained at an optimum level. The flue gas volume decreases as a result of the decreasing temperature thereof.

Further embodiments of a heating boiler according to the invention are given in the description and the claims.

The invention further relates to modules intended for use with a heating boiler according to the invention and to a heating apparatus comprising a heating boiler according to the invention. The invention moreover relates to a method for controlling a heating apparatus according to the invention, characterized by the features of claim 14, and to a control unit suitable therefor.

To explain the invention, exemplary embodiments of a heating boiler and a heating apparatus according to the invention will hereinafter be described, with reference to the accompanying drawings. In these drawings:

Fig. 1 is a side elevational view of a heating boiler according to the invention;

Fig. 2 is a sectional front view of a heating boiler taken on the line II-II in Fig. 1;

Fig. 3 is a sectional front view of a heating boiler according to Fig. 1 in an alternative embodiment;

Fig. 4 is a sectional view of a heating boiler according to the invention in a further alternative embodiment; and

Fig. 5 schematically shows a heating apparatus comprising a heating boiler according to the invention.

Fig. 1 is a side elevational view of a heating boiler 1 according to the invention, comprising a body part 2, a head part 3 and a series of fans 4. As appears from the sectional front view of Fig. 2, this heating boiler 1 is built up of a series of modules, to be distinguished into a series of first modules 5 located in the central area and two second modules 6 forming the ends. These modules 5, 6 will first be described separately and then in combination as incorporated into the heating boiler 1. Preferably, the modules 5, 6 are manufactured through casting from light metal, such as aluminum or an aluminum alloy, so that each module substantially consists of one piece.

Each module 5 comprises a water duct part 7 which is meander-shaped and extends between a first, upper end 8 for connecting to a feed distributor 9, and a second, lower end 10 for connecting to a return distributor 11. The feed and return distributors should be understood to be part of or at least connectable to a heating circuit that should be fed by the heating boiler 1, for instance a space heating circuit or a sanitary-water heating circuit. The water duct part 7 is on either side bounded by a wall 12. From each wall 12, a number of rows and columns of projections 13 extend approximately at right angles to the plane of the wall 12 in a direction away from the water duct part 7. Preferably, the projections 13 are arranged in the rows in such a manner that the projections 13 of two rows lying above or next to each other are slightly staggered relative to one another, so that zigzag extending passages are formed between the projections 13. The purpose thereof will be further explained hereinbelow.

Each second module 6 also comprises a meandering water duct part 14, bounded by two walls 15, with a number of rows and columns of projections 13 provided on only one side of one wall 15, which projections are comparable with and arranged in identical positions as the projections 13 of the

first modules 5. The end faces of the modules 5, 6 are covered by an integrally cast end wall part 16, one of which is shown in Fig. 1. During use, the end wall parts 16 form a closed wall along all modules 5, 6 on either side thereof (in the position shown in Fig. 2 along the modules at the front and back thereof).

As the projections 13 extend approximately at right angles to the plane of the water duct 7 respectively 14, in this case a wall 12 respectively 15, the projections 13 are withdrawable, so that a mold for manufacturing such module, or at least for the outer shape thereof, can be made in a simple manner. For forming each water duct 7, 14, a core should be included in the mold.

As shown in Fig. 2, the first modules 5 are arranged side by side and interconnected with the projections 13 facing each other, with the interposition of sealing packings. Then, at the two ends of the heating boiler, a second module 6 is fixed against the series of first modules 5 in such a manner that the projections 13 of the second modules 6 are positioned opposite projections 13 of the adjoining first module 5. Preferably, the projections 13 of two juxtaposed modules 5, 5, respectively 5, 6 do not touch each other, yet the free ends thereof are generally closely spaced. To be able to effect a gastight connection between the different modules, many different types

of connecting means, not shown in the drawings, can be used, such as clamping means, screw means, adhesion means and the like.

After the modules 5, 6 have been interconnected, a heat-exchange area 17 is in each case enclosed between two adjoining modules 5, 5 respectively 5, 6, which heat-exchange area in each case comprises a large number of zigzag extending passages between the projections 13. The walls 12 have such a configuration at their top sides that the upper part 18 thereof extends approximately centrally above the water duct 7, while of each second module 6 the wall 15' that faces the first module 5 during use is lower than the opposite wall 15" As a result, above each heat-exchange area 17 a burner space 19 is formed that is slightly wider than the subjacent heat-exchange area 17. At the top side, a burner 20 is provided in the relevant burner space 19 above each heat-exchange area 17, which burner 20 preferably extends over substantially the entire surface of the burner space 19. Each burner 20 is preferably of a premix type. At the top side, a sealing cover cap 22 is provided over each burner 20, having a fan 23 connected thereto. By means of each fan, a gas-air mixture can during use be fed, under pressure, to the burner deck 21 of the subjacent burner 20.

As appears in particular from Fig. 1, the fans 23 are positioned so that the fans 23 of two juxtaposed burners 20 are staggered in such a manner that sufficient space remains around each fan 23 so that it can readily be reached. Moreover, this allows the use of relatively large fans. As a matter of fact, the fans can also be staggered in different manners, for instance through tilting forwards and/or backwards, or through vertical displacement.

Provided in each burner space 19 is a sight glass 24 and an igniter 25 for the adjacent burner 20. The igniting means can for instance be of electronic design or enable manual ignition. The projections 13 adjacent the burner space 19 have a relatively slight length, which length quickly increases in the direction of the lower side of the heat-exchange area 17. Thus, between the upper rows of projections 13 (the upper four rows in the exemplary embodiment shown) a free space 19A is created whose width decreases downwards. At the bottom side, a manifold (not shown) for flue gases is connectable to each heat-exchange area 17. The heat-exchange areas 17 taper in downward direction, as a result of which the flue gas velocity adjacent the bottom side of the heat-exchange areas 17 is kept high, while the volume thereof decreases due to the cooling. The projections 13 form a relatively large heat-transferring surface in each heat-exchange area.

Further, for each heat-exchange area 17, a check valve 32 is provided for closing the passage thereof. In the exemplary embodiment shown in Fig. 1, each check valve 32 is accommodated directly downstream of the fan 23 and upstream of the burner 20 in a relatively cool part. The purpose of each check valve 32 is to prevent, when the burner 20 and fan 23 of the relevant heat-exchange area 17 are switched off, flue gases from flowing back from one or more of the other heat-exchange areas 17 and via the relevant non-engaged heat-exchange area and the relevant fan 23, to the feed-in side of the unit. After all, this might cause flue gases to flow into the space where the unit is installed, with all its obvious dangers involved. Each check valve 32 is settable via the central unit 26 and is preferably moreover provided with safety means which close the check valve 32 in the event of failure of the relevant burner 20 and/or fan 23. Actually, a check valve 32 may also be included at another position, for instance upstream of the fan 23 or on the outlet side of a heat-exchange area 17. However, at that location the temperature is considerably higher. As check valve 32, different types of valves can be employed.

A heating boiler 1 according to the invention can be used as follows.

The feed and return manifolds 9, 11 are connected to a heating circuit, with each fan 23 being connected to at least a gas feed pipe. Moreover, the manifold for the flue gases is connected to the bottom side of the modules 5, 6 and brought into communication with a chimney 28 (Fig. 5). A control unit 26, schematically shown in Fig. 5, is on one side connected to feeler means 27 in or at the heating circuit V, which means are adapted to measure the heat requirement in the relevant circuit or for instance a space to be heated. In the heating circuit V, only one radiator 31 is shown, schematically, yet it will be appreciated that more heating elements can be included and, moreover, more heating circuits can be connected. On the other side, at least the fans 23, gas and air feed means and the igniters 25 are connected to the control unit 26. Moreover, the control unit 26 may comprises setting means for preferences. Furthermore, a water pump 29 in the heating circuit V is controllable and regulable, for instance in speed, by the control unit 26.

Depending on the heat requirement measured, the optimum setting is selected (with or without modulation) for each burner 20 and the burners 20 are ignited simultaneously or in succession, while all burners 20 or only a limited number thereof can be ignited. All burners can be set in the same manner or in mutually different manners, depending on the desired burner pattern. Moreover, a number of burners 20 may be out of operation. Through modulation of the burners 20 and/or engagement and disengagement thereof, the desired amount of heat can each time be fed to the heat-exchange areas 17 via the flue gases. At the disengaged burners 20 and/or fans 23, the check valve 32 is closed. As the burner space 19 is wider than the heat-exchange area 17 therebelow, heat will also be transmitted via the shoulders 32 constituting the transition between a wall 12, 15' and the top part 18 of the relevant wall of the module. In the heat-exchange areas 17, heat exchange occurs between the projections 13 and water in the

water duct parts 7, 14 that have mutually been combined into one or, possibly, a number of water ducts. Owing to the space 19A, the flue gases of a burner can at first flow into the heat-exchange areas 17 in a relatively undisturbed manner, until the flue gases undergo resistance in the zigzag extending passages. In this connection, the zigzag extending ducts provide an intensive contact between the flue gases and the projections 13. As a result, the heat exchange is intensified. Via the manifold, the cooled flue gases are discharged to the chimney 28 or the like.

A heating boiler of modular construction according to invention, wherein in each case, a section is substantially defined by two adjoining modules 5, 5 respectively 5, 6, offers the advantage that depending on the heat requirement that will maximally occur in the heating circuit V to be controlled (or the heating circuits to be collectively controlled), the number of necessary modules can be determined and combined into one heating boiler. As the first modules 5 are all identical, like the second modules 6, adjustment of the size of the heating boiler 1 is possible in a simple and economical manner, while only a limited number of molds are necessary for the formation thereof. In fact, the second modules can in principle be manufactured in a mold for the first modules with only a slight adjustment of the mold. Because the modules are at least substantially of withdrawable design, they can readily be manufactured through casting without this requiring complicated molds. During use, a modular heating boiler moreover offers the advantage that maintenance thereof is readily possible, by removing the modules and/or the covering caps, while moreover, for instance a single module can be taken away or added, or be replaced by a comparable or different module. Further, all modules may be identical or, if necessary, of mutually different designs.

The number of sections that a heating boiler according to the invention can comprise is theoretically unlimited.

Fig. 3 shows an alternative embodiment of a heating boiler 101 according to the invention, which substantially corresponds to a heating boiler according to Figs. 1 and 2. In this embodiment, however, each module 105 comprises a water duct part 107 having projections 113 on one side thereof, which projections during use substantially abut against the substantially flat wall 112' of an adjoining module 105. To the right in Fig. 3 an end module 106 is provided which is identical to the modules 105, with the understanding that this end module 106 carries no projections 113. The check valve are not shown in Fig. 3. In use, this heating boiler 101 corresponds to the heating boiler 1 according to Figs. 1 and 2. This alternative embodiment has the advantage that the modules can all be manufactured by means of only one mold and are relatively simple in construction and use, requiring withdrawal in one direction only. In this embodiment, the maximum width B of the heat-exchange areas 117 is determined by the length of the (longest) projections 113 and will be less than the width of the heat-exchange areas 117 according to Figs. 1 and 2. The flue gas resistance of such heating boiler 101 will hence be higher than in the above-described heating boiler in an otherwise identical design.

Of course, modules 5, 6 and 105, 106 can be combined as desired, whereby a still greater range in setting values becomes possible. For instance, in the case of a small heat requirement, the modules 105, 106 can be opted for, and in the case of greater heat requirements, the modules 5, 6 can be opted for, optionally in combination with the modules 105, 106. Also, to the different modules 5, 6 respectively 105, 106, different heating circuits can be connected, for instance respectively a space heating circuit and a sanitary-water heating circuit.

Fig. 4 shows a further alternative embodiment of a heating boiler 201 according to the invention. In this embodiment, each section is formed from two modules 205, 205 respectively 205, 206 in the form of a segment of a circle, with the burner 220 arranged on the outward-facing side of the section and the flue gas manifold 230 arranged adjacent the center of the (partially virtual) circle formed by the sections. In this embodiment, each heat-exchange area 217 slightly tapers in the direction of the flue gas manifold 230 in that the walls 212, 215 converge in that direction. In this embodiment, sufficient space is provided for the fans 223 in that they are disposed in radial direction. Check valves are not shown in this Figure.

The invention is by no means limited to the embodiments represented in the drawings and the description. Many variations thereto are possible.

For instance, the elements increasing the heat-transferring surface may be of a different design, for instance entirely or partially designed as partitions. Further, the outer shape of the modules may be chosen differently, for instance with a rectangular side view (Fig. 1). For two or more adjoining sections, one fan may possibly be sufficient, while, preferably, control means such as valves are included for controlling the feed of a gas-air mixture to each of the burners connected to the fan in question. Moreover, the burners may be of a different type, possibly integrated in the modules. The modules may be manufactured in a manner entirely or partly different from casting, for instance when non-withdrawable parts are to be included.

These and many comparable adjustments are understood to fall within the framework of the invention.

Claims

1. A sectional heating boiler comprising a series of heating sections, each comprising at least a water duct part and heat-exchange elements, wherein burner means are provided for heating in each section, through heat exchange via the heat-exchange elements, water in the relevant water duct, **charac-**

terized in that the heating boiler (1,101,201) is of modular construction, wherein at least a series of sections and preferably each section is individually provided with a burner (20,120,220), a heat-exchange area (17,117,217) and flue gas discharge means, wherein control means (26) are provided for controlling, individually or batchwise, at least a part of the burners (20,120,220).

2. A heating boiler according to claim 1, characterized in that the heating boiler (1,201) comprises, in a central area thereof, a series of connected, preferably substantially identical first modules (5,205), wherein on either side of said series, a closing second module (6,206) is provided, wherein each module (5,6;205,206) comprises at least a part of a water duct (7,14;207,214), said water duct parts together forming a water circuit through at least a part of the heating boiler (1,201).

3. A heating boiler according to claim 2, characterized in that each first module (5;205) comprises a central water duct part (7;207), wherein on either side of the water duct part (7;207) a portion, preferably a half of at least a heat-exchange area (17,217) of a section extends, wherein each second module (6,206) comprises a water duct part (14,214) and, on one side thereof, a portion, preferably a half of at least a heat-exchange area (17,217) of a section, wherein the facing parts of two adjoining modules (5,6;205,206) together form at least substantially the heat-exchange area (17,217) of a section.

4. A heating boiler according to claim 3, characterized in that the heat-exchange elements comprise elements (13,213) increasing the heat-transferring surface, wherein each first module (5,205) is on two opposite sides of the water duct part (7,207) provided with series and/or rows of elements (13,213) increasing the heat-transferring surface, while each second module (6,206) is on one side of the water duct part (14,214) provided with series and/or rows of elements (13,213) increasing the heat-transferring surface, wherein the elements (13,213) increasing the heat-transferring surface preferably comprise projections and/or partitions extending approximately at right angles to the flow direction of the relevant water duct part (7,14;207,214).

5. A heating boiler according to claim 2, characterized in that each module (105,106) comprises at least the heat-exchange area (117) of a section.

6. A heating boiler according to any one of the preceding claims, characterized in that the modules (5,6;105,106;205,206) are substantially manufactured through casting from light metal, in particular aluminum or an aluminum alloy, wherein the or each water duct part (7,14;107,114;207,214) and the heat-exchange elements are cast integrally therewith.

7. A heating boiler according to any one of the preceding claims, characterized in that the burner means comprise a series of premix burners (20,120,220), wherein each burner is incorporated into a section, wherein for each burner (20,120,220) a fan (23,123,223) is provided for feeding, during use, a gas-air mixture.

8. A heating boiler according to claim 7, characterized in that the fans (23,123,223) are arranged in at least two rows (4), wherein each fan (23,123,223) is arranged in a row other than the fan (23,123,223) of an adjoining section.

9. A heating boiler according to any one of the preceding claims, characterized in that at least the heat-exchange areas (17,117,217) taper in the direction away from the burner means (20,120,220).

10. A heating boiler according to any one of the preceding claims, characterized in that the water duct parts (7,14;107,114;207,214) of the different sections connect to a feed distributing duct (9) and return distributing duct (11) extending along the sections, wherein the return distributing duct (11) is preferably located on the side of the relevant heat-exchange area (17,117,217) remote from the burner means (20,120,220).

11. A heating boiler according to any one of the preceding claims, characterized in that each section is individually provided with ignition and safety means (25,125,225) for the relevant burner means and preferably with a control member of its own.

12. A heating boiler according to any one of the preceding claims, characterized in that for each heat-exchange area (17,117,217) a check valve (32) is provided for closing a flue gas connection between the flue gas discharge means for the relevant heat-exchange area (17,117,217) and the associated fan (23,123,223).

13. A module intended for use in a heating boiler according to any one of the preceding claims.

14. A heating apparatus comprising a sectional heating boiler (1,101,201) according to any one of claims 1-12 and at least one heating circuit V.

15. A method for controlling a heating apparatus according to claim 14, wherein in the or each heating circuit the heat requirement is measured and, on the basis of the heat requirement measured, the

burners (20,120,220) of the heating boiler (1,101,201) are controlled in such a manner that for each burner (20,120,220) the optimum operation is set and the collective burners (20,120,220) meet the heat requirement, wherein the burners (20,120,220) can have an equal operation or can be set differently.

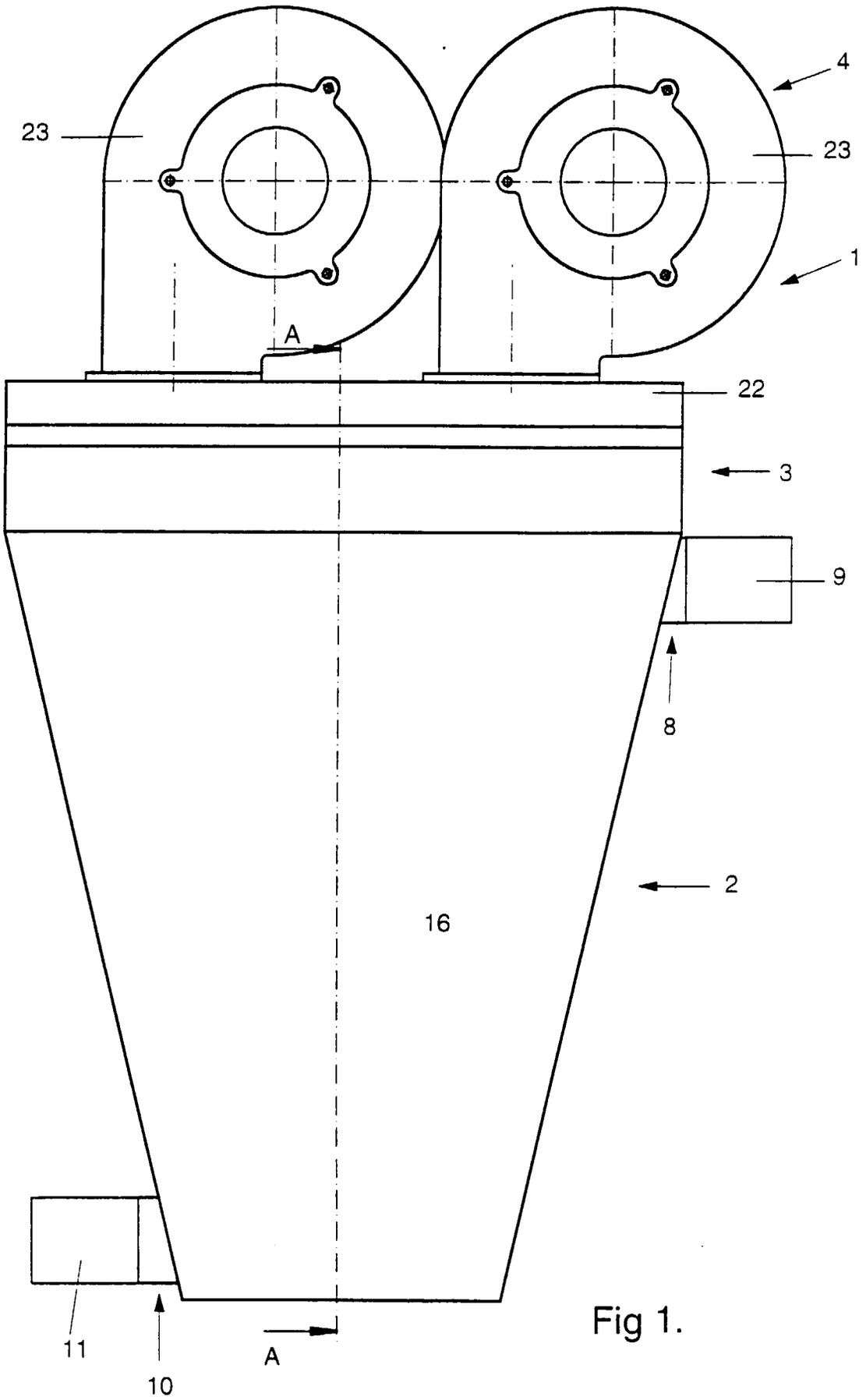

Fig 1.

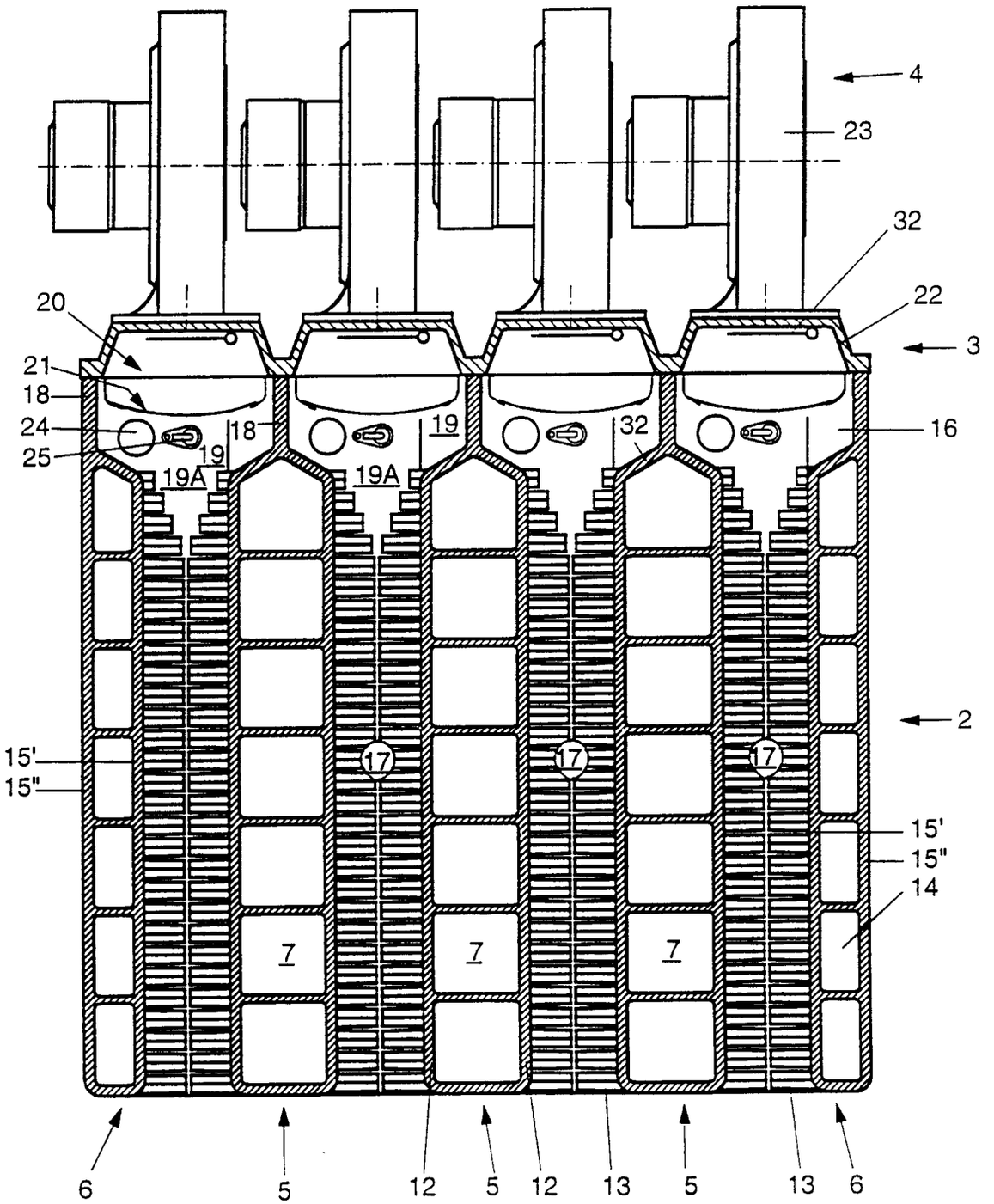
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FIG. 2

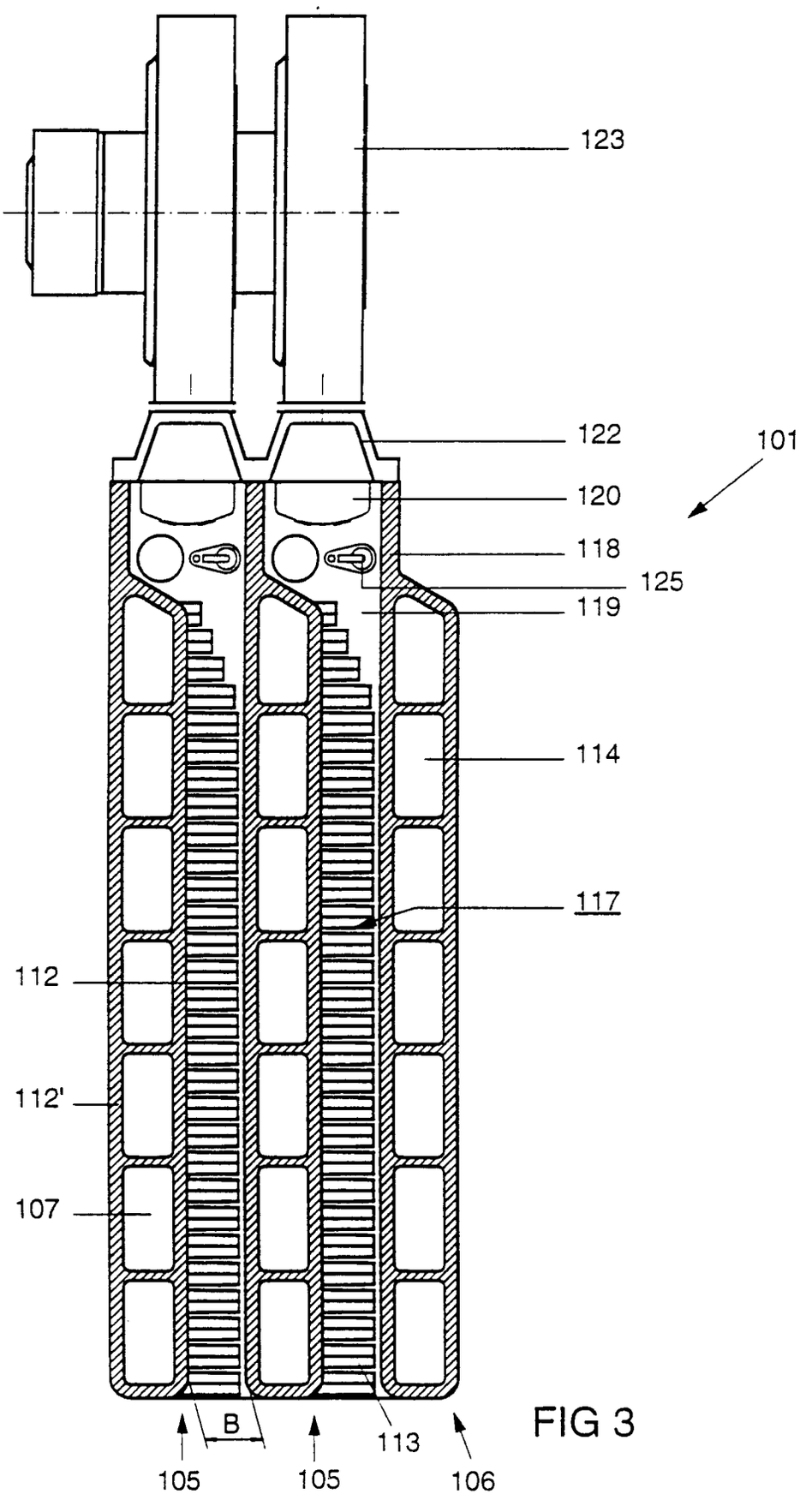

FIG 3

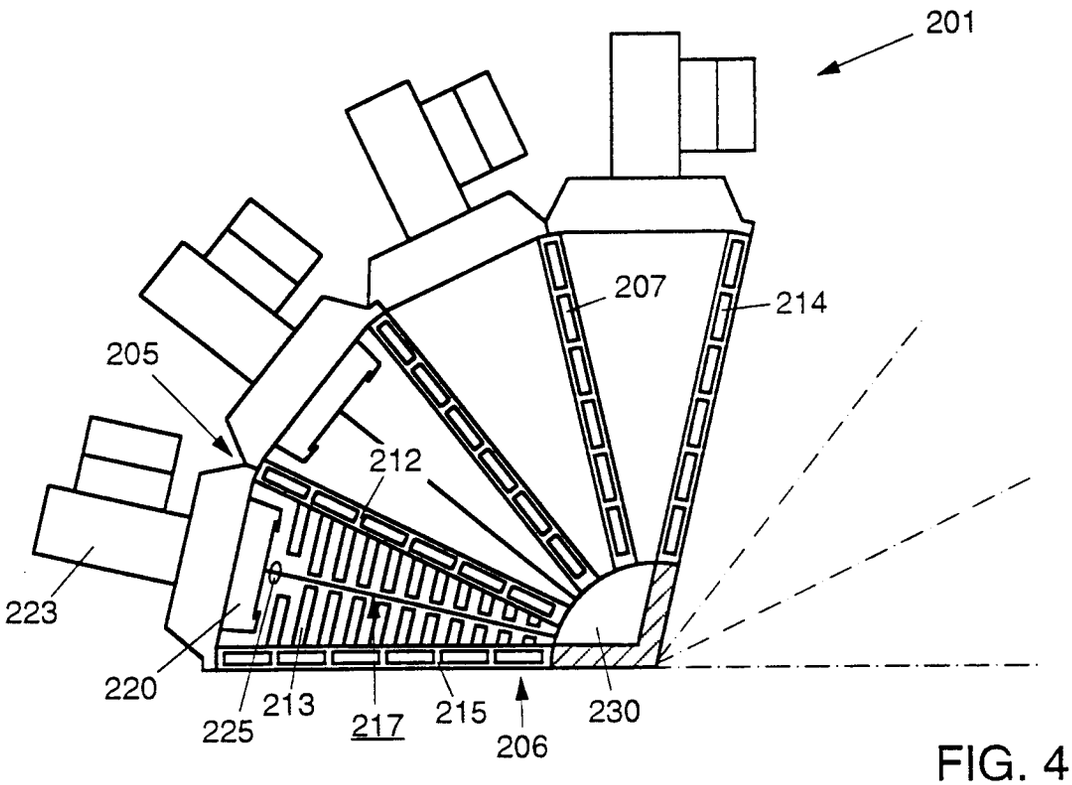

FIG. 4

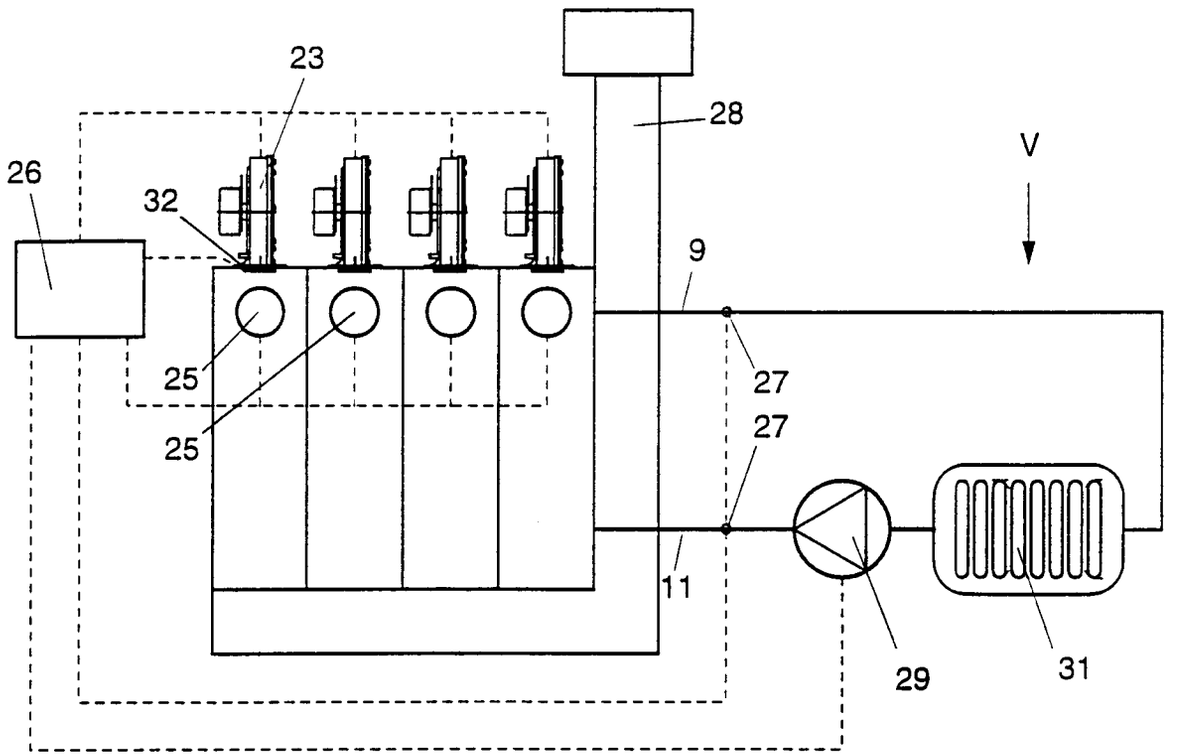

FIG. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 20 2216

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	WO 91 16576 A (ITALIAN APPLIANCES SAS DI ENRI) 31 October 1991 * abstract; figures *	1-5,12	F24H1/32
X	DE 29 48 838 A (SCHIRMER WILHELM DIPL ING) 11 June 1981 * the whole document *	1,5,10, 11,15	
A	EP 0 645 591 A (FERROLI SPA) 29 March 1995 * abstract; figures *	1-3,7	
A	GB 367 106 A (THE METROPOLITAN FUEL COMPANY LIMITED) 10 March 1932 * figure 1 *	1,9	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
F24H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 January 1998	Van Gestel, H

CATEGORY OF CITED DOCUMENTS

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