Jan. 18, 1966 R. F. MIRIGAY 3,229,672

BOILER AND A BOILER ELEMENT WITH COMBUSTION UNDER PRESSURE

Filed Dec. 15, 1961 3 Sheets-Sheet 1

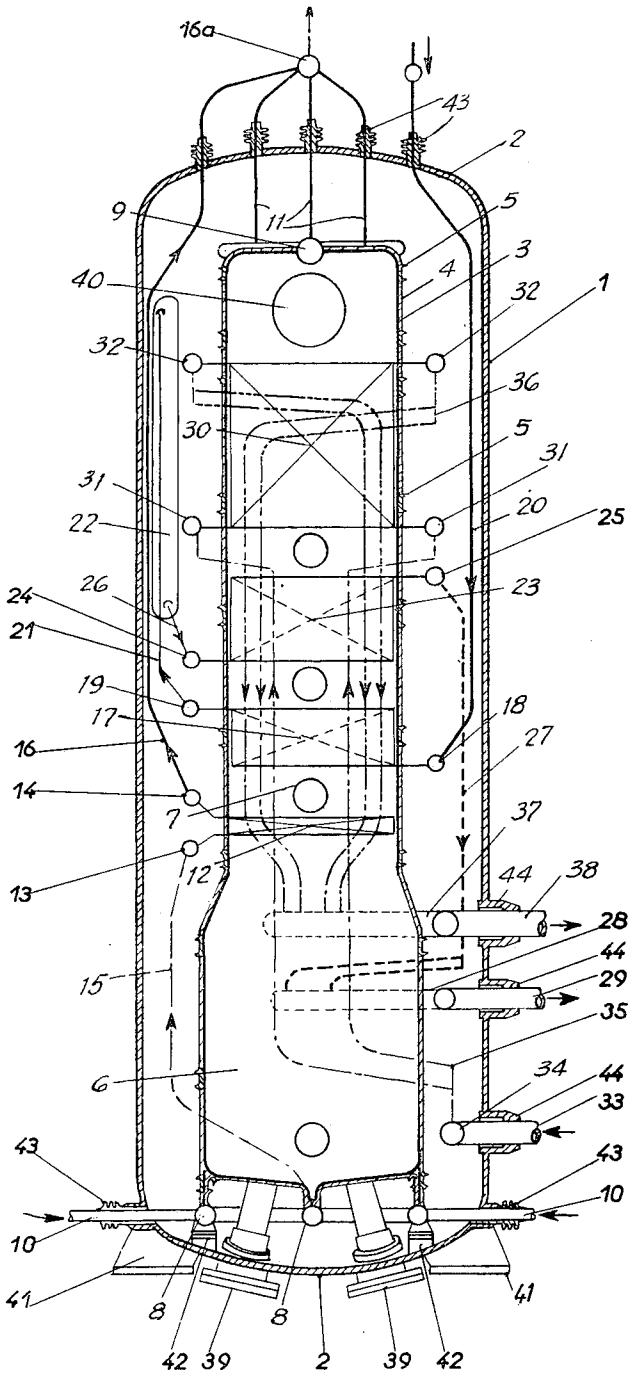

Fig. 1

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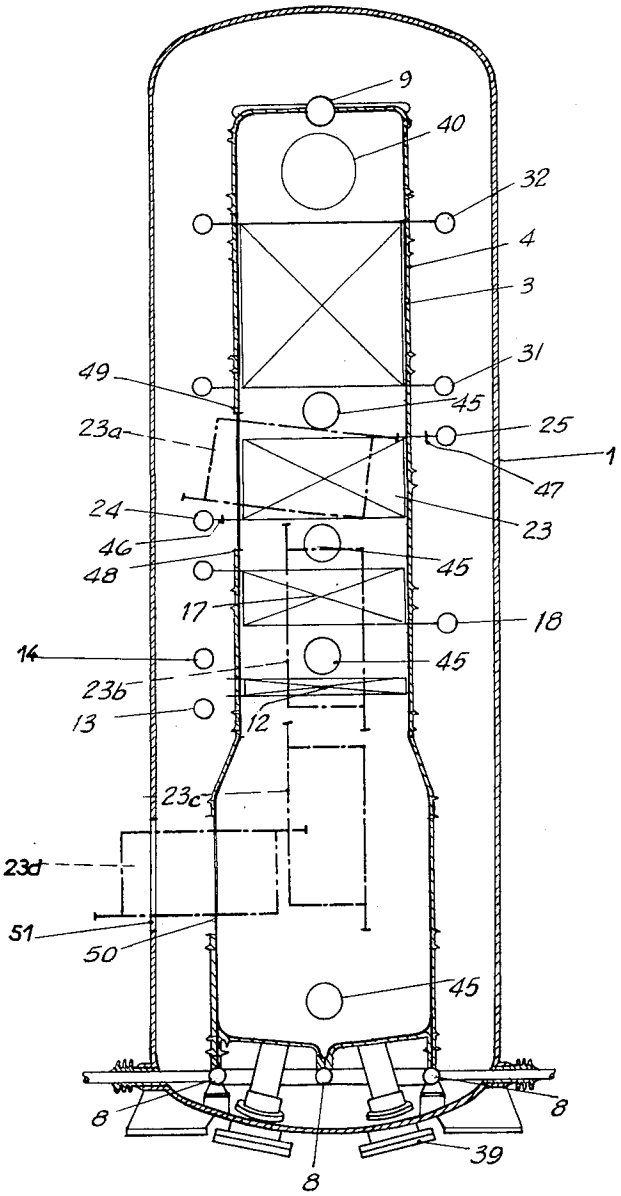
Fig.:2



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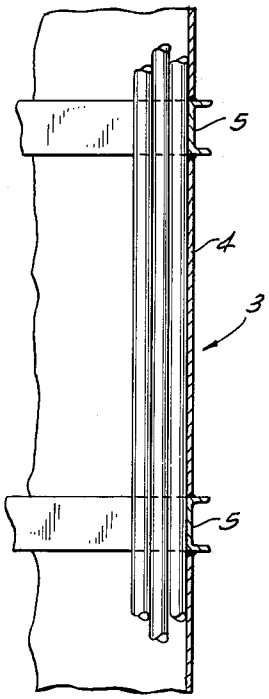

FIG. 3

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BOILER AND A BOILER ELEMENT WITH COMBUSTION UNDER PRESSURE

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12 Claims. (Cl. 122—510)

The present invention relates to an element of a boiler with combustion under pressure, and also to boilers constituted by one or a plurality of such elements.

The element according to the invention comprises an outer vertical cylindrical body which is pressure-resisting, and an inner body constituted by contiguous vaporizing tubes.

According to a particular feature of the invention, the exchangers such as vaporizers, superheaters, resuperheaters, etc., are carried by the walls of the inner body and are coupled to supply and waste collectors located in the space comprised between the outer and inner bodies.

This arrangement makes it possible in particular to put the exchangers in the order which is considered preferable, and especially to produce parallel flow of the medium passing through the exchangers and the combustion gases, which enables the temperature of the tubes to be reduced, and, in consequence, less highly-alloyed steels to be adopted, or for a steel of given quality, higher steam temperatures to be employed.

According to a further feature of the invention, the first exchanger through which pass the combustion gases is a steam generator working by convection, which enables the radiation vaporizer to be reduced to a minimum. This method of construction is very advantageous, since the coefficients of exchange by convection are increased by reason of the pressure of the gases and since the volume necessary for the installation of a convection exchanger is very much smaller than that required for a radiation exchanger having the same surface area.

In addition, a boiler element according to the invention has appreciable advantages in connection with the inspection, cleaning and maintenance of the parts which constitute this element.

Further particular features and advantages of the invention will become clear during the course of the description which follows below, reference being made to the accompanying drawings, given by way of example and without any implied limitation, and in which:

FIG. 1 is a very diagrammatic view in vertical section of an element of a boiler with combustion under pressure in accordance with the invention;

FIG. 2 is a similar simplified view, showing particularly the dismantling and removal of a member of the boiler element; and

FIG. 3 is a partly sectioned elevational view showing part of the inner body of the embodiment of FIG. 1 on an enlarged scale.

The element of a boiler with combustion under pressure according to the invention comprises an outer vertical cylindrical body **1** terminated by substantially elliptical ends **2** which are pressure-resisting, and an inner body **3**.

The inner body **3** is constituted by contiguous steam-generating tubes, generally of small diameter, comprised for example between 25 and 50 mm. This body is completely closed with the exception of certain openings which will be referred to later and which are produced by widening out the layer of tubes. The fluid-tightness of the inner body **3** is completed by a protective casing **4** rigidly fixed to the tubes through the intermediary of rings **5** welded to the tubes (see FIG. 3). The metal

casing **4** is substantially at the same temperature as the tubes and expands with them. The space between the two bodies **1** and **3** is swept by the air supplying the burners which will be referred to later, and the rings **5** ensure the stiffening of the inner body **3** so that the latter resists the slight difference in pressure applied on the two faces and arising from the pressure losses of the burners and the exchangers. The general shape of the inner body is cylindrical in the lower portion **6** working by radiation and reserved for the combustion, and prismatic with a square section in the upper portion **7** in which are housed the convection exchangers.

The tubes forming the inner body **3** are supplied by a system of collectors **8** and have their outlet at the upper portion through a system of collectors **9**. The collectors **8** are supplied with water by conduits **10** and the outlet of the water-steam emulsion towards the separator-reservoir (not shown) from the collectors **9** is ensured by the conduits **11**.

The convection exchangers are constituted by horizontal coils, so that the path of the combustion gases is perpendicular to the axis of the tubes, thereby ensuring a high coefficient of exchange. The form of construction of the exchangers according to the invention makes it possible to arrange them in the most suitable order and, in particular to produce, if so desired, exchangers through which the medium flows in the same direction as the combustion gases flowing about the exchangers, in which the steam outlet is located in the cooler gases. By this means, it is possible to reduce the temperature of the metal of the tubes and to use less highly-alloyed steels for their construction, or to use higher temperatures for a steel of given quality.

The exchangers are carried by the walls of the inner body **3** and are connected to inlet and outlet collectors located in the space formed betwen the two bodies **1** and **3**.

By way of indication, the boiler element of FIG. 1 comprises the following exchangers, encountered successfully by the gases moving upwards inside the element:

A vaporizer **12** with its inlet collector **13** and its outlet collector **14**. The inlet collector is supplied with water by pipes coupled to the collector **8**, and the water-steam emulsion passes out in the pipes **16** coupled to a conduit **16***a* leading to the separator-reservoir (not shown) and into which the pipes **11** deliver.

A low-temperature superheater **17** with its inlet collector **18** and its outlet collector **19**. The inlet collector **18** is supplied with saturated steam by the pipes **20**, and the steam at the outlet of this exchanger is directed by the pipes **21** to a de-superheater by injection of water, constituted by a vertical body **22** located between the inner body **3** and the outer body **1**.

A high-temperature superheater **23** with its inlet collector **24** and its outlet collector **25**. The inlet collector **24** is supplied from the de-superheater **22** by pipes **26**, and the outlet of the steam is effected through the pipes **27** terminating in a header **28** coupled to a steam turbine (not shown) by a conduit system **29**.

A re-superheater **30** with two inlet collector **31** and two outlet collectors **32**. The supply from a coupling piping system **33** to the steam turbine is ensured by a header **34** and the conduits **35**, terminating in the inlet collector **31**. In the same way, the discharge of the steam is effected from the outlet collectors **32** through the pipes **36**, a header **37** and the outgoing conduit system **38**.

One of the particular features of the invention resides in the fact that, as the first exchanger traversed by the exhaust gases, there is installed a vaporizer working by convection. This installation makes it possible to reduce the vaporizing exchanger working by radiation in the zone **6** to the minimum compatible with the de-

velopment of the flames and to produce the additional vaporization necessary by convection. This replacement is advantageous since the coefficients of exchange by convection are considerably increased by reason of the pressure of the gases, while the coefficients of exchange by radiation are increased only to a definitely less extent, and furthermore, the volume necessary for the installation of a convection exchanger is much smaller than that which is required for the installation of a radiation exchanger having the same surface area. Finally, the presence of the convection vaporizer **12** makes it possible to prevent the tubes of the first superheater **17** from being subjected to the very intense radiation coming from the combustion chamber **6** and which would be liable to adversely affect their behaviour.

The arrangement forming the object of the present invention makes it possible to choose, for the passage through the outer body **1** by the connection pipes **29** to the turbine for the superheated steam, **33** for the steam to be re-superheated and **38** for the re-superheated steam, points for which there is little or no relative movement between the piping system and the outer body **1**, taking account of the expansions of the outer body **1**, the inner body **3**, and the coupling piping systems **27**, **35** and **36**. However, the outline of these coupling pipes is chosen so as to give them a certain flexibility in order to obviate differences in expansion which could exist, especially during the starting-up periods.

The burners **39** are installed in the extremity **2** of the outer body **1**. The outlet of the gases to a gas turbine (not shown) is located at **40** in the upper portion of the body **1**.

The outer body **1** is self-supporting and is mounted at its lower portion on feet **41**. The whole of the elements (similar to that of FIG. 1) forming a boiler, can support, through the intermediary of the outer body **1**, the separator-reservoir for the water-steam emulsion, together with all the accessories such as the circulating pumps. In this way, it is possible to avoid the construction of a special structure.

The inner body **3** supports the exchangers, as has been indicated above, and rests on the lower portion of the outer body **1** through the intermediary of the support **42**. Thus, there are no relative vertical movements between the inner body and the outer body at the level of the burner **39**, which facilitates their installation.

The fluid-tightness of the passages through the outer body of the various piping systems is effected either by expansion bellows **43**, when the pipes have a relative displacement with respect to this body by reason of expansion, or by transition sleeves **44** when the pipes can be considered as fixed with respect to the body, such as is the case for example, for the piping systems **29**, **33** and **38**.

In addition to the advantages referred to during the foregoing description, the boiler element according to the invention has substantial advantages in connection with the inspection, cleaning and maintenance of all the portions of which that element is constituted (see FIG. 2).

In the first place, there exists sufficient room to permit the circulation between the outer body **1** and the inner body **3**, the inspection and maintenance of the protective casing **4** providing the fluid-tight sealing of the inner body.

Access to the inner body **3** can be obtained through the outlet **40** of the combustion gases and by doors **45** arranged in the inner body, for example in the cylindrical portion **6** and between the levels occupied by the exchangers **12**, **17**, **23** and **30**, for the cleaning and inspection of the combustion chamber and of the various exchangers. It should be observed that the dividing up of the exchangers into sections of small height facilitates this cleaning work. It also permits the installation in the spaces between two successive exchangers, of soot blowers for the automatic cleaning of the installation during working.

It is also possible to cut and to replace without difficulty any portion of the evaporator tubes constituting the inner body **3**. In this case, access is available from both sides in order to carry out the welding of the tubes, since it is possible to circulate between the two bodies and that furthermore access is available to the interior of the inner body by the various doors **45**. Access to the coupling welds of the tubes on the collectors **9** is possible under the same conditions. Access to the welds coupling to the collectors **8** is also possible from both sides, since it is possible to pass into the portion located between the ends of the two bodies **1** and **3**, after having taken down one of the burners **39**, when so required.

The dismantling and replacement of any exchanger element can be carried out without difficulty. By way of example, there has been shown in chain-dotted lines in FIG. 2 the sequence of operations for the dismantling of a high-temperature superheater element **23**. These operations are as follows:

Breaking the connections **46** and **47** of the element **23** to the collectors **24** and **25**;

When so required, breaking at **48** and **49** of one or two tubes of the vaporizer in order to facilitate handling of the element and bringing it into the position **23***a*, represented in chain-dotted lines;

Lowering the element thus removed inside the combustion chamber through the low-temperature superheater **17** and the vaporizer **12**. The element successively takes up the positions **23***b* and **23***c*. These elements are of course spaced apart expressly so as to permit this passage.

Removal of the element at **23***d* through a rectangular opening **50** of small width, provided for that purpose in the inner body **3**, in the zone **6** of the combustion chamber, and then through a corresponding door **51** in the outer body **1**.

The re-erection of the replacement elements is effected exactly by the reverse process. It should be observed that the welds **39** and **48** of the vaporizer tubes which may eventually be taken down, can be carried out without difficulty since access is available to both sides of the layer of tubes. In the same way, the couplings to the collectors **24** and **25** of the sleeves **46** and **47** are readily effected as a result of access being also available on both sides of the welds.

What I claim is:

1. A structural element for a boiler with combustion under pressure comprising, in combination, a pressure-resistant vertical cylindrical outer body having a first opening transversely of its direction of elongation; an inner body formed by contiguous vaporizing tubes and a metal casing fixed to said tubes, said metal casing and said tubes thereby forming a fluid-tight inner body, said inner body being located in said outer body with the complete outer surface of the inner body being spaced from the inner surface of the outer body, said inner body being formed with a second opening transversely of its direction of elongation and aligned with said first opening, said surfaces defining between themselves a free space for the passage of combustion air therethrough; a heat exchanger structure having an opening and arranged in said inner body and extending in substantially horizontal direction; and a plurality of vertically superposed releasably connected heat exchange elements located also within said inner body, said heat exchange elements being so dimensioned as to be extractable first in vertical direction through said opening on said heat exchanger structure and then in substantially horizontal direction through said first and second openings, whereby servicing and repair of said heat exchange elements are facilitated.

2. An element as defined in claim **1** wherein said inner body is of cylindrical cross-section in the lower zone of said boiler element, and of prismatic cross-section in the upper zone of said boiler element.

3. An element as defined in claim 1 wherein said heat exchanger elements are convection exchangers.

4. An element as defined in claim 3 wherein said convection exchangers comprise substantially horizontal coils traversed perpendicularly by combustion gases.

5. An element as claimed in claim 4, in which the first convection exchanger in the direction of travel of the gases is a vaporizer exchanger.

6. An element as claimed in claim 4, in which each of said exchangers is a parallel flow exchanger, so that the stream outlet is located in the zone of the coolest gases.

7. An element as claimed in claim 5, comprising vaporizer exchanger, at least one low-temperature superheater, a high-temperature superheater, and a re-superheater respectively arranged downstream of said vaporizer exchangers.

8. An element as claimed in claim 7, comprising a desuperheater located between said low-temperature superheater and said high-temperature superheater, and installed in said space formed between the inner body and the outer body.

9. An element as claimed in claim 1, in which said spaced formed between the outer body and the inner body is sufficient to ensure the inspection and maintenance of said inner body together with said exchangers, the inner body and outer body being accessible through said first and second openings.

10. An element as claimed in claim 1, in which the outer body is closed at its upper portion by an upper end and at its lower portion by a lower end, and in which the inner body rests on said lower end of the outer body.

11. An element as claimed in claim 10, and further comprising burners installed in said lower end of the outer body.

12. An element as defined in claim 1 wherein the releasable connection for said exchange elements are located in said space between said inner and outer bodies.

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