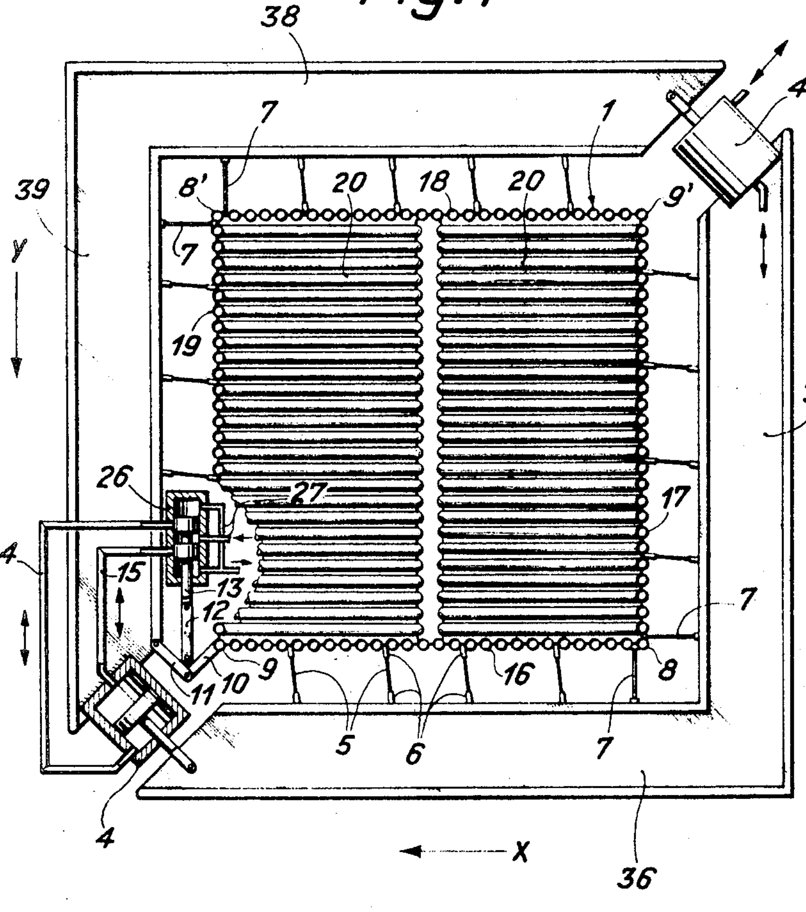
Fig. 1



Inventor:
ALFRED BRUNNER

BY

Kenyon & Kenyon
ATTORNEYS

Fig. 2

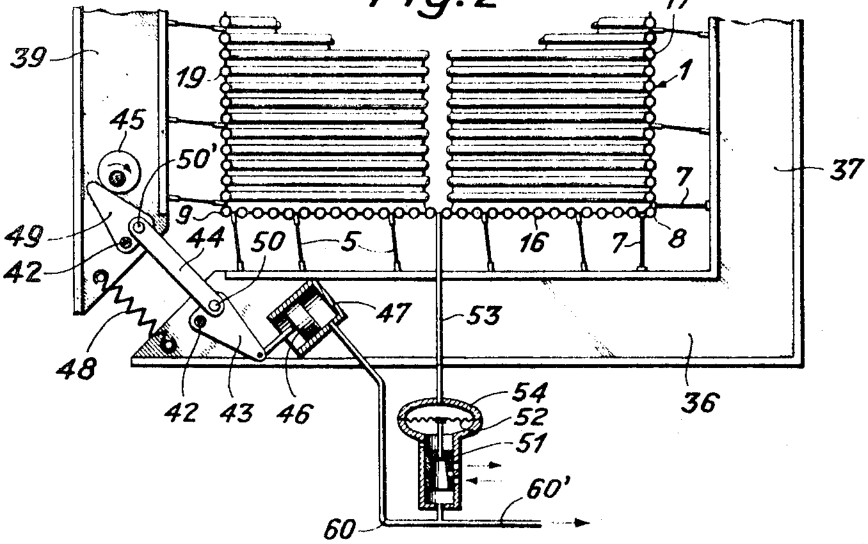


Fig. 3

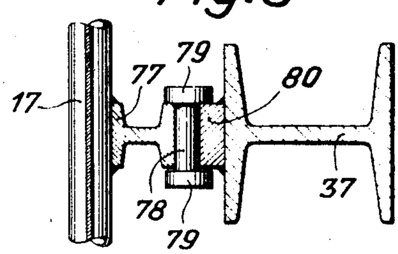
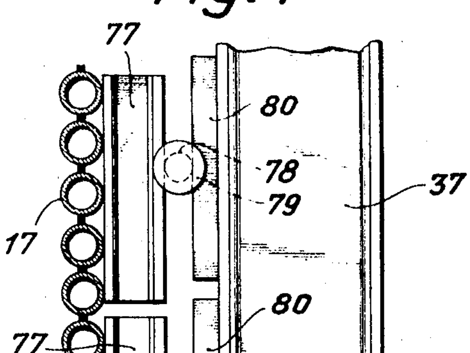


Fig. 4



Inventor:
ALFRED BRUNNER
BY
Kenyon & Kenyon
ATTORNEYS

United States Patent Office

3,467,068

Patented Sept. 16, 1969

3,467,068

COMBUSTION CHAMBERS OF ANGULAR CROSS-SECTION FOR STEAM-RAISING PLANTS

Alfred Brunner, Winterthur, Switzerland, assignor to Sulzer Brothers, Ltd., Winterthur, Switzerland, a corporation of Switzerland

Filed May 7, 1968, Ser. No. 727,312
Claims priority, application Switzerland, May 11, 1967, 6,691/67
Int. Cl. F22b *37/24*
U.S. Cl. 122—510 10 Claims

ABSTRACT OF THE DISCLOSURE

The girders bounding the tubes of the combustion chamber are allowed to move under the influence of thermal expansion of the tubes while being maintained at a fixed spacing relative to the tubes. The tensile stress imparted to the girders is thus held at a minimum. Various connections are disclosed for connecting the surrounding girders to each other.

This invention relates to a combustion chamber of angular cross-section for steam-raising plants. More particularly, this invention relates to a combustion chamber which is bounded by gas-tight tube banks and surrounded by flanged girders.

Generally, steam-raising plants of the type which are constructed with gas-tight tube banks and surrounding flanged girders distributed over the length of the tube banks to prevent dishing have had the girders of each cross-sectional plane resiliently joined together on at least two corners of the combustion chamber to form a belt. Heretofore, these resilient joints have utilized hydraulic damping elements to interconnect the girders in order to prevent sudden stresses on the tube banks should a gas discharge occur in the combustion chamber. In addition, the flanged girders have been directly connected to the tube banks.

However, these systems have the disadvantage that the tube banks become severely stressed in tension in the presence of a continuous positive pressure acting in the circumferential direction of the combustion chamber, a feature which is particularly detrimental if the tubes extend transversely to the flanged girders. In order to overcome this, belt ties have been connected to the tube banks so as to be thermally conducting and, at the ends, to the flanged girders supporting the adjacent tube banks. However, the provision of such belt ties has been detrimental because, in the event of rapid temperature fluctuations of the kind which can occur during starting up or restarting of the steam-raising plant, the belt ties have temperatures different from those of the tube banks. This results in differential expansion between the belt ties and tube banks and leads to additional stresses which can, in turn, result in deformation of the tube banks.

Accordingly, it is an object of the invention to maintain the tensile stress in the circumferential direction of a combustion chamber at a minimum.

It is another object of the invention to maintain the tensile stresses in the girders surrounding the gas-tight tube banks of a combustion chamber at a minimum during starting and restarting of the steam-raising plant.

It is another object of the invention to absorb the internal pressure of the combustion chamber in adjusting means resiliently connecting the girders of the combustion chamber together.

It is another object of the invention to vary the circumference of the girders to the same extent as the variation

due to thermal expansion of the circumference of the tube banks of the combustion chamber.

Briefly, the invention provides a combustion chamber for a steam-raising plant which is bounded by gas-tight tube banks and surrounded by belts of flanged girders with adjusting means which resiliently join the girders together and which absorb the internal pressure of the combustion chamber. The adjusting means are controlled in a manner such that the circumference of the belts always vary to the same extent as the variation due to thermal expansion of the circumference of the tube bank.

In one embodiment, the adjusting means resiliently connecting two adjacent girders is controlled by a control element which is actuated by a measuring element biased by the relative distance between the combustion chamber tube bank and the flanged girder. The regulation is therefore applied to the distance between one combustion chamber corner adjacent the resilient joint and a pair of girders.

In another embodiment, the adjusting means resiliently connecting two adjacent girders is controlled by a control element which is actuated by a pressure measuring element. This element is connected into the combustion chamber to react to an internal pressure higher than atmospheric in the combustion chamber so as to actuate the control element for regulation of the adjusting means. In this embodiment, the force exerted by the adjusting means upon the flanged girders is directly proportional to the positive pressure in the combustion chamber.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates a horizontal section through a vertically disposed combustion chamber of a steam-raising plant according to the invention;

FIG. 2 illustrates a fragmentary view similar to FIG. 1 of a modified adjusting means and control element of the invention;

FIG. 3 illustrates a cross-sectional view of FIG. 4 of a modified support for a tube bank on a flanged girder; and

FIG. 4 illustrates a plan view of the modified support of FIG. 3.

Referring to FIG. 1, the steam-raising plant combustion chamber **1** is bounded by four vertical tube banks **16, 17, 18, 19** and by a tube bank **20** forming a floor. The tube bank **20** is provided with a gap in the middle so that slag can be withdrawn from within the combustion chamber **1**. The tubes of the tube banks **16–19** and the tubes of the tube floor **20** are joined to each other in gas-tight manner, for example, by means of webs welded between the tubes. Alternatively, the tube banks can be rendered gas-tight by the direct welding together of adjacent tubes or by the welding together of finned tubes, or by means of a plate or sheet metal skin disposed to bear externally directly upon the tubes. This latter system is known as skin-casing construction.

The combustion chamber **1** is surrounded by belts formed by four flanged girders **36, 37, 38, 39** of H-section at various levels. Each pair of girders **36, 37** and **38, 39** respectively disposed rectangularly to each other are permanently joined, for example, by welding, to form a right angle. In addition, the pairs of joined girders are resiliently joined to each other at diagonally disposed corners of the combustion chamber by adjusting means, such as, hydraulic servomotors **4, 4'** mounted between the free ends of the girders. The tube banks **16–19** are connected by struts **5** to the internal flange of the flanged girders **36–39**. Each of these struts **5** are movably supported at the ends in cups **6** which are mounted on the tube banks and flanged girders. A pair of struts **7** are also provided between the tube banks and girders at the diagonally opposite combustion chamber corners **8**, **8'** adjacent the respective joints of the flanged girders **36**, **37** and **38**, **39**. These struts **7** are disposed rectangularly to each other and are permanently joined to the tube banks and internal flange of the girders in fixed relation so that the corners **8**, **8'** of the combustion chamber **1** are retained relative to the associated adjacent girders while at the tube banks adjoining the corners **8**, **8'** are permitted to expand in parallel relation to the adacent girder.

Each hydraulic servomotor **4**, **4'** is controlled by a control element, e.g. a control valve **26**, mounted within girder **39**, to adust to the expansion or contraction of the combustion chamber tube banks **16–19**. The control valve **26** is actuated by a measuring element formed by a lever **10** which is pivotally mounted at one end on a corner **9**, **9'** of the combustion chamber tube banks and at the opposite end to a lever **12** secured to a piston **13** of the control valve **26**, and a lever **11** pivotally mounted at one end to the end of the girder **39** opposite the corner **9** and at the other end to the lever **12** at the same point as lever **10**. The levers **10**, **11** are of equal length and are disposed at right angles to each other. The control valve **26** communicates via pressure medium ducts **14** and **15** with the two cylinder chambers of the servomotors **4** whose cylinder is fixedly mounted on the end of the flanged girder **39** while the piston rod of the servomotor **4** is pivotally mounted on the end of the other flanged girder **36**. The servomotor piston axis extending through the aforementioned pivoting point is disposed in parallel to the diagonal extending to the combustion chamber corners **8** and **8'**.

The control valve **26** is also connected via a duct system **27** to a pressure medium source (not shown) for the supply and discharge of pressure medium. The levers **10**, **11**, **12** are so dimensioned that any movement of a unit of length in the X or Y direction of the tube banks **16** and **19** which adjoin at the corner **9** is accompanied by a displacement of equal magnitude of the control valve piston **13** such that, in the event of a thermal expansion of the tube banks, the servomotor **4** automatically increases the circumference of the belt formed by the flanged girders **36–39**. This increase is such that the distance between the corner **9** and the girders **36**, **39** remains constant. During thermal expansion of corner **9**, the control valve piston **13** moves downwardly as viewed in FIG. 1 whereupon the inflowing pressure medium from the duct system **27** acts via pipeline **15** upon the servomotor piston to move the piston downwardly to the right, as viewed, until the initial position of the corner **9** relative to the girders **36**, **39** is restored.

Similarly, the servomotor **4'** at the opposite corner **9'** of the combustion chamber **1** is actuated by a control valve corresponding to the control valve **26** and therefore need not be further described.

The girders which surround the combustion chamber **1** at the various levels along the height of the combustion chamber **1** are distributed in a manner to provide a good support for the tube banks over the entire height of the combustion chamber **1**. Since there is usually a slow change of temperature in the combustion chamber with a corresponding small rate of expansion, the servomotors **4**, **4'** operate very accurately. This method of operation is practically a regulation with the distance of the corners **9**, **9'** from the respective pairs of girders **36**, **39** and **37**, **38** representing the controlled condition. In this regard, the deviation associated with slight flexure of the tube banks can be neglected.

Referring to FIG. 2, wherein like numerals refer to like components above, the adjusting means resiliently connecting the girders **36**, **39** can utilize a hydraulic servomotor **47** which indirectly joins the ends of the flanged girders **36**, **39** via a lever transmission including a linkage **43** and a lever **44** and which is actuated under the influence of the pressure prevailing in the combustion chamber **1**. The cylinder of the servomotor **47** is mounted on the flanged girder **36** while the servomotor piston **46** is pivoted on one arm of a two-armed lever **43** pivotally mounted about a fulcrum **42** on the girder **36**. An identical lever **49** is provided on the other girder **39** and has an arm bearing upon an eccentric **45** rotatably journalled in the girder **39**. The remaining arms of the levers **43**, **49** are joined to each other at pivot points **50**, **50'** by a link **44**, the pivot points being disposed such that the link **44** is parallel to the diagonal extending through the combustion chamber corners **8**, **8'**. A tension spring **48** is also connected between and to the ends of the girders **36**, **39** to urge these girders towards each other. A similar adjusting means (not shown) is provided at the diagonally opposed corner of the combustion chamber to the corner **9** and therefore need not be further described.

A pressure measuring element, e.g. a diaphragm cell **54**, is provided which communicates on one side via a pipeline **53** with the interior of the combustion chamber **1** while the other side below the diaphragm **52** communicates with the atmosphere. A control element, e.g. a bell **51**, is connected to the diaphragm **52** and slidably mounted in a cylinder extending from the cell **54** in order to control the supply and discharge of a pressure medium from a source (not shown). A pipeline **60** is connected to the cylinder of the cell **54** below the bell **51**, as viewed, and extends to the servomotor **47** to transfer the pressure medium to and from the servomotor cylinder. A pipeline **60'** is connected in parallel with pipeline **60** and communicates with the servomotor at the diagonally opposite corner of the combustion chamber for similar purposes. Also, pipelines can be branched off the pipeline **60**, **60'** to connect the corresponding servomotors in the other levels of girders.

In operation, should the tube banks **16** and **19** expand, the forces exerted via the struts **5** upon the flanged girders **36** and **39** become larger so that the pressure in the servomotor **47** also becomes larger. As a consequence, the control bell **51** moves upwardly, as viewed in FIG. 2, to allow pressure medium to escape via the cylinder surrounding the bell **51**. This is accompanied by an increase of desired extent in the circumference of the belt formed by the girders.

Also, should the combustion chamber be subjected to a pressure increase, for example, due to an increasing load of the steam-raising plant, but without an accompanying expansion of the tube banks, the pressure on the diaphragm **52** becomes greater and the bell **51** moves downwardly, as viewed. This allows pressure medium to flow inwardly so that the pressure in the pipeline **60** rises until equilibrium is restored.

The slightly prestressed springs **48** provided at the opposite corners serve to prevent the servomotors at these corners from assuming unequal positions. Thus, the gaps on opposite corners between the ends of adjacent flanged girders are always of equal magnitude.

The eccentric **45** is provided in order to impart motion to the system by a continued slow rotation of the eccentric, for example, by means of an electrically driven motor (not shown). The disturbance thus introduced is constantly corrected by the control system so as to prevent blockage of the lever system during prolonged continuous operation.

The thermal insulation of the combustion chamber, which is not drawn in the interests of clarity, is disposed between the tube banks and the flanged girders.

In order to prevent the struts **5** from becoming excessively long in combustion chambers having large cross-sectional dimensions, it is appropriate in accordance with the invention to provide the fixed points not at the corners **8** and **8'** respectively but in the middle of each tube bank. With such a system it would, however, be necessary to provide servomotors on all four corners of the belt formed by the girders.

Referring to FIGS. 3 and 4, instead of using struts, rollers **79** can be used, for example, between the tube bank **17** and girder **37** to provide a connection. In this instance, a beam **77** is provided at each level of the girder **37** on the tube bank **17** to extend over the rolling zone of one roller. Each roller **78** is formed at the ends with annular shoulders **79** which envelop the outer flange of the beam **77** to guide the roller **78** along the beam **77**. Also, a strip **80** of a length corresponding approximately to the length of a beam **77** and of a width correspondingly approximately to the flange width of the beam **77** is welded onto the internal flange of the girder **37** to receive the roller **78** in rolling engagement. Alternatively, instead of providing a plurality of strips **80** for each tube bank, a single strip can be extended over all the beams **77** of the affected tube bank.

It is noted that while only one roller **78** has been described, that a plurality of similar rollers are used between respective beams and strips on the tube bank **17** and girder **37**.

It is also noted that screw threaded spindles with nuts which are driven by electric motors can be used as the control elements instead of the hydraulically actuated servomotors.

The invention thus provides a resilient joining of the flanged girders about the tube banks of a combustion chamber in a simple and reliable manner wherein the final control elements are actuated in a certain manner. The tube banks are further supported under all operating conditions and are able to expand without substantial tensile stresses occurring in the tube banks in the circumferential direction of the combustion chamber. At the same time, additional stresses due to severe temperature changes are avoided because the circumference is constantly adjusted to the combustion chamber circumference by virtue of the controlled adjusting means.

What is claimed is:

1. A combustion chamber of angular cross-section for a steam-raising plant comprising:

a plurality of gas-tight tube banks bounding the combustion chamber;

a plurality of belts distributed in spaced relation over the length of said tube banks, each said belt including a plurality of flanged girders surrounding said tube banks in a cross-sectional plane thereof;

an adjusting means disposed on at least two diagonally disposed corners of the combustion chamber resiliently joining said girders thereat together to absorb internal pressure from the combustion chamber; and

a control element connected to each said adjusting means for varying the circumference of said belt to the same extent of the variation of the circumference of said tube banks due to thermal expansion.

2. A combustion chamber as set forth in claim **1** wherein each said adjusting means joins to a pair of spaced adjacent girders at two points disposed on a line parallel to the diagonal extending through the two adjacent corners of the combustion chamber.

3. A combustion chamber as set forth in claim **1** wherein each said adjusting means includes a hydraulically actuated servomotor secured at opposite ends to said resiliently connected girders at each of said two corners.

4. A combustion chamber as set forth in claim **1** wherein the combustion chamber is rectangular in cross-section and wherein two pair of adjacent flanged girders are rigidly connected and disposed at right angles to each other at the remaining two diagonally disposed corners of the combustion chamber.

5. A combustion chamber as set forth in claim **1** which further includes a measuring element secured to said control element to actuate said control element in response to a relative movement between at least one of said tube banks and a flanged girder adjacent thereto.

6. A combustion chamber of rectangular cross-section as set forth in claim **5** wherein each adjusting means includes a servomotor having a piston secured to one of said resiliently joined girders and a cylinder receiving said piston secured to the other of said resiliently joined girders, wherein said control element includes a control valve connected to each said cylinder, said control valve having a piston projecting therefrom, and wherein said measuring element includes a first lever pivotally connected to one of said tube banks at one of said corners and to said control valve piston and a second lever pivotally connected to one of said girders at said one corner and to said control valve piston.

7. A combustion chamber as set forth in claim **1** which further includes a pressure measuring element secured to said control element to actuate said control element in proportional response to a pressure in the combustion chamber greater than atmospheric whereby the force exerted upon said resiliently joined girders is directly proportional to the positive pressure in the combustion chamber.

8. A combustion chamber as set forth in claim **7** wherein said adjusting means includes a servomotor mounted on one of said resiliently joined girders at one of said corners, said servomotor having a movable piston therein, and a lever transmission connected to said piston and to the ends of each of said resiliently joined girders.

9. A combustion chamber as set forth in claim **8** wherein said lever transmission includes a link povatally connected at one end to one of said girders and at the other end to a linkage having a fulcrum fixed on the other of said girders, said linkage having a lever arm pivotally connected to said link and another lever arm pivotally connected to said piston of said servomotor.

10. A combustion chamber as set forth in claim **8** wherein said lever transmission includes a two-armed lever pivotally mounted on each end of the resiliently joined girders, a link pivotally mounted on one arm of each lever, one of said levers being pivotally connected to said servomotor piston at the other arm thereof, and an eccentric bearing on the other arm of said other of said levers, said eccentric being rotatably journalled in the other of said girders for periodically pivoting said other lever.

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