July 2, 1957 W. S. PATTERSON 2,797,667

CONTROLLED CIRCULATION BOILER WITH NOVEL DUAL FURNACE

Filed Dec. 3, 1953 4 Sheets-Sheet 1

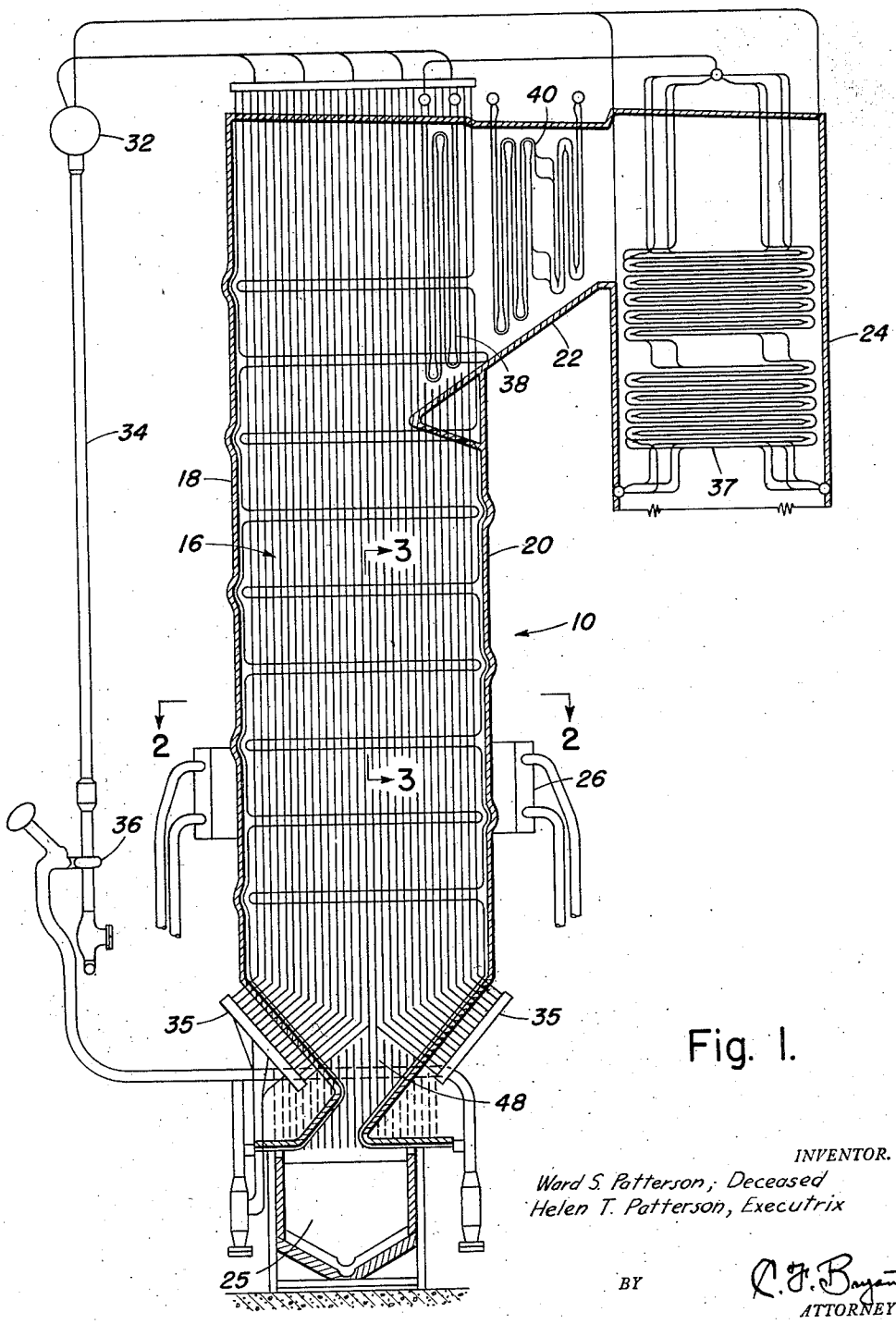


Fig. 1.

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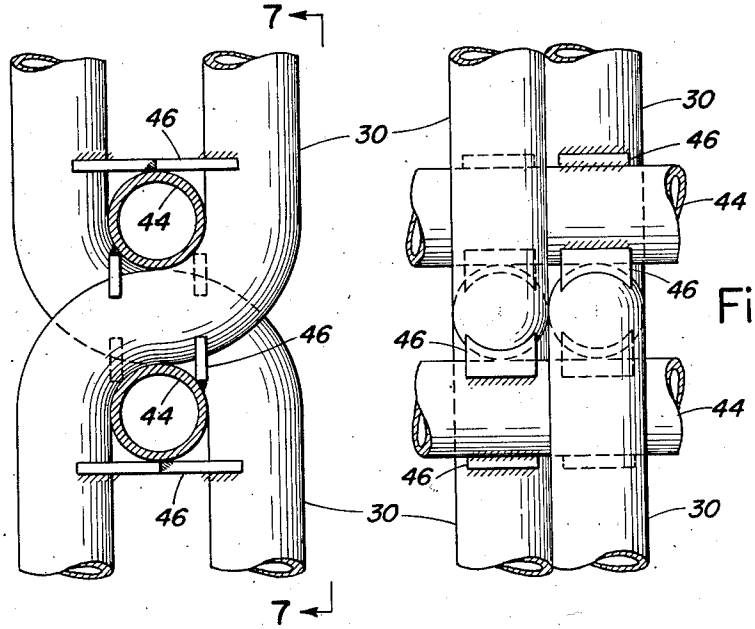


Fig. 6.

Fig. 7.

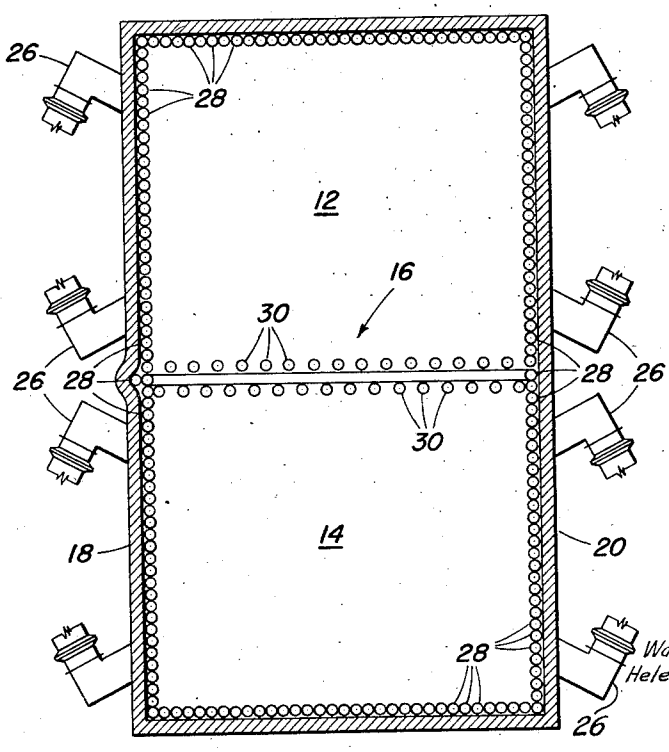


Fig. 2.

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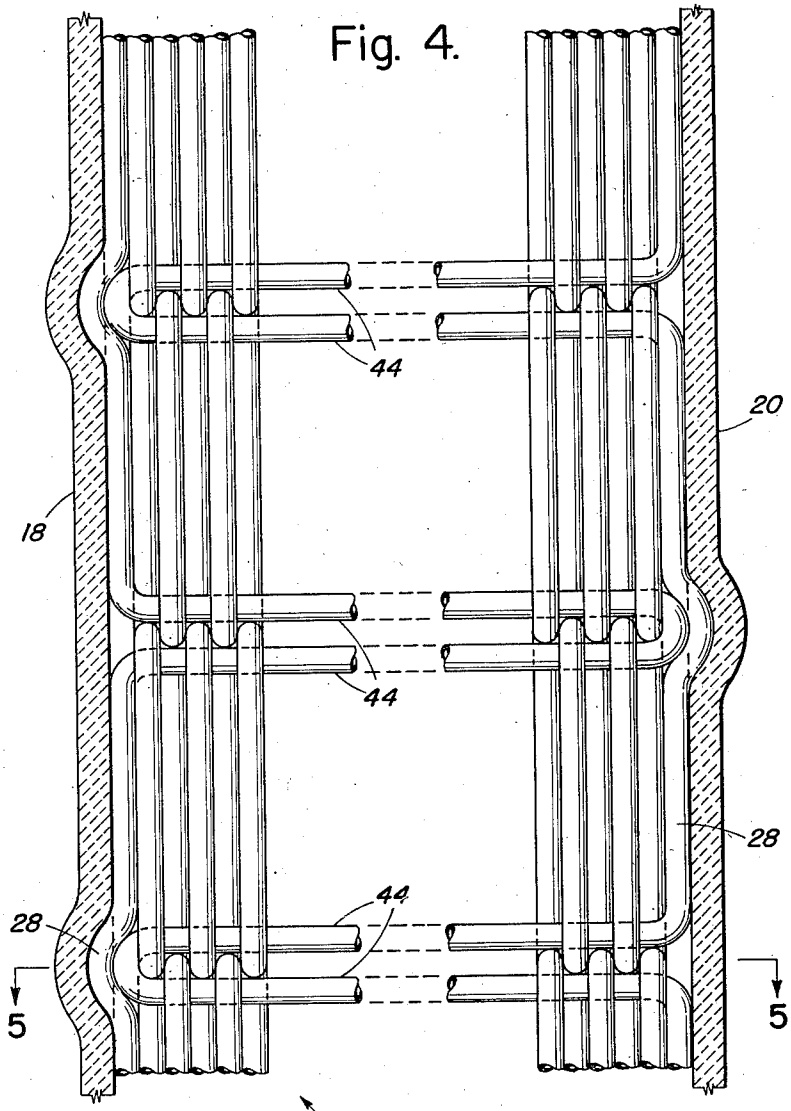
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CONTROLLED CIRCULATION BOILER WITH NOVEL DUAL FURNACE

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Fig. 4.



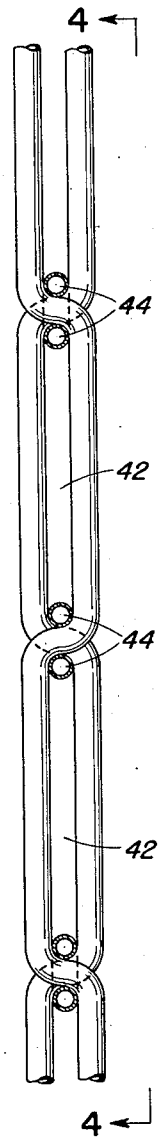


Fig. 3.

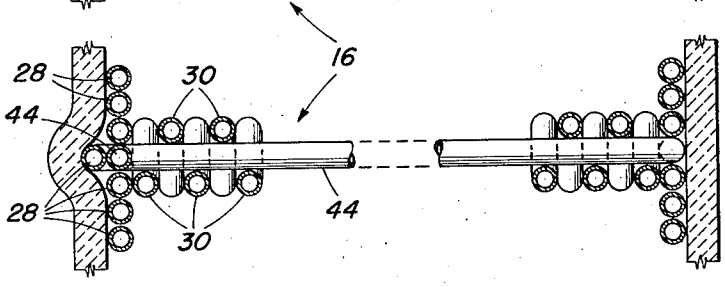


Fig. 5.

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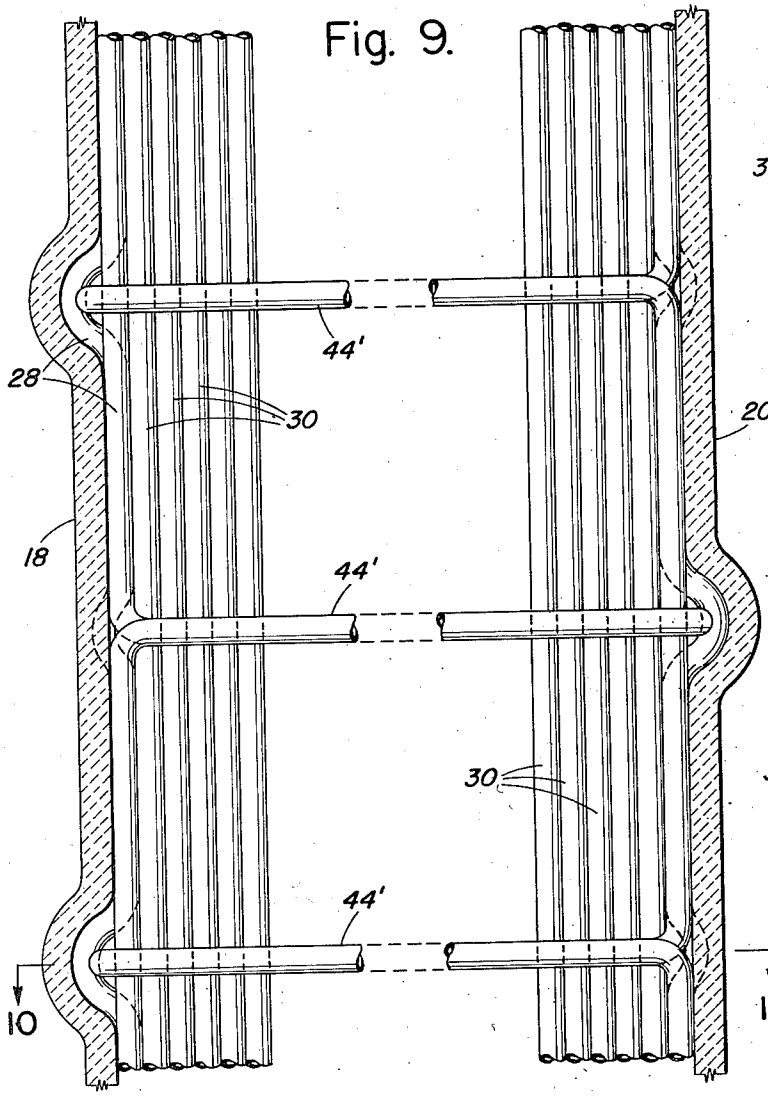
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CONTROLLED CIRCULATION BOILER WITH NOVEL DUAL FURNACE

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Fig. 9.



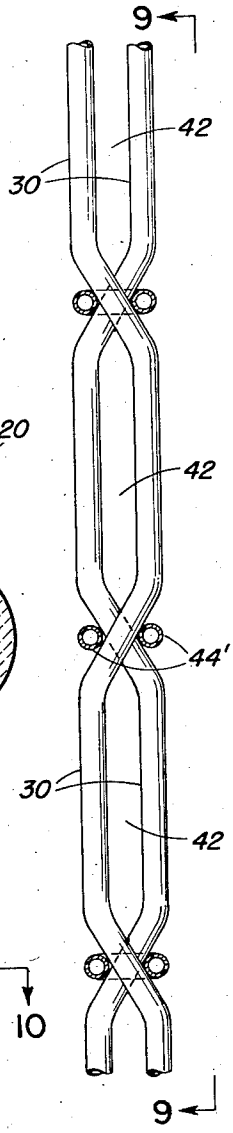


Fig. 8.

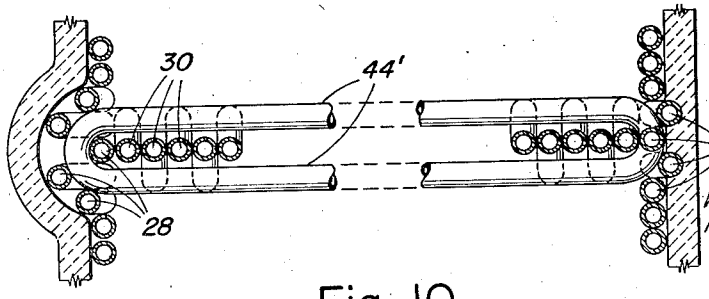


Fig. 10.

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CONTROLLED CIRCULATION BOILER WITH NOVEL DUAL FURNACE

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Application December 3, 1953, Serial No. 395,952

9 Claims. (Cl. 122—240)

This invention relates to boilers of the controlled circulation type and particularly to such a boiler provided with a dual furnace which includes a tubular division wall.

In general the invention comprises a boiler having a steam generating circuit through which there is established a positive circulation by means of a suitable pump. The furnace of the boiler is divided into two parallel compartments by means of a tubular division wall which forms a part of the steam generating circuit of the boiler. The tubes which make up this wall are of serpentine configuration throughout a major portion of their length having tube portions laterally displaced from the median plane of the wall first on one side thereof and then on the other side thereof with certain of the tubes being displaced oppositely of others thereby forming openings or passages through the wall. The tube portions which interconnect these laterally displaced tubes and extend through the median plane of the wall are in alignment across the wall at predetermined elevations and at each of these elevations a pair of stiffener tubes extend across the wall and are arranged so that the interconnecting tube portions are embraced between the tubes of each pair. These stiffener tubes are rigidly secured to the tubes of the division wall and form a part of the steam generating circuit of the boiler so that they are provided with a positive circulation. This division wall is very rigid being braced by the fluid cooled stiffener tubes and provides for pressure equalization in the two furnace compartments through the numerous openings formed in the wall.

One of the general objects of this invention is to provide an improved controlled circulation boiler of the type having a dual furnace provided with a tubular division wall.

Other and further objects of the invention will become apparent to those skilled in the art as the description proceeds.

With the aforementioned objects in view, the invention comprises an arrangement, construction and combination of the elements of the boiler in such a manner as to attain the results desired as hereinafter more particularly set forth in the following detailed description of an illustrative embodiment, said embodiment being shown by the accompanying drawing wherein:

Figure 1 is a sectional view of a large capacity boiler embodying the present invention and showing the division wall extending throughout the length of the furnace;

Figure 2 is a transverse sectional view of the furnace of this boiler taken generally along line 2—2 of Figure 1 and showing the disposition of this division wall and the location of the burners for each of the furnace compartments;

Figure 3 is a longitudinal sectional view of a portion of

the division wall of Figure 1 taken along 3—3 of Figure 1 and showing in detail the construction of this wall;

Figure 4 is an enlarged detailed view of the wall portion of Figure 3 taken generally from line 4—4 of Figure 3;

Figure 5 is a transverse sectional view of the division wall taken along line 5—5 of Figure 4;

Figure 6 is a fragmentary detail view showing the method of interconnecting the wall tubes with the stiffener tubes;

Figure 7 is a side view of the detail of Figure 6 taken from line 7—7 of Figure 6;

Figure 8 is a sectional view of a wall portion similar to that of Figure 3 but showing a modified form of construction;

Figure 9 is a side view of the wall portion of Figure 8 taken from line 9—9 of Figure 8;

Figure 10 is a transverse sectional view of the modified embodiment taken from line 10—10 of Figure 9.

In many modern boiler installations wherein water walled furnaces are employed the capacity of the boilers have become so large that it is necessary to provide the furnaces of these boilers with a division wall dividing the same into two compartments in order to maintain the ratio of protected area of wall surface of the furnace to the volume of the furnace within the limits necessary for efficient operation. Since both sides of such a division wall are exposed to the intense heat within the furnace compartments the conventional means for stiffening the wall and securing the tubes together, including structural steel members secured to and extending transversely of the tubes, cannot be used because they would quickly be destroyed by the intense heat generated within the furnace. It is therefore necessary to provide a special means for stiffening these walls in order that they will be sufficiently rigid to withstand the rough usage to which they are subjected. Moreover, since no detrimental effect can occur because of the passage of combustion gases from one of the compartments of the dual furnace to the other compartment through the division wall it is both permissible and desirable to provide openings within this wall for the equalization of pressure on both sides thereof thereby reducing or eliminating excessive stresses which would otherwise be produced in the wall because of a differential pressure existing thereacross.

The present invention contemplates a division wall for the dual furnace of a controlled circulation boiler which is both structurally rigid and provided with the openings necessary for rapid pressure equalization in the two furnace compartments.

Referring now to the drawings wherein like reference characters are used throughout to designate like elements, the boiler of Figure 1 includes an elongated generally vertical furnace 10 of rectangular transverse section divided into furnace compartments 12 and 14 by vertically extending tubular division wall 16 disposed between front and rear walls 18 and 20. The upper portion of the furnace is in communication through its rear wall 20 with horizontal gas pass 22 which extends substantially the full distance across said rear wall and which communicates with the upper end of gas pass 24. The furnace's bottom is of the hopper type formed by inwardly sloping portions of front and rear walls 18 and 20 terminating in spaced relation to form an opening for passage of ash into pit 25.

Each of the furnace compartments is provided with

burners **26** located adjacent the corners of the compartments for the purpose of tangential firing in a well known manner.

The steam generating circuit of the boiler includes tubes **28** which line the four walls of the furnace and extend throughout the length of these walls and tubes **30** which extend throughout the length of the furnace and make up division wall **16**. All of these tubes are connected at their upper or outlet ends with steam and water drum **32** through suitable headers and connecting conduits and at their lower or inlet ends with pumps **36** (only one being shown) likewise through suitable headers and connecting conduits. The pumps **36** receive boiler water from drum **32** through downcomers **34** and are effective to force this boiler water upwardly through tubes **38** and **40** back into drum **32** with a portion of the water being converted to steam during its passage through these tubes. The inlet or lower ends of division wall tubes **30** are bent toward the front and rear walls of the furnace as shown in Fig. 1 so that approximately half of these tubes project through the sloping portion of the front wall at right angle thereto while the remaining tubes project through the sloping portion of the rear walls at right angles thereto with the tube ends connecting into inlet headers **35** positioned adjacent and in parallel relation with these sloping wall portions.

In controlled circulation boilers a flow restrictor or orifice is provided for each of the tubes, preferably at the inlet of the tube, in order that the flow through each tube may be regulated as desired for maximum operating efficiency of the unit. Thus in the boiler of Fig. 1, although not shown, each of the tubes **28** and **30** is provided with an orifice to regulate flow through the tube.

The steam generated in the steam generating circuit passes from steam and water drum **32** through superheater sections **36** and **38** in the usual manner and then to a desired point of use such as a turbine. In addition to having superheater section **38** disposed therein gas pass **22** accommodates reheater **40** to which steam, after having a portion of its energy utilized, is returned for reheating to a desired temperature and pressure.

In order to provide division wall **16** with openings throughout at least a major portion of its length for the purpose of equalizing pressure differentials in furnace compartments **12** and **14**, which are caused by puffs, unequal distribution of fuel and the like, tubes **30** of this wall are bent in a serpentine manner whereby portions of each tube are disposed first on one side of the median plane and then on the other side of this median plane as clearly shown in Fig. 3. Adjacent tubes are oppositely bent thereby forming passageways **42** therebetween which are effective to equalize the pressure in the two furnace compartments.

The portion of tubes **30** which extend through the median plane of wall **16** and interconnect the laterally displaced tube portions are disposed in alignment across the wall, as shown in Figs. 3, 4, 8 and 9, and at the location of these aligned tube portions a pair of fluid cooled stiffener tubes extend across the wall with these aligned tube portions positioned intermediate the pair of stiffener tubes and rigidly connected thereto.

In the embodiment of Figs. 1 through 5, these pairs of stiffener tubes, identified as **44**, are in the form of a U with the two legs thereof (which constitute the pair of tubes) positioned one above the other and embracing the aforementioned aligned tube portions therebetween. The ends of the U-shaped tubes **44** are serially interconnected with the furnace wall tube **28** which is adjacent thereto and disposed in the plane of the division wall (Figs. 4 and 5) so that boiler water which is forced through this tube **28** flows through stiffener tubes **44**. The U-shaped stiffener tubes **44** are oppositely arranged throughout the length of wall **16** so that they are alternately interconnected with and form a part of the tube **28** at one edge of the wall and the tube **28** at the other edge of the wall.

In order to assist in preventing division wall **16** from moving either laterally or vertically within furnace **10** the return bends of stiffener tubes **44** are positioned in between a pair of wall tubes **28** with the wall tube which lies in the median plane of division wall **16** being bent outwardly to permit this positioning of the return bend. Since the outward bend of this tube **28** closely conforms with the return bend this arrangement prevents the stiffener tube **44** from moving both vertically and laterally within the furnace.

The stiffener tubes **44** are rigidly secured to each of the division wall tubes **30** and for this purpose metal connector plates **46** may be provided, these plates being welded to the stiffener tubes **44** and the division wall tubes **30** as shown in Figs. 6 and 7.

The division wall thus provided is extremely rugged because of stiffener tubes **44** extending thereacross at predetermined intervals and since passageways **42** are provided across the the entire wall as well as throughout its length any pressure differential between furnace compartments **12** and **14** will be quickly equalized preventing the formation of undue stresses in the wall.

In addition to providing an extremely compact tube and header arrangement the disposition of the lower ends of tubes **30** and their interconnections with headers **35** forms a large centrally located passage **48** (Fig. 1) which establishes communication between furnace compartments **12** and **14** and is effective to assist in the equalization of pressure in the two compartments.

While stiffener tubes **44** have been disclosed as interconnected with the wall tubes **28** of the furnace in a highly efficient manner so that boiler water is forced through tubes **44** this represents only one possible arrangement for fluid cooling the stiffener tubes since any arrangement which establishes a forced circulation through tubes **44** will be effective, although perhaps not as compact or efficient as the organization shown.

The modified embodiment of Figs. 8, 9 and 10 differs from the embodiment of Figs. 1 through 7 by having the tubes making up each pair of stiffener tubes **44'**, i. e., the two legs of the U-shaped tube, disposed in a horizontal rather than a vertical plane with the return bend which interconnects the tubes in each pair embracing the adjacent wall tube **28** which lies in the median plane of division wall **16** (Fig. 10). The wall tubes **28** on both sides of the wall tube embraced by the return bend are bent outwardly to permit the return bend to embrace the tube as aforesaid and by this arrangement the pair of stiffener tubes **44'** are prevented from moving laterally or vertically within the furnace.

The tube portions embraced by each pair of stiffener tubes **44'** are so inclined with respect to the median plane of the wall as to permit the tubes **44'** to be positioned within the extremities of the division wall's surfaces thereby providing greater protection for the stiffener tubes against the deleterious effects of the intense heat within the furnace than if these tubes projected laterally from the surfaces of the division wall.

As in the case of the previously described embodiment the ends of U-shaped stiffener tubes **44'** are serially interconnected with the furnace wall tube **28** which is adjacent thereto and disposed in the plane of the division wall with the stiffener tubes being oppositely arranged throughout the length of division wall **16** so that they are alternately interconnected with and form a part of the tube **28** at one edge of this wall and tube **28** at the other edge of this wall.

While I have illustrated and described a preferred embodiment of my novel boiler organization it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing from the spirit and scope of the invention. I therefore do not wish to be limited to the precise details set forth but desire to avail myself

of such changes as fall within the purview of my invention.

What is claimed is:

1. A boiler of the controlled circulation type having a steam generating circuit and a pump means effective to force the boiler water therethrough, a tubular division wall separating the furnace of the boiler into two compartments each of which communicates with a gas pass leading from the furnace, said tubes being vertically arranged in adjacent side by side relation with certain adjacent tubes being laterally offset relative to one another throughout at least a portion of the wall's length so as to provide openings in said wall for communication between the compartments through the division wall with other portions of the tubes being in alignment across the wall at spaced predetermined intervals, generally horizontal stiffener tubes extending laterally across said division wall at said predetermined intervals throughout the length of said wall and secured to the tubes thereof, said stiffener tubes forming a portion of the steam generating circuit of the boiler.

2. In a boiler of the type described wherein pump means force boiler water through the steam generating circuit, an upright elongated furnace divided into two parallel compartments by a tubular division wall which forms a part of said steam generating circuit and has the tubes extending longitudinally thereof in adjacent side by side relation with certain adjacent tubes of said wall being laterally offset relative to one another throughout at least a portion of the wall's length to form openings in said wall with other portions of the tubes being in alignment across the wall at spaced predetermined intervals, a pair of stiffener tubes extending across the wall at at least some of said spaced predetermined intervals with the tubes of the wall disposed between said pair of stiffener tubes and rigidly secured thereto, said stiffener tubes being connected into and forming a part of the boiler's steam generating circuit.

3. In a controlled circulation boiler having an upright furnace the inner surface of the walls of which are lined with vertically extending steam generating tubes forming a portion of the steam generating circuit of the boiler, a vertically disposed tubular division wall extending across the furnace and dividing the same into two sections with the tubes of said wall disposed generally vertical and a portion of each of these tubes being laterally displaced from the median plane of the wall first on one side thereof and then on the other side thereof with certain of said tubes being displaced oppositely of others and with the tube portions that extend through the median plane and interconnect the tube portions disposed on each side of the median plane being in alignment across the wall, U-shaped alignment tubes extending across the wall at the locations of the said interconnecting tube portions that pass through the median plane, said alignment tubes having the division wall tubes interposed between and interconnected with the legs thereof, the boiler wall's inner surface having pockets formed therein to snugly receive the return bends of the alignment tubes and prevent displacement of the same, said alignment tubes forming a portion of the steam generating circuit of the boiler and having boiler water forced therethrough.

4. A controlled circulation boiler having an upright elongated furnace the inner surface of the walls of which are lined with vertically extending steam generating tubes forming a portion of the steam generating circuit of the boiler, a vertically disposed tubular division wall extending across the furnace and dividing the same into two sections with the tubes of said wall disposed generally vertical and at least a major portion of the length of said tubes being of serpentine configuration weaving through the median plane of the wall so that each tube is displaced from said median plane first on one side thereof and then on the other side thereof with certain tubes being displaced oppositely of others and with the tube portions that extend through said median plane being in alignment across the wall at predetermined elevations therealong, U-shaped alignment tubes extending across the wall at the locations of said aligned tube portions that penetrate the median plane of the wall and embracing said tube portions between the legs thereof, said tube portions and said alignment tubes being rigidly secured together, the legs of said U-shaped alignment tubes being serially interconnected with the furnace wall tube juxtaposed to the edge of the division wall adjacent the ends of said legs and the boiler wall's inner surface having pockets formed therein snugly receiving the return bends of said alignment tubes to prevent displacement thereof.

5. A controlled circulation boiler having an upright elongated furnace the inner surface of the walls of which are lined with vertically extending steam generating tubes forming a portion of the steam generating circuit of the boiler, a vertically disposed tubular division wall extending across the furnace and dividing the same into two sections with the tubes of said wall disposed generally vertically and at least a substantial portion of the length of numerous of said tubes being of serpentine configuration weaving through the median plane of the wall so that each such tube is displaced from said median plane first on one side thereof and then on the other side thereof with certain tubes being displaced oppositely of others and with the tube portions that extend through said median plane being in alignment across the wall at predetermined elevations therealong, U-shaped alignment tubes extending across the wall at the locations of said aligned tube portions that penetrate the median plane of the wall and snugly embracing said tube portions between the legs thereof, and the legs of said U-shaped alignment tubes being serially interconnected with the furnace wall tube juxtaposed to the edge of the division wall adjacent the ends of said legs.

6. The organization of claim 5 wherein the legs of the U-shaped alignment tubes are one above the other.

7. The organization of claim 6 wherein the legs of the U-shaped alignment tubes are side by side.

8. A controlled circulation boiler having an upright elongated furnace the inner surface of the walls of which are lined with vertically extending steam generating tubes forming a portion of the steam generating circuit of the boiler, a vertically disposed tubular division wall extending across the furnace and dividing the same into two sections with the tubes of said wall disposed generally vertically and at least a substantial portion of the length of said tubes being of serpentine configuration weaving through the median plane of the wall so that each tube is displaced from said median plane first on one side thereof and then on the other side thereof with adjacent tubes being oppositely displaced and with the tube portions that extend through said median plane being in alignment across the wall at predetermined elevations therealong, U-shaped alignment tubes extending across the wall at the locations of said aligned tube portions that penetrate the median plane of the wall and snugly embracing said tube portions between the legs thereof, and the legs of said U-shaped alignment tubes being serially interconnected with the furnace wall tube juxtaposed to the edge of the division wall adjacent the ends of said legs.

9. In a boiler of the type wherein the fluid is forced therethrough by a pump the combination of an elongated furnace the inner surface of the walls of which are lined with side-by-side tubes, a division wall in said furnace extending longitudinally thereof and made up of longitudinally disposed tubes positioned in side-by-side relation, numerous of said tubes being of serpentine configuration having portions thereof displaced from the median plane of the wall with certain tubes being displaced oppositely of others, these tubes also having portions

positioned in said median plane and which are in alignment across the wall at several longitudinal positions herealong, said division wall at the location of said aligned tube portions having tubes extending laterally thereacross and embracing and connected to the longitudinal tubes of said wall, these laterally extending tubes being in series with and forming part of tubes lining the inner surface of the furnace wall at the edges of the division wall.

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