June 7, 1955 H. W. WIEGAND 2,709,991

BOILER

Filed March 30, 1954. 2 Sheets-Sheet 1

Fig. 1.

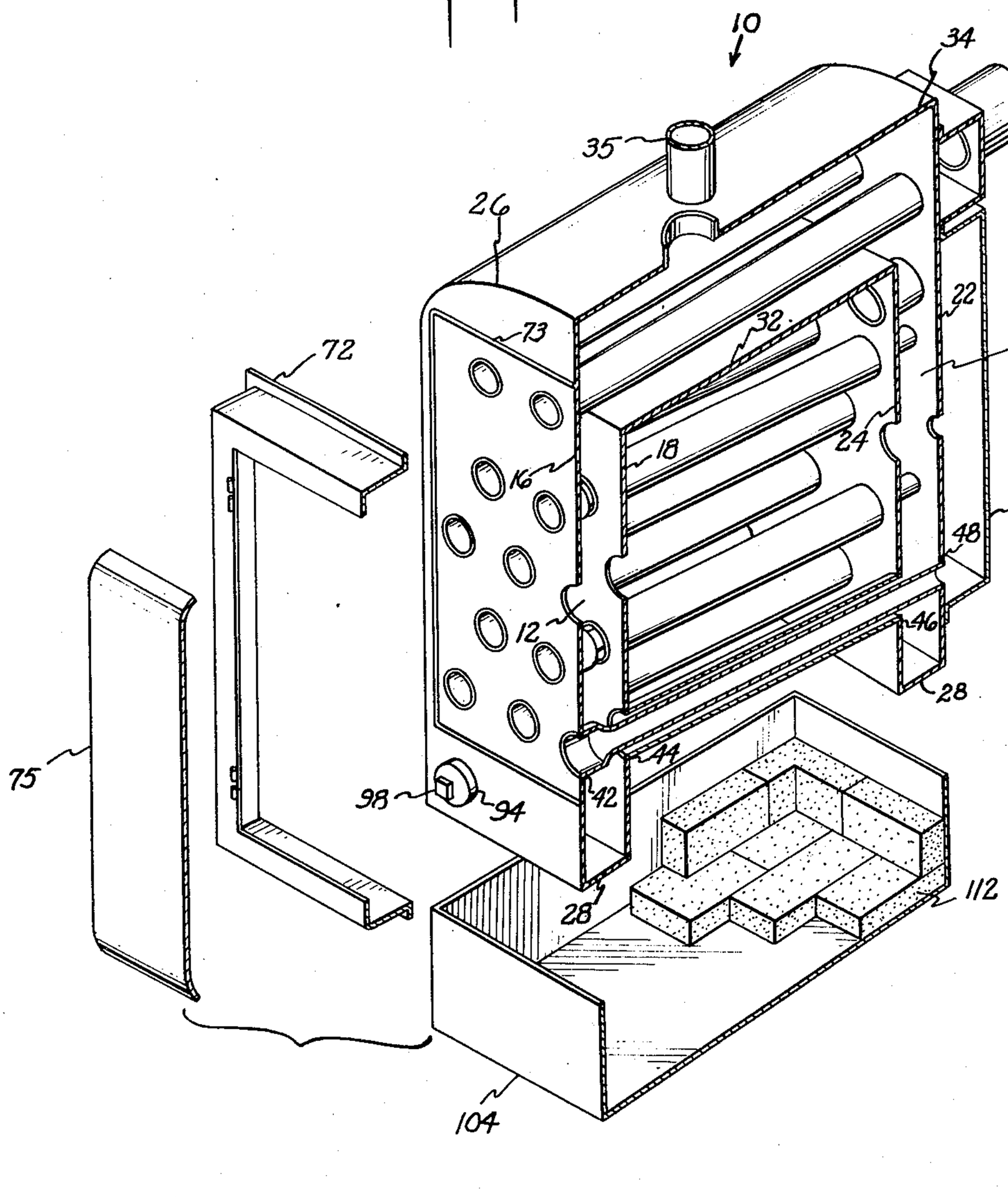

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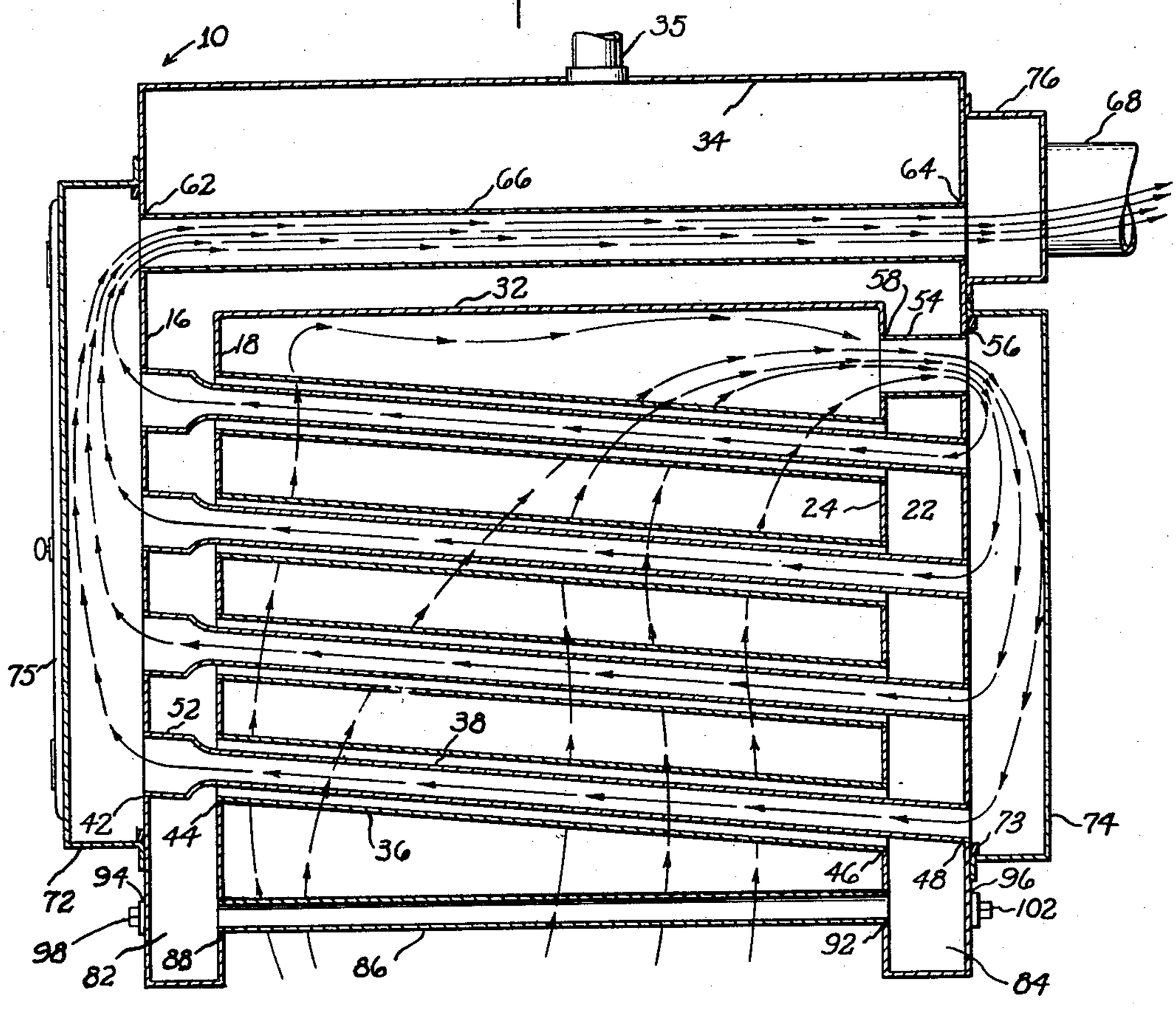
Fig. 2.



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BOILER

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1 Claim. (Cl. 122—268)

(Granted under Title 35, U. S. Code (1952), sec. 266)

This invention relates to boilers and more particularly to smaller boilers that are subject to minimum corrosion, permit only minimum sedimentation, that are compact, provide increased heat transfer surface in the path of the combustion gases as the latter pass through the water or steam, and are easily cleaned or repaired.

Smaller size boilers that are currently being used for generating hot water or steam do not afford sufficient heat transfer surface, in proportion to their size, between the hot gases generated by the fuel combustion and the water in the boiler. In these boilers the hot gases pass only once or twice across heat transfer surfaces that separate the hot gases from the water to be heated. Only a small fraction of the available heat energy is derived by the water from the hot gases because of inefficient design for heat transfer. This represents a considerable waste of fuel since much of the heat energy made available by combustion of the fuel is lost through delivery of high temperature gases to the chimney. Partially, this is a result of the arrangement of the boiler tubes. Furthermore, in the smaller boilers in current use the percentage of total surface in the path of the hot gases between the fire box and the chimney that is effective as heat transfer surface is too small thereby limiting the boiler rating. In addition, an important consideration in the construction of boilers aside from the problem of efficient heat exchange and one that is often ignored in small boiler construction is the need for an arrangement whereby stagnant water pockets in the boiler are eliminated so that corrosion and sedimentation are minimized.

This invention marks a departure from the prior art in that it provides a boiler of simple efficient construction. It includes a series of fire tubes each of which is supported concentrically within a corresponding series of water tubes. Each of the fire tubes and each enveloping water tube is secured to the sides of the boiler at a predetermined angle to the horizontal, thereby permitting improved circulation. In addition, the sides of the boiler hereinafter referred to as headers are joined at or near their lower ends by tubes for permitting water circulation. The combination of the latter and the tilted tube arrangement provides for improved water circulation and the virtual elimination of stagnant water pockets in the boiler. Consequently, corrosion and sedimentation are minimized. Furthermore, the tubes are arranged for easy access whereby cleaning and repair is facilitated.

An object of this invention is to provide a boiler.

A further object is to provide an improved boiler for generating water or steam.

A further object is to provide a boiler of the class known as tubular boilers, that is light in weight, compact, efficient, and characterized by large heat transfer surface area.

A further object is to provide a boiler of the class known as tubular boilers for generating steam or hot water and including provision for rapid circulation of the water adjacent the heat transfer surfaces of the boiler.

A further object is to provide new and useful improvements in hot water boilers of the multitubular type.

A further object is to provide new and useful improvements in hot water boilers of the multitubular type which are characterized by increased heat transfer surface and increased water circulation while consuming a minimum amount of fuel and which are further characterized by overall simplicity of construction and compactness.

A further object is to provide a boiler which is characterized by large heating surface, maximum water circulation, and a minimum fuel consumption.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is an exploded perspective view of a boiler, partly in section, according to a preferred embodiment of this invention, and

Fig. 2 is a longitudinal section of the boiler shown in Fig. 1.

Referring to Fig. 1 and Fig. 2, the boiler **10** includes a pair of headers **12** and **14**. The header **12** is bounded by an outer tube sheet **16** and an inner tube sheet **18**. The opposing header **14** is bounded by an outer tube sheet **22** and an inner tube sheet **24**. The width of the tube sheets **16**, **18**, **22**, and **24** are equal. The inner tube sheets **18** and **24** are rectangular and are substantially identical. The outer tube sheets **16** and **22** are longer than the inner tube sheets and are curved at the upper ends thereof as shown at **26**. The pair of tube sheets bounding each header are joined in parallel spaced relationship by narrow lengths of boiler plate as shown at **28**.

The headers **12** and **14** are joined to one another by means of a pair of crown sheets **32** and **34**. The crown sheet **32** is sealed to the inner tube sheets **18** and **24**. The crown sheet **34** is sealed to the outer tube sheets **16** and **22**. The crown sheet **32** may be arched slightly between the tube sheets **18** and **24** for increased strength. The portion of the boiler between the crown sheets **32** and **34** is known as the dome. A boiler outlet for hot water or steam is provided in the crown sheet **34** by a pipe part of which is shown at **35**.

Each of the tube sheets is formed with a plurality of openings; each of the openings of the several tube sheets is adapted to have secured and sealed therein one end of a boiler tube. Most of the openings formed in the tube sheets **16** and **22** are adapted to receive the ends of the fire tubes **38** and most of the openings in the tube sheets **18** and **24** are adapted to receive the ends of the water tubes **36**. Each concentric pair of tubes comprising a water tube **36** and a fire tube **38** requires four aligned openings, one in each of the tube sheets **16**, **18**, **22**, and **24**. The concentric pairs of tubes are arranged at an angle to the horizontal plane defined by the bases of the two headers **12** and **14** to improve water circulation. Each opening **42** in tube sheet **16** is larger than each opening **48** in tube sheet **22**. One end of each fire tube **38** is secured in an opening **42** in tube sheet **16** and the other end of each fire tube **38** is secured in an opening **48** in tube sheet **22**. The reason behind the enlarged openings **42** is to provide for removal and replacement of water tubes **36** when the latter develops a fault such as a crack or leak. By first detaching and removing the fire tube **38** through the opening **42** it is then possible to remove the corresponding water tube **36** through the same opening **42**. Because the methods of detaching and removing boiler tubes are well established, details are

omitted. Each enlarged opening 42 receives the enlarged end of a fire tube 38. The latter is sealed into the opening 42 of the tube plate 16. The openings in the four tube plates are arranged in a staggered pattern (see Fig. 1) to cause the hot combustion gases to follow circuitous paths in flowing upward from the firebox.

Bridging the header 14 adjacent the upper end thereof is, at least, one bridge pipe 54. The bridge pipe 54 is sealed into a pair of horizontally aligned openings 56 and 58 formed in the two tube plates 22 and 24. The bridge pipe 54 permits the hot combustion gases to pass from the space within the boiler occupied by the boiler tubes on the way to the inside of the fire tubes 38, as indicated by the flow lines shown in Fig. 2.

A plurality of pairs of axially aligned openings, each pair including an opening 62 and an opening 64 of equal diameter are formed in the outer tube sheet 16 and 22 in a horizontal plane above the crown sheet 32. Horizontally disposed fire tubes 66 are sealed into the openings 62 and 64. The fire tubes 66 present channels to permit the flow of hot combustion gases after they have left the fire tubes 38 and are on their way to the smoke pipe 68.

Secured to the outer surface of the outer tube sheets 16 and 22 are removable recessed closures 72 and 74. Both removable closures 72 and 74 are substantially rectangular and provide an air tight chamber on the outside of each of the tube sheets 16 and 22 which enclose the open ends of all the fire tubes 38. Guide means for the closures may be provided as at 73. The guide means 73 are suitably formed or secured by welding or the like. The closure 72 also covers the open ends of the fire tubes 66 while the closure 74 also covers the open end of the bridge pipe 54. The fastening means for the closures 72 and 74 are not shown on the drawing since conventional fastening arrangements, for example bolts, suffice. The closure 72 includes a hinged door generally shown at 75 for easy access and inspection. The door 75 is secured by means of lugs, dogs or their equivalent.

The door 75 permits frequent cleaning of the fire tubes 38 to free them of accumulated soot. Since the soot acts as a heat insulator, the more frequently it is removed, the more efficient the operation of the boiler. Whenever the boiler is shut down for a period that is long enough to permit the structural elements to cool down, it is possible to open the door 75 and force a fire tube cleaning brush into and out of each fire tube 38 to quickly remove the insulating deposit of soot.

Connecting the lower ends 82 and 84 of the headers 12 and 14, respectively is at least one water tube 86. The water tube 86 is sealed into aligned openings 88 and 92 in the tube sheets 18 and 24 respectively. An opening 94 is formed in the tube sheet 16 and an opening 96 is formed in the tube sheet 22. Both of the latter openings are near the bottoms of the respective headers. The opening 94 is shown closed by a sealing plug 98. However the plug 98 is adapted to be replaced by a plumbing connection to a source of feedwater under sufficient pressure. The plug 102 in the opening 96 is adapted to be replaced by suitable plumbing to a water level indicator tube not shown, and to a length of downwardly extending stub piping suitably sealed off by a valve, likewise not shown. The latter is for the purpose of effecting a blowdown to remove sediment.

If only one water tube 86 is used, it is located toward one transverse extremity of the boiler. The opening 96 in which is adapted to be the plumbing for effecting a blowdown, is located toward the opposite transverse extremity of the boiler. By means of this arrangement, sediment that collects in the lower end of each header is easily cleaned out by the blowdown, i. e., letting some of the hot water under pressure in the boiler escape through opening 96.

Due to the presence of the water tube(s) 86, there are no stagnant water pockets in the lower ends 82 and 84 of the headers. Because the water circulates continuously through all parts of the boiler, there is a minimum of corrosion.

The open sides of the boiler between the headers are adapted to be covered by removable closures, not shown, in a manner similar to that described in connection with closures 72 and 74 except that the side closures are mounted flush with the recessed portions directed inwardly to reduce size. The latter recesses in the side closures not shown for receiving insulating material such as soft brick. Whenever necessary, the outer surfaces of the water tubes 36 may be brushed free of accumulated deposits by simply removing the side closures.

The entire boiler is arranged to sit on a firebox 104 lined with firebrick 112. By not securing the firebox in position on the supporting floor and by not securing it to the boiler 10 with any more than a sealing compound for preventing leak of hot gases from the firebox, it is a simple matter to effect repairs on the firebox. It is only necessary to chip away the sealing compound, jack up the boiler just a bit so as not to put any undue strain on the connecting plumbing and then simply sliding out the firebox. After the repairs are made, the procedure is reversed. Since no grate is shown, the firebox 104 is for fluid fuels. However, the same applies to a firebox for coal.

In operation, the boiler may be completely filled with water in which case it would be a source of hot water or it would be in a closed hot water heating system. If the water level is below that of the tubes 66, the boiler serves to generate steam. The hot gases originate in the combustion chamber of the firebox 104. The hot gases rise up, as shown in Fig. 2, around the outer surfaces of the staggered water tubes 36 and along the inner surfaces of the tube plates 18 and 24, to heat the water on the other side of the surfaces. Because of the staggered arrangement of the boiler tubes, the gases circulate around all parts of the surfaces of the water tubes 36. The gases rise to the top of the space including the water tubes 36, heating the inner surface of the crown sheet and flow out into the chamber defined by the closure 74, by passing through the bridging pipe 54. The hot gases distribute through the chamber defined by the closure 74 and then divide to flow through fire tubes 38 to heat the water between the fire tubes 38 and the water tubes 36. Upon leaving the fire tubes 38 at the left side of the boiler as seen in Fig. 2, the gases again combine as a body in the chamber defined by the closure 72 and rise upwardly dividing among the several fire tubes 66 to flow into the bridging or smoke box 76 on the way to the smoke pipe 68 and then to the chimney not shown. Assuming that the headers 12 and 14 are completely filled with water, the level of the water terminating just below the lower surfaces of the fire tubes 66, the boiler produces steam efficiently and rapidly. The efficient and rapid generation of steam is due to the fact that the hot gases of combustion make three passes through the water. The first "pass" of the hot gases is the latter's rising upward from the combustion chamber in the firebox 104 toward the crown sheet 32. The second "pass" of the hot gases is the latter's flow through the fire tubes 38. The third "pass" is the latter's flow through the fire tubes 66 toward the smoke pipe 68. Aside from the "passes" additional heat transfer occurs as the hot gases move along the surfaces of the tube sheets 16, 18, 22 and 24.

A plug 102 is shown sealing the opening 96. Actually, it is preferable to connect a pipe of suitable length at one of its ends so that it is sealed within the opening 96. The other end of which pipe may be selectively opened or closed by means of a gate valve. The valved end of the above-mentioned pipe would preferably feed into

the sewage system. By this arrangement of pipe and valve, not shown, sediment that collects in the bottom of the headers **12** and **14** also called water legs **82** and **84** may be expeditiously disposed of with a minimum of effort and without curtailing operation of the boiler. By simply opening the valve in the pipe connected to the opening or openings **96** a "blowdown" is effected removing all of the sediment collected in the water legs **86** and **88**.

The effects of additional "passes" for increased heat transfer plus tilted tubes **38** and connecting tube **86** for increased water circulation combine to make the disclosed boiler compact for its rating, efficient, and less subject to breakdown resulting from corrosion. The arrangement of the closures as discussed previously simplify cleaning and repair.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claim the invention may be practiced otherwise than as specifically described.

I claim:

A boiler comprising a pair of parallel horizontally-spaced vertical headers, each of said headers including an inner tube sheet, an outer tube sheet, a first arched crown sheet joining the upper extremities of the inner tube sheets; a second arched crown sheet joining the upper extremities of the outer tube sheets, whereby a domed space is defined between said crown sheets; the tube sheets of said headers being formed with a plurality of vertically staggered sets of aligned openings, each set of aligned openings including one opening in each of the tube sheets and each set of openings being at a predetermined angle relative to a plane defined by the bases of said headers; a plurality of pairs of concentric tubes, one pair of said concentric tubes for each set of openings in the tube sheets, each pair of concentric tubes including an inner fire tube and an outer water tube, said pairs of concentric tubes disposed in the aligned openings formed in the tube sheets whereby the said pairs of tubes are vertically staggered and rising combustion gases are forced to follow circuitous paths around the water tubes, said inner tube sheets further formed with a pair of aligned openings adjacent the lower extremities thereof; a water tube secured within the last mentioned pair of openings in the inner tube sheets for eliminating stagnant water pockets in the lower extremities of said headers; the upper extremities of the tube sheets of one of said headers formed with a pair of aligned openings for receiving a bridge pipe; a bridge pipe sealed into the aligned openings formed in the upper extremities of the tube sheets of the said one header; the outer tube sheets further formed with a plurality of axially aligned openings above the level of said crown sheet; a plurality of horizontal fire tubes sealed in the last mentioned aligned openings formed in the outer tube sheets; a removable recessed closure secured to the outer tube sheet of each of said headers for defining a chamber with one of said headers common to one end of each of said fire tubes and one end of said bridge pipe and for defining a chamber with the other of said headers common to the other end of each of said fire tubes and one end of said plurality of horizontal fire tubes said boiler adapted to be supported on a fire box whereby hot combustion gases originating in the firebox are adapted to rise circuitously about the water tubes, flow through said bridge pipe into the chamber defined by one of said removable recessed closures and thence through the fire tubes into the chamber defined by the other removable recessed closure, through said fire tubes located above said first crown sheet toward a chimney for raising the temperature of fluid adapted to be disposed in said headers, in the spaces between the inner and outer tubes of the concentric pairs, and above said first crown sheet.

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