Feb. 28, 1961 W. H. ALLEN 2,972,985

BOILER

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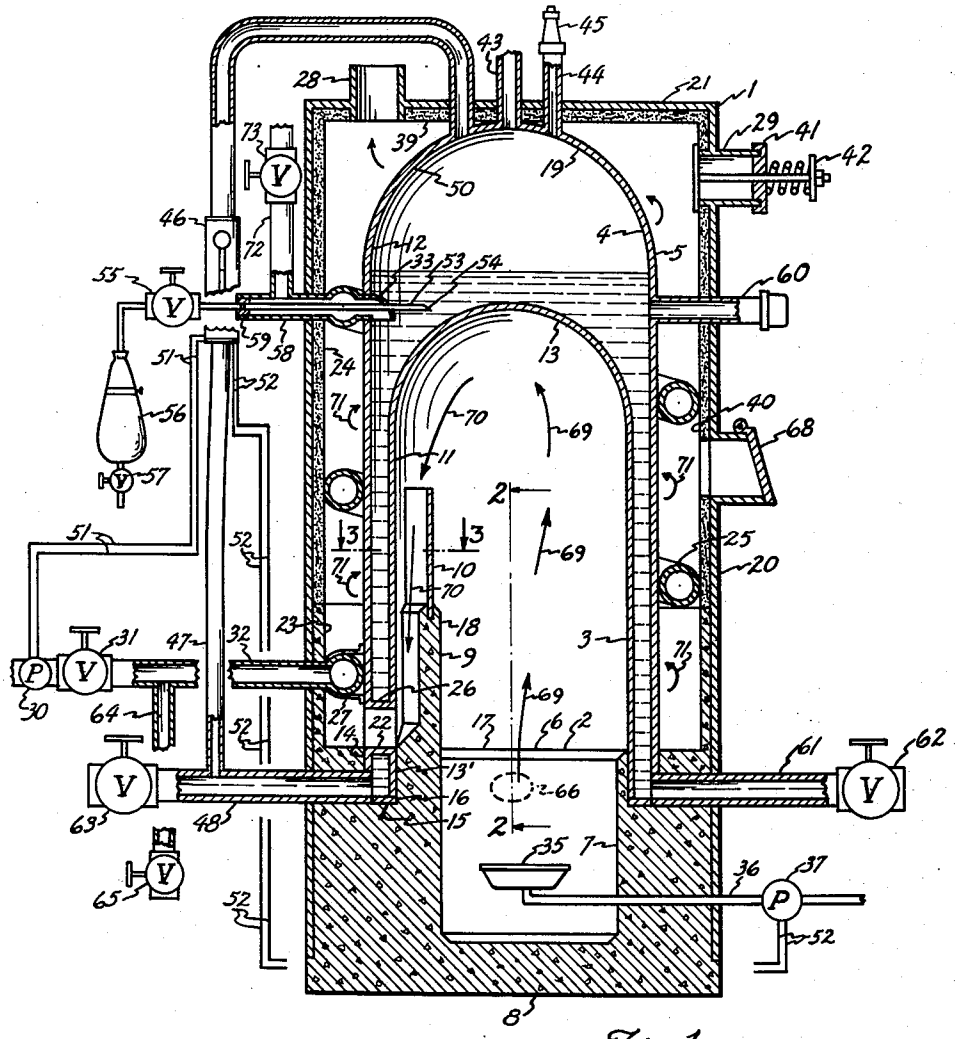


Fig. 1.

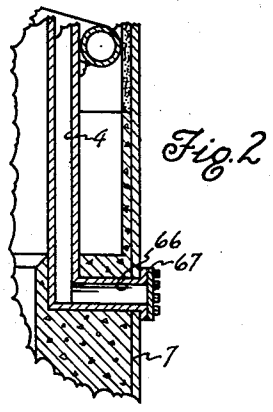


Fig. 2

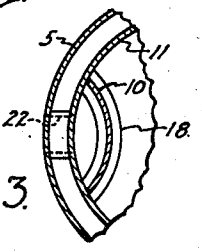


Fig. 3.

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BOILER

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This invention relates to boilers and more particularly to steam and hot water boilers.

A general object is to provide a boiler in which the feed water is heated by the combustion gases prior to the entry of the water into the steam or hot water generation chamber.

In particular it is an object of the invention to provide a boiler which is highly efficient in operation because the available heat content of the gases of combustion is fully utilized and which is simple in construction and thereby substantially free of maintenance problems.

The novel features which are believed to be characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in which:

Fig. 1 is a sectional side elevational view of a generally cylindrically shaped boiler according to the invention;

Fig. 2 is a fragmentary sectional view along the line 2—2 of Fig. 1 illustrating means which are provided for gaining access to the steam generation chamber; and

Fig. 3 is a fragmentary sectional top view along the line 3—3 of Fig. 1 illustrating a baffle arrangement incorporated in the boiler.

With particular reference to Fig. 1, the boiler is generally cylindrical in shape and is designated in the drawings at 1. It includes a combustion chamber 2 in which there is a zone 17 in which fuel is burned, an internal radiation chamber 3 in which is primary radiation zone 38, a water chamber 4, which has a steam retaining top portion 19, and an external radiation chamber 5.

The combustion chamber 2 is generally cylindrical in shape and has an open top portion 6 which opens directly into the open bottom portion of the internal radiation chamber 3. The combustion chamber 2 is provided with a thick cylindrical wall 7 which is composed of suitable refractory material and is further provided with a thick refractory bottom portion 8 that underlies the cup shape cavity or combustion zone 17 and which is formed integrally with the wall 7. A burner 35 is disposed centrally in the cavity, and oil or other combustible material is supplied to the burner through pipe 36 by means of pump 37. Pipe 36 extends through wall 7. Immediately adjacent the top portion of the cup shape cavity 17 and at one side thereof as viewed in Fig. 1 is an upstanding outwardly convexed refractory portion 9 on which is mounted an upstanding and outwardly convexed metal plate 10 bowing into the combustion zone and away from the wall 7. Refractory portion 9 and plate 10 serve as a baffle 18 which because of its disposition in the zone 38 causes the combustion gases to be retained in the zone 38 for an adequate period and to circulate sufficiently therein. As seen in Fig. 3 the baffle 18 is contiguous along its sides with shell 11 and provides, together with the adjacent wall portion of shell 11, a passageway through which the combustion gases proceed downwardly from the top of the radiation zone to passageway 22, the latter passageway serving as a conduit which communicates with the internal and external radiation zones, 38 and 40, respectively.

Steam or hot water is produced in the water chamber 4. Chamber 4 is composed of two concentrically arranged cylindrical shells 11 and 12, the former of which is disposed concentrically within the latter. The inner shell 11 is provided with a hemispherical top portion 13 which serves as a fire dome for the internal radiation chamber 3. The outer shell 12 is provided with a top hemispherical portion 19 which may serve as a steam dome beneath which the steam collects. The bottom portions, 13 and 14, of shells, 11 and 12, respectively, are joined by an annular plate 15 which provides a watertight joint at the base of the shells. The shells are suitably mounted in an annular recess 16 which surrounds the cavity 17 in the combustion chamber 2. Shell 11, in addition to functioning as a portion of the water chamber 2, defines the internal radiation chamber 3, and the major portion of the heat transfer from the combustion gases to the water takes place through the walls of shell 11.

The external radiation chamber 5 surrounds the internal radiation chamber 3 above the combustion chamber 2 and includes the shell 12 and a third cylindrical shell 20 which is concentrically disposed relative to shell 12 and which forms a casing that encloses the principal members of the boiler. Casing 20 is suitably mounted surroundingly on and about the wall 7 of the combustion chamber 2, and extends upwardly therefrom to a flat circular enclosing top portion 21 which extends over the zones existing in the respective chambers. The external radiation chamber 5 and the internal radiation chamber 3 are interconnected by means of gas passageway 22 which extends through shells 11 and 12 at the bottom of the radiation zones adjacent the combustion chamber. The lower portion of the casing 20 is provided with an internal cylindrical refractory lining 23 which is integral with and extends upwardly from the refractory wall 7 of combustion chamber 3. Lining 23 terminates upwardly spacedly below the top portion 21 of the outer shell or casing 20. Above the refractory lining 23 the casing 20 has another internal cylindrical lining 24 which may be composed of less expensive refractory materials such as asbestos millboard. Top 21 is also provided with an insulated lining 39 which is preferably composed of asbestos millboard material like that of lining 24.

Water is fed to the boiler 1 by means of a pump 30 which is connected through valve 31 and pipe 32 to a helical boiler tube 25 the connection being made to the tube 25 immediately above the passageway 22 in zone 40. Tube 25 is wound tightly around shell 12 in the form of a helix and extends upwardly from its connection with pipe 32 to a point at which water inlet pipe 33 is connected thereto. Pipe 33 enters the water chamber 4 through the shell 12 immediately below the steam dome 19 and discharges the water downwardly in the chamber adjacent to the inside of shell 12. Tube 25 is attached to the shell 12 by means of bands, such as band 27, which surround the tube and hold it contiguous to shell 12 yet permit the tube to move longitudinal when expanding and contracting.

Tube 25, in addition to being wound tightly around the shell 12 is of such diameter as to be contiguous with linings on the inside of casing 20. Because of this the gases from the primary radiation zone 38, upon entering the external radiation chamber 5 through passageway 22, are caused to take a helical path around the shell 12 in proceeding upwardly in the secondary radiation zone 40 for final discharge from the boiler through flue pipe

28. Flue pipe 28 is located at and extends through the top portion 21 of casing 20.

Boiler 1 is also provided with an auxiliary flue pipe connection 29 which may be employed in lieu of pipe 28 where a laterally extending flue connection is desired. As shown in Fig. 1 the auxiliary flue pipe 29 is located adjacent the top 21 and is sealed by means of a cover plate 41 which is held in place by a suitable spring mechanism designated at 42, thereby serving as a safety relief plate for relieving excess pressure in the gas chambers.

Steam outlet pipe 43 is provided at the top of the boiler 1 and communicates with the steam chamber 4 by passing through the top 21 of casing 20 and through steam dome 19. Pipe 44 also communicates with the water chamber through steam dome 19 and is connected to a suitable relief valve 45 for automatically venting steam from the chamber 4 when the steam pressure therein exceeds a predetermined value.

The level of the water in the steam generation chamber 4 is automatically regulated by an externally located water level control device 46. The device 46 is located at substantially the same level as the water in chamber 2 and is connected through interconnecting pipes 47 and 48 to the bottom of the steam chamber 4, pipe 48 being so disposed as to pass through an outer portion of the wall 7 and to communicate with the water chamber 4 adjacent plate 15. Pipe 49 is also connected directly to the level control device 46 and extends upwardly therefrom to enter the boiler 1 through the top of shell 20, and to therein communicate with the steam zone 50 in the water chamber 4 by passing through steam dome 19. By means of these connections with the water chamber, the level of the water in the device 46 is always maintained at the same as the level in chamber 4. As such the operation of device 46 is in response to the level of water in water chamber 4.

The level control device 46 is connected to a suitable source of electricity and is electrically controllingly connected to the water pump 30 and to the fuel pump 37 by means of wires 51 and 52, respectively. Pumps 30 and 37 respond to the device in accord with the sensed level of the water in chamber 2. As the level of water falls in chamber 2, pump 30 is activated by the device 46 whereby water is pumped into water chamber 4 through pipe 32 and boiler tube 25. The supply of fuel to burner 35 is also regulated in response to the device 46. Fuel pump 37 responds to the device 46 and is shut off or regulated to operate at a slower speed when the water level falls below a predetermined sensed level in chamber 4. The converse is true when the sensed level of the water in chamber 4 increases above a predetermined level.

As is apparent to those skilled in the art, sludge and other undesirable matter continuously collects on the surface of the water in the boiler during operation unless distilled water is employed for generating the steam. It is contemplated that the boiler described herein will, normally, be employed with tap water and accordingly a small pipe 53 is provided for continuously removing the sludge from the surface of the water in chamber 4. The inlet 54 to pipe 53 is disposed just below the surface of the water in chamber 2 and passes outwardly through the shell 12 by way of the same opening utilized for pipe 33 from whence it passes through the side wall of tube 25 and through casing 20 to a throttle valve 55 and sediment trap 56. From the sediment trap the water is discharged to a drain through valve 57. It will be understood that valves 55 and 57 are open during normal operation of the boiler and thereby control the continuous removal of small amounts of water from adjacent the surface in chamber 2 together with the sludge contained therein. To facilitate the passage of pipe 53 through casing 20 and into tube 25, a laterally extending pipe 58 is provided. Pipe 58 is mounted in casing 20 and opens through the wall of tube 25. Pipe 53, being of smaller diameter than pipe 58 is concentrically mounted therein and passes externally of the pipe through end plug 59 in pipe 58.

Additionally the removal of surface sludge from the surface of the water in chamber 4 may be accomplished by periodically draining the surface sludge from the chamber through the inlet water tube 25 while the boiler is under steam pressure. For accomplishing this periodic removal of the sludge, pipe 64 and valve 65 are provided. Pipe 64 is connected to the water feed pipe 32 between the valve 31 and the connection of pipe 32 with tube 25. Valve 65 controls the flow through pipe 64. Valve 31 is closed for effecting the sludge removal in accord with this method and valve 65 is opened. This will permit the head of steam in chamber 4 to force the surface water out through pipe 33 and into tube 25 from whence the sludge will be discharged from valve 65 through interconnecting pipes 64 and 32. Thereafter valve 65 may be closed, valve 31 opened and normal operation of the boiler resumed.

Capped pipe 60 which communicates with the water chamber 2 just below the surface of the water therein is also provided. By suitable attachments to pipe 60, hot water may be withdrawn from the boiler when desired.

To permit flushing of the water chamber 4 and removal of loose scale accumulations at the bottom thereof, pipe 61 and associated valve 62 are provided. Pipe 61 extends through the outer portion of wall 7 and communicates with the water chamber 4 at the bottom thereof adjacent the annular plate 15. Valve 62 is provided in the pipe 61 and it will be understood that valve 62 is normally closed when the boiler is in operation, as is valve 63 in pipe 48 which is located on the opposite side of the boiler. When the boiler is not in use, the water chamber 4 may be flushed by opening valve 63 which is connected to pipe 48 and water is pumped into the chamber through pipe 48. Valve 62 is open under such conditions and the water admitted to the chamber through pipe 48 is discharged through pipe 61 and valve 62 together with any scale and other material which have accumulated at the bottom of the chamber.

Pipe 72 is connected to plugged pipe 58 and has a valve 73 connected thereto for purposes of being attached to a supply of acid when it is desirable to clean either tube 25 or the inside of chamber 4 with acid. To pass an acid solution through tube 25, valve 31 is closed and drain valve 65 opened. Thereafter through open valve 73, the acid solution may be pumped into pipe 58 from whence it will pass through tube 25, pipes 32 and 64 and through valve 65 to the drain. To pass the acid solution through chamber 4, valves 65 and 31 are closed and valves 63 and/or 62 opened. This arrangement permits the acid solution to be directly pumped into pipe 72 through open valve 73 from whence it travels through pipe 58 across tube 25 and into the chamber 4 through water inlet pipe 33. From chamber 4 the acid solution is discharged through pipes 48 and 61 and the associated valves 63 and 62 respectively.

As shown in Fig. 2, another conduit 66 is provided at the rear of the boiler for the purpose of affording access to the water chamber 4 for manually cleaning the water chamber. Conduit 66 communicates with the lower portion of the water chamber 4 by extending through an outer portion of the wall 7 of combustion chamber 2, a removable cover plate 67 being provided over the external opening of the conduit to provide a watertight seal thereat when the boiler is in use. Cover plate 67 is removed when access to the chamber 4 is desired for cleaning purposes.

A suitable weighted pressure relief door 68 is also provided in casing 20 for gaining access to the external radiation chamber as shown in Fig. 1 and for relieving excess gas pressure within the gas chambers of the boiler.

During the normal operation of the boiler 1, all of the valves shown in the drawing, except valves 31, 55 and 57 are closed and pumps 37 and 30 are electrically actuated and controlled through level control device 46. As previously pointed out valves 55 and 57 are open and suitably throttled to permit continuous removal of the surface sludge. Where removal of sludge is to be accomplished periodically by the alternative method described previously, valves 55 and 57 may be closed. When valve 31 is open, and the water level in chamber 4 is below the predetermined level regulated by device 46, the device 46 actuates pump 30 and water is pumped into the water chamber 4 through pipe 32, helical tube 25 and downwardly directed inlet pipe 53. The operation of pump 30 is controlled by water level control device 46 and as soon as the level of water in chamber 4 reaches the predetermined level pump 30 is shut off. Device 46 also actuates fuel pump 37 through the electrical connections 52 therewith. Fuel pump 37 may be controlled in accord with the same or a different water level than that at which the water pump 30 is controlled by device 46. By a suitable ignition system, not shown, the fuel oil supplied by pump 37 to burner 35 is ignited and burned in combustion chamber 2. The gases resulting from the combustion of the fuel in burner 35 proceed upwardly from the burner 35 into the primary radiation zone 38 in accord with the path shown generally by arrows 69. Upon reaching the fire dome area the gases then proceed generally downwardly through the opening defined between the shell 11 and baffle 18 and toward opening 22 in accord with the path generally indicated by arrows 70. A major portion of the heat content of the combustion gases is transmitted to the shell 11 by radiation as the gases pass through chamber 3, the heat being in turn transmitted through the shell 11 by conduction to the water whereby steam is generated in chamber 4 and collected beneath the steam dome 19.

The gases, after having given up the major portion of their available heat content in chamber 3, leave the chamber 3 through passageway 22, from which they proceed upwardly, in the generally helical path indicated by arrows 71, through the external radiation chamber 5, from which they are discharged through flue pipe 28. The balance of the available heat content of the combustion gases is given up principally by radiation to the tube 25 and shell 12 as they pass upwardly to the flue in the generally helical path. Accordingly, the water in the chamber 4 is further heated by the gases through shell 12, and the inlet water is heated in tube 25.

By causing the gases to traverse a long helical path which is defined in part by the tube through which the cold boiler water is fed, the gases are caused to be exposed to a greater surface area through which heat may be transmitted to the water than if permitted to pass directly to the flue and are so exposed for a long period of time. Also, the gases discharged into chamber 5 have a low heating potential as compared to the heat potential of the gases in chamber 3. By exposing the gases of low heat potential to the relatively cool surfaces of tube 25, the heat content of the gases is effectively transmitted to the water therein.

The steam generated in chamber 3 collects beneath the steam dome 19 and is withdrawn through pipe 43, the level of the water in the chamber being influenced in part by the rate of such steam withdrawal. Accordingly, as steam is withdrawn and more steam produced the level of water in chamber 4 recedes thereby causing the level of liquid in device 46 to recede and thus actuating pump 30 into supplying more water to the chamber 4.

It will be apparent that pump 37 may be controlled by device 46 in accord with a different water level than that utilized for controlling water supply pump 30. Thus water supply pump 30 may be controlled by device 46 to maintain a liquid level which is higher than the water level at which the fuel pump 37 is controlled to supply a maximum amount of fuel to the burner.

While only a certain preferred embodiment of this invention has been shown and described by way of illustration, many modifications will occur to those skilled in the art and it is, therefore, desired that it be understood that it is intended in the appended claims to cover all such modifications as fall within the true spirit and scope of this invention.

What is claimed as new and what it is desired to secure by Letters Patent of the United States is:

1. In a boiler, a combustion chamber having an upwardly opening cavity, a fuel burner disposed in said cavity, means for supplying fuel to said burner, a water chamber including a pair of concentrically arranged cylindrical shells mounted on said chamber and adapted to retain water and steam between the inner and outer of said pair of shells, said shells having respective upper closure portions, a baffle mounted on said combustion chamber adjacent said cavity and extending upwardly into the inner of said shells, said baffle having a top portion disposed spacedly below the upper portion of said inner shell and side edges therebelow which are contiguous with the wall of said inner shell, said baffle being spaced from said wall of said inner shell between said sides and defining therewith a vertically extending passageway, another cylindrical shell having an insulating lining concentrically arranged around and disposed spacedly outwardly of said outer shell thereby defining a vertically extending gaseous zone between said outer shell and said other shell, a flue pipe extending through said other shell and communicating with the upper end of said zone, a boiler water feed tube having an inlet end adjacent said combustion chamber and extending therefrom upwardly and helically around said outer shell and having an upper end communicating within said water chamber adjacently below said upper portion of said outer shell, said tube being in contact with said outer shell and with said other shell and defining a helical gas path between said outer shell and said other shell, and conduit means connected to said lower end of said tube for passing water into said tube, a second passageway extending through said shells of said water chamber adjacent said combustion chamber and interconnecting the lower end of said vertically extending passageway and the lower end of said zone whereby hot gases produced by combustion in said cavity pass upwardly into said combustion chamber and thence downwardly through said vertically extending passageway and from said lower end thereof through said second passageway into the lower end of said zone and thence upwardly through said helical gas path to said upper end of said zone and into said flue pipe.

2. In a steam boiler, a cylindrical refractory combustion chamber having an upper portion and having a cavity opening upwardly through said upper portion, said chamber having an annular recess spaced outwardly of and surrounding said cavity in said upper portion, a fuel burner disposed in said cavity for burning fuel to form hot gases, first conduit means connected to said burner for supplying fuel to said burner, a pair of concentrically arranged and radially spaced cylindrical shells having respective interconnected bottom portions disposed in said recess whereby said gases pass into the inner of said pair of shells, said shells defining therebetween a water chamber and having spaced respective hemispherical upper portions defining therebetween a steam dome portion of said water chamber, said chamber being adapted to retain water and steam between said shells, an outwardly convexed baffle having opposite side edges and including an upstanding refractory portion integrally formed with said refractory combustion chamber and an upstanding plate mounted on said refractory portion, said baffle being disposed within said inner shell and terminating upwardly therein spacedly below the hemi-

spherical portion of said inner shell, said side edges of said baffle being joined to the cylindrical wall of said inner shell whereby said wall and baffle define a vertically extending passageway having an upper opening for receiving said gases in said inner shell, an outer cylindrical cover shell mounted on said combustion chamber spacedly outwardly of and concentrically to said pair of shells, said outer cover shell having a flat circular top portion disposed spacedly above said pair of shells and a heat insulating lining whereby said outer cover shell and the outer one of said pair of shells define a gaseous zone, a horizontal passageway extending through said water chamber interconnecting said vertically extending passageway and said zone whereby gases in said vertical passageway are admitted to said gaseous zone, a boiler tube disposed within said zone and pipe means connected to said tube above said horizontal passageway for supplying boiler water to said tube, said tube extending upwardly from said connection with said pipe means in a helix extending around and in contact with the outer face of the outer one of said pair of shells, said tube communicating within said water chamber below the hemispherical upper portion of said one shell of said pair whereby water passed into said tube is discharged into said water chamber, said tube being in contact with the inner face of said outer cover shell and defining a helical path extending circuitously upwardly in said gaseous zone for the passage of gases therethrough, an exterior flue pipe communicating with said zone above said tube for the withdrawal of said gases from said zone, second conduit means extending through the hemispherical portion of said outer shell for withdrawing steam from said water chamber, and means responsive to the level of water in said water chamber for regulating the flow of water through said pipe and for regulating the flow of fuel through said first conduit means.

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