March 15, 1949. H. W. LYKE 2,464,701

BOILER CONSTRUCTION

Filed Sept. 10, 1945 2 Sheets-Sheet 1

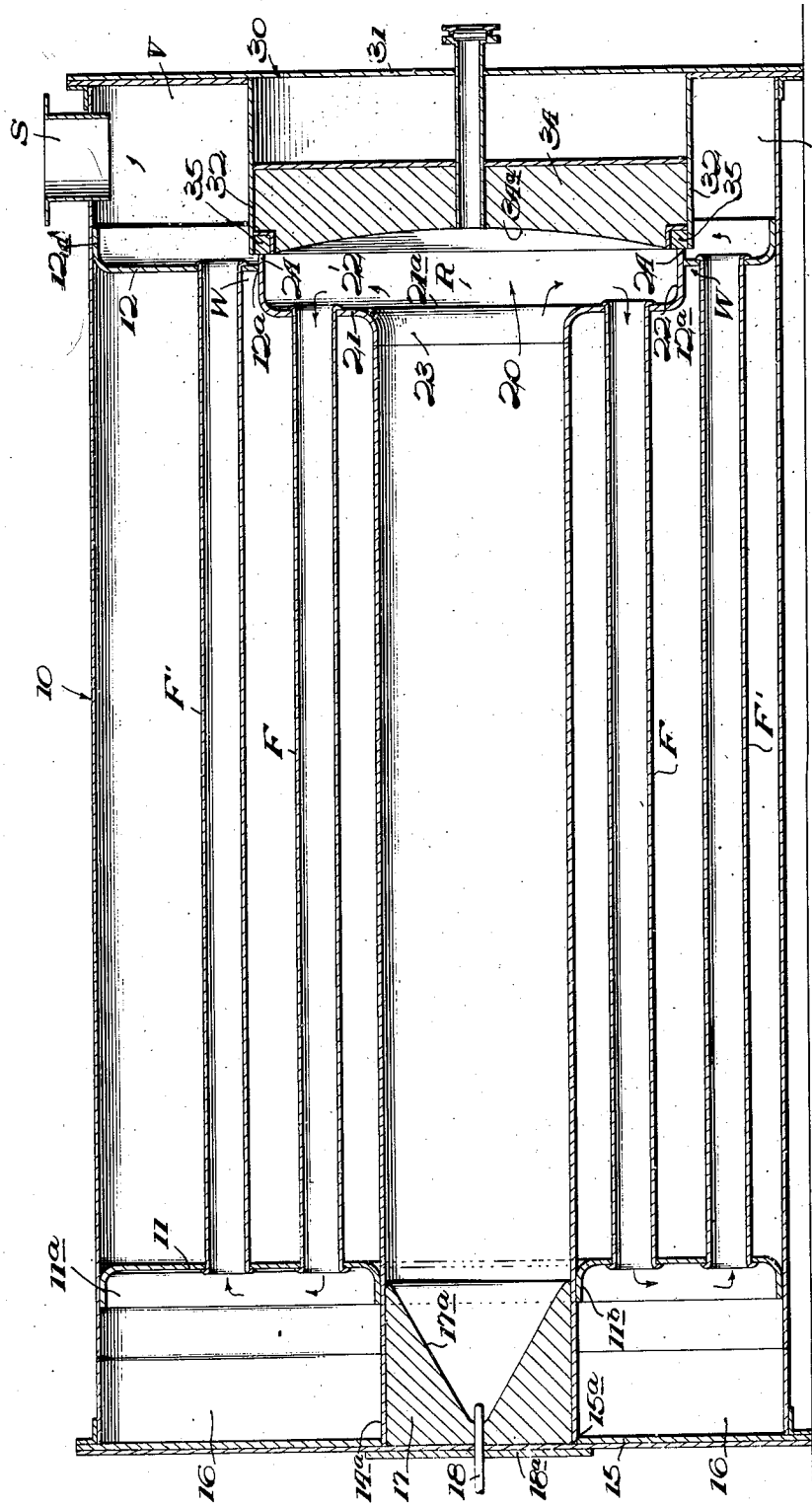


Fig. 1.

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March 15, 1949. H. W. LYKE 2,464,701

BOILER CONSTRUCTION

Filed Sept. 10, 1945 2 Sheets-Sheet 2

Fig. 3.

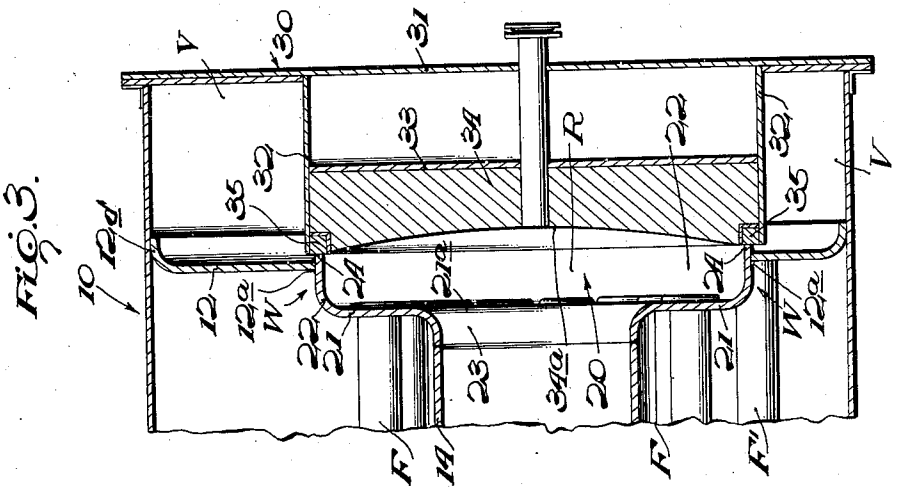
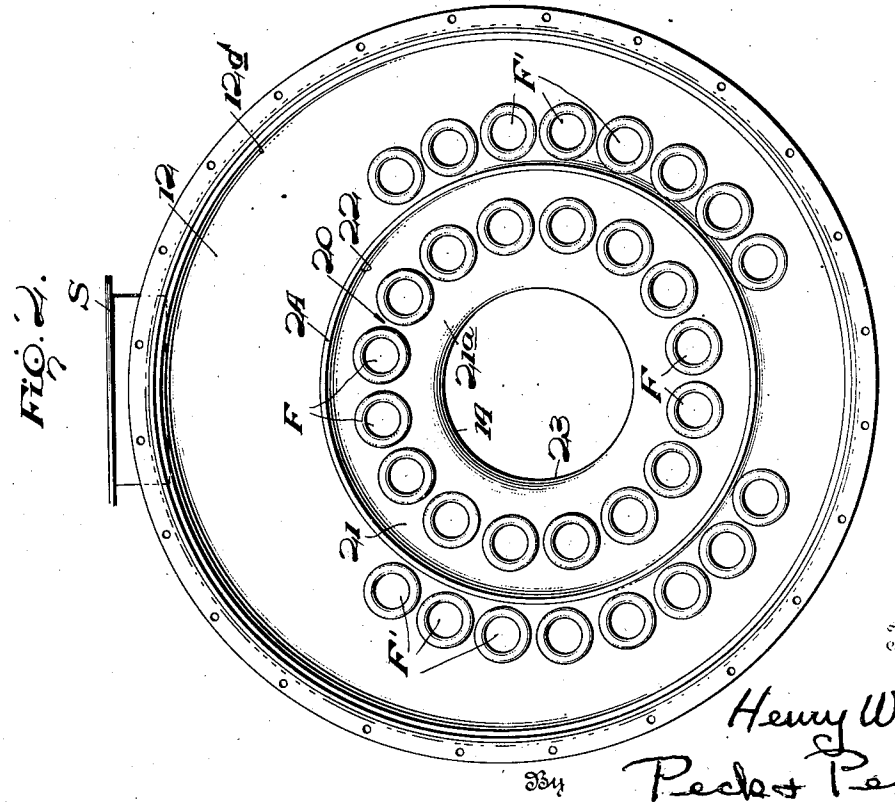


Fig. 4.



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Patented Mar. 15, 1949 2,464,701

UNITED STATES PATENT OFFICE

2,464,701

BOILER CONSTRUCTION

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Application September 10, 1945, Serial No. 615,307

7 Claims. (Cl. 122—149)

1

This invention relates to certain improvements in boiler construction for steam generators and the like; and the nature and objects of the invention will be readily recognized and understood by those skilled in the arts to which the invention pertains, in the light of the following description and detailed explanation of the accompanying drawings illustrating what I now consider to be a preferred embodiment and mechanical and structural expression of my invention, from among various other embodiments, expressions, arrangements, and constructions and combinations of parts and elements, of which the invention is capable and adapted within the broad spirit and scope thereof.

My present invention is particularly concerned with boilers of the so-called horizontal or vertical fire tube types for steam generators, and especially such boilers of the horizontal fire tube types designed to burn fluid fuels, such as oil or gas, although the invention is not in all respects limited or restricted in either its adaptation or in its utility, to boilers of the horizontal and/or of the fluid fuel burning types.

It is a general object of my present invention to improve the design and construction and thereby increase the efficiency of operation, of steam boilers of those types having a gas recirculating chamber at one end thereof for receiving combustion gases from a combustion tube for recirculation from said chamber through the boiler.

A further and more specific object is to eliminate or substantially reduce the possibility of structural failures such as fractures, cracks or the like in the wall structure of such a gas recirculating chamber which may be caused by the extremes of temperature to which the wall structure is subjected.

And another object is to provide a design and construction of boiler having such a gas recirculating chamber by which a gas receiving chamber is formed in the boiler around and surrounding the outer portion of the gas recirculating chamber with a minimum of area of the side wall structure of the gas recirculating chamber being exposed to the surrounding gas receiving chamber.

With the foregoing general objects, features and results in view, as well as certain other objects, features and results which will be readily recognized by those skilled in the art from the following detailed disclosure and explanation, my invention consists in certain novel arrangements and combination of parts and elements, and in

2

the design and construction thereof, all as will be fully referred to hereinafter.

Referring to the accompanying drawings in which similar reference characters refer to corresponding parts and elements throughout the several figures thereof.

Fig. 1 is a view in vertical, longitudinal section through a form of horizontal fire tube type of boiler for a steam generator, embodying a design and construction of gas recirculating chamber forming head structure at one end of the boiler designed and constructed in accordance with my present invention.

Fig. 2 is a view in end elevation of the boiler of Fig. 1 with the removable outer end wall of the recirculating chamber forming head structure, removed from the boiler, and particularly showing the unitary end wall and recirculating chamber peripheral side wall of the recirculating chamber forming head structure of my invention.

Fig. 3 is a view in vertical longitudinal section through the recirculating chamber forming head structure of the boiler of Fig. 1, taken as on the line 3—3 of Fig. 2, but with a portion only of the boiler being shown.

I have selected, and have illustrated and described herein, by way of example, a boiler embodying my invention, of the horizontal fire tube type having a horizontally disposed generally centrally located combustion tube therethrough designed for use with fluid fuel, such as oil or gas, such type of boiler being particularly adapted for use with steam generator units. However, it is to be understood that my invention is not limited to adaptation and use with this particular type and design of boiler, but is adapted for use with boilers generally of the broad types embodying fire tubes with a recirculating chamber for changing the direction of flow and directing the hot gasses and products of combustion from the combustion tube into a bank of fire tubes for circulation thereof through such tubes, and in which it is found desirable or expedient to close off and seal such a recirculating chamber from an adjacent or surrounding chamber.

In the selected example of boiler embodying the present invention, referring now to Fig. 1 of the drawings, the boiler includes a preferably annular, elongated tubular enclosure or boiler casing 10 which is provided at its forward end with a wall 11 forming in effect a tube sheet which, in this example, is secured in position transversely across the forward end of the boiler casing 10 spaced a distance inwardly from the outer

end thereof by an outwardly directed, peripheral flange 11*a* therearound which is secured to the boiler casing 10, in any suitable manner familiar in the art. The boiler is provided at the rear end of the casing 10 with a transverse wall or tube sheet 12 which is secured in position disposed transversely across the casing 10 spaced a distance inwardly from the outer rear end of the casing by an outwardly directed peripheral flange 12*d*, similar to the flange 11*a* of the tube sheet 11 at the forward end of the boiler.

A combustion tube 14 is provided disposed longitudinally of an extending generally centrally through the boiler casing 10 from the forward end wall 11, and this combustion tube 14, in this instance, in accordance with the illustrated adaptation of my invention, terminates spaced a distance inwardly within the casing 10 from the rear end wall or tube sheet 12. The combustion tube 14 is of generally cylindrical cross section and, in this instance, is of substantially uniform diameter throughout its length and may be of straight, smooth internal surface, or may be provided with annular corrugations therearound spaced longitudinally therealong, or may be formed and provided with suitable refractory or the like material, linings, as may be found expedient in any particular use, all of which constructions and arrangements of the combustion tube are familiar and well known in the art and have no limiting effect on and are not critical to my present invention.

In this instance, the combustion tube 14 extends outwardly through and is suitably secured in a centrally located circular opening in the forward tube sheet 11, which opening is surrounded and defined by a forwardly extended annular flange 11*b*, is bent up and formed from the wall 11 and secured in any suitable manner to and around the exterior of the combustion tube 14 to form a water-tight joint with the exterior surface of the combustion tube. The combustion tube 14 at the forward end thereof extends a distance outwardly beyond the tube sheet 11 of the boiler casing 10 to form a section or length 14*a* which is received and secured at its forward end in a head or end plate 15 that is secured in position across and closing the outer end of boiler casing 10 which extends beyond the end wall 11. This head or end plate 15 is formed with a circular opening or aperture 15*a* therein and therethrough into which the forward end of the section 14*a* of the combustion tube is received. The combustion tube section 14*a* is received and secured in opening 15*a* of head plate 15 with the tube section forming a case-tight sealed joint with the edge of the head 15 surrounding and defining the opening 15a therethrough. Thus, an annular chamber 16 is formed around and surrounding the extended section 14*a* of the combustion tube 14, between the tube sheet 11 and the end plate 15, and the casing 10 and the combustion tube section 14*a*.

In this particular type of boiler construction designed for burning fluid fuel, the section 14*a* of the combustion tube 14 is provided with a suitable refractory or fire and heat resistant material block 17 which is formed with a conical chamber therein coaxial with the tube 14 and diverging or increasing in diameter outwardly to its discharge end, which end, in the example hereof, is of a diameter substantially equal to the diameter of the combustion tube 14. A suitable fuel burner, such as an oil or gas burner nozzle 18, is mounted to discharge at the inner end of the chamber

17*a* within the block 17. Such burner nozzle 18 is, in this instance, mounted extending axially through the block 17, and a suitable base or holder plate 18*a* is mounted over and across the outer end of the section 14*a* of the combustion tube 14, which plate 18*a* receives and supports the block 17 at the outer base side of the block.

The transverse end wall 12 located at the rear end of the boiler casing 10 opposite that end of the boiler in which the burner nozzle 18 is located, is formed with a central, circular opening 12*a* therethrough coaxial with the combustion tube 14 and of greater diameter than the diameter of the combustion tube. In this particular example of the invention, the diameter of the opening 12*a* in the boiler end wall 12 is approximately twice the internal diameter of the combustion tube 14, although my invention is in no sense limited or restricted to such relationship between the diameter of the aperture 12*a* of the end wall 12 and the internal diameter of the combustion tube 14, such relationship in this specific example being primarily dictated by the location of the inner bank of fire tubes F which have their rear ends located within the projected area of the opening 12*a* of wall 12 and generally intermediately located between the outer edge of such opening and the adjacent end of the combustion tube 14.

In accordance with my invention, a unitary, circular head 20 is provided for mounting in and closing the opening 12*a* in the end wall 12 of the boiler, to form and complete such end wall, and to provide by its design and construction the side wall around and surrounding and defining the gas recirculating chamber, separating such gas recirculating chamber from the surrounding gas chamber, as will be hereinafter fully described and explained.

The head 20 is preferably constructed as an integral, unitary structure formed of a suitable sheet or metal plate so as to provide a base or body wall 21 having an annular peripheral flange 22 thereon, bent-up or otherwise formed from the body of the head and extending from and around the periphery of the body wall 21 from one side thereof, being disposed in a plane generally perpendicular or at an angle of approximately 90° to the plane of the body wall 21. Thus, the head 20 is of a generally dished or cup-like form. The base or body wall 21 of the head unit 20 is provided with a central aperture 21*a* therethrough surrounded by a flange portion 23 which is bent or otherwise formed from the portion of the body wall 21 surrounding such aperture or opening 21*a* and which extends outwardly from the opposite side of the body or base wall 21 from that at which the peripheral flange or annular peripheral wall 22 extends. The flange 23 at its outer edge portion has an internal diameter corresponding to the internal diameter of the rear end of the combustion tube 14, and in this instance has an external diameter substantially the same as the external diameter of the rear end of tube 14. The outer edge of this flange 23 is adapted to be secured and fixed to the rear edge of the rear end of tube 14, so that, the flange forms a longitudinal, rearward continuation of the tube and provides in effect a discharge mouth for the combustion tube 14, opening through the base wall 21 of of the head unit 20 and discharging into the space surrounded by the annular peripheral flange 22 of the unit 20 at the rear side thereof.

The head unit 20 is mounted in the aperture 12*a* of the end wall 12 of the boiler casing 10, to form and complete such end wall, by attaching

and securing the edge portion of the wall 12 surrounding the opening 12a therethrough, to and around the exterior side of the flange 22 of the unit 20, intermediate the width of such flange 22. The unit 20 is mounted and positioned in the opening 12a of the end wall 12, with the body or base wall 21 of the unit 20 disposed at the forward side thereof spaced inwardly from and generally parallel to the wall 12 within the boiler casing 10, and with the flange 22 at the opposite or rear side of the unit extended rearwardly a distance beyond the end wall 12 to provide an annular side wall portion 24 disposed within the space defined and surrounded by the portion of the boiler casing 10 which is extended rearwardly beyond the end wall 12 and its securing flange 12a. The edge portion of the wall 12 which surrounds the opening 12a in which the unit 20 is mounted and which is closed by such unit, is secured to and around the exterior side of the flange 22 to form a water and gas tight joint therewith, as by welding the same to the flange 22.

In such mounted position of the head unit 20, the inwardly extended flange 23 which surrounds the opening 21a in the body wall 21 of the unit 20, is axially alined with the combustion tube 14 and joins with and forms a longitudinal continuation rearwardly, of the wall of the tube 14. The rear end edge portion of the wall or tube 14 is joined and fixed to the adjacent forward edge portion of the flange 23, preferably by welding, to form a water and gas tight joint, and in effect to provide the rear discharge end of the tube 14 with a rear discharge mouth opening into the space at the rear side of the body wall 21 of unit 20 within and surrounded by the rearwardly extending flange 22 of the unit. Preferably, as in the specific example hereof, the flange 23 is curved at its rear side radially outwardly and merges into the wall 21 of the unit 20, so as to provide the rear discharge end of the discharge mouth for the combustion tube 14, as of increasing internal diameter rearwardly, and without an abrupt or sharp shoulder therearound at the discharge end, thus aiding in the smooth flow and equal distribution of the hot gasses and products of combustion from the combustion tube 14.

The boiler of the particular example here selected, is of the multi-pass type, being specifically of the two-pass type in which the gasses and products of combustion from the combustion tube 14 have their direction of flow reversed in a recirculating chamber of which the unit 20 forms the forward and side walls, and are directed and circulated forwardly through an inner bank of fire tubes F surrounding and spaced from the combustion tube 14. The fire tubes F discharge gases into the gas chamber 16 at the forward end of the boiler and such gases are directed from said chamber into the second bank of fire tubes F', which surround and are spaced around and from the first bank of tubes F. The fire tubes F' then discharge into a chamber V at the rear of the boiler which chamber in effect forms a smokebox from which the gases are discharged from the boiler.

In the specific design and arrangement of a boiler embodying my invention of the particular example here selected, the inner or first bank of fire tubes F extend between the forward end wall 11 of the boiler casing 10 and the body or base wall 21 of the unit 20 which forms a part of the rear end wall 12 of the boiler casing 10. The fire tubes F of the inner bank are secured at their opposite ends extending through the

walls 11 and 21, respectively, being fixed and secured in such walls to form a water and gas tight joint therewith, in the usual manner familiar in this art. The fire tubes F at their rear ends extend through and are secured in and spaced apart around the wall 21 of the unit 20 intermediate the flange 22 and the discharge mouth defining flange 23 for the combustion tube 14, as will be clear by reference to the drawings. The outer or second bank of fire tubes F' extend between the forward end wall 11 and the rear end wall 12 of the boiler casing 10, and are secured with their opposite ends extended through and forming water and gas tight joints with such walls, respectively. In this instance, the fire tubes F' are located and positioned with their rear ends secured in and extending through the wall 12, adjacent but spaced from the wall formed by the flange 22 of the head unit 20.

The unit 20 provides a re-entrant, indented or forwardly recessed portion of the rear end wall or tube sheet 12 of the boiler, with the transversely disposed base or body wall 21 of the unit forwardly offset inwardly from the plane of the wall 12, and with the combustion tube 14 attached and discharging rearwardly therethrough into the space surrounded and defined by the peripheral side wall 22. By thus forwardly and inwardly offsetting the body wall 21 of the unit 20, and securing and joining the end wall 12 to and around the exterior of the peripheral side wall 22 of unit 20 adjacent but spaced a distance inwardly from the outer rear edge of the peripheral side wall forming flange 22, this peripheral side wall 22 extends for the major portion of its width into the water space formed within the boiler casing 10 and is thus surrounded by a body of water in direct contact and heat exchange relation with the exterior surface of the wall 22, as indicated at the locations W on the drawings. In this manner the peripheral side wall formed by the flange 22 of unit 20 is effectively water cooled against the high temperatures to which this wall is subjected by the hot gases and products of combustion discharged from the combustion tube 14 into contact and heat exchange relation with the inner side or interior surface of the wall 22.

At the rear or smokebox end of the boiler of this specific example, the rear or outer end of the boiler casing 10 which extends outwardly beyond the end wall 12 is closed by a removable end closure head 30, which includes an end wall 31 of a diameter to extend across and close the rear end of the boiler casing 10. At its inner side this end wall 31 is provided with a centrally located annular wall 32 which extends a distance inwardly from the inner side of wall 31, perpendicular to the plane or wall 31 and coaxial with the combustion tube 14 and with the unit 20 which forms a part of the end wall 12 of the boiler. The annular wall 32 of head 30 is provided with a transverse wall 33 secured in position therein and thereacross intermediate the width of the wall 32, and a suitable refractory material block or disk 34 is seated and supported on the transverse base wall 33 secured in position in the head 30 and of a diameter to occupy and fill the space within and defined by the annular wall 32 and the transverse wall 33. The inner or forward face or side 34a of the refractory material block 34 is formed concave for a purpose referred to and explained hereinafter. The refractory material block or disk 34 is formed with an annular peripheral groove therearound at the inner side thereof surrounding the concave

inner face 34a, and a sealing ring or gasket 35 of a suitable fire and heat resisting material, is seated and secured in such groove at the inner face or side of block 34 surrounding the concave face 34a of the block.

The end closure head 30 of the boiler is preferably removably mounted, as for example, by mounting one side of the wall 31 on suitable hinges in a manner familiar in this art, with the outer peripheral edge portion of the wall 31 being suitably removably bolted to the rear end of the wall of the boiler casing 10. In the accompanying drawings the end head 30 is disclosed in its mounted position closing the end of the boiler casing and thus forming an annular chamber V within the boiler casing 10 between the end wall 12 and the rear or outer wall 31 of the head, and the annular wall of the casing 10 and the inner annular wall 32 of the head 30. This annular chamber V thus formed with the head 30 in mounted position, provides a gas vent or smokebox into which the second bank of fire tubes F' discharge through the end wall 12, as will be clear by reference to Fig. 1 of the drawings. The gas chamber or smokebox V is provided with a suitable discharge outlet S by which the hot gases and products of combustion may pass and discharge from the chamber V.

The refractory material block or disk 34 at the inner side of the head 30 is coaxial with the combustion tube 14 when the head 30 is in mounted, closed position and is of a diameter such that when in closed position the sealing ring 35 is alined with the rear edge of the peripheral side wall 22 of the unit 20, and is tightly forced against and engaged with the rear edge of wall 22 to form a gas tight joint therewith to seal the chamber V from the space within and surrounded by wall 22. The head 30 in mounted closed position thus forms with the unit 20 of the end wall 12, a gas recirculating chamber R having its rear wall formed by the refractory material block or disk 34, its forward or inner wall formed by the body wall 21 of the unit 20 and its peripheral or annular side wall formed by the flange 22 of the unit 20 together with the annular wall 32 of head 30, with the combustion tube 14 discharging into this chamber R through the wall 21, and with the gases discharging and flowing from the chamber R into the inner or first bank of fire tubes F.

By this construction and arrangement it is to be noted that the major portion of the inner side wall of the chamber or smokebox V is provided and formed by the wall 32 of the head 30, and that this inner side wall of chamber V is completed by that portion of the annular flange 22 of the head 20 which extends rearwardly beyond the end wall or crown sheet 12, with this projected portion of the flange 22 forming but a small portion of the inner wall of the smokebox V. It is to be also noted that by this construction the flange 22 of the unit 20 forms the entire peripheral side wall for the gas recirculating chamber R, but that the major portion of this side wall 22 is surrounded by the body of water within the boiler and is thus effectively water cooled against the high temperatures to which it is subjected at its inner side by the hot gases discharged into the chamber R from the combustion tube 14.

In the operation of the boiler of the present example, the hot gases and products of combustion pass rearwardly through the combustion tube 14 from the burner 18 at the forward end thereof and are discharged at the rear end of the tube through the discharge mouth 23 formed in the wall 21 of the unit 20, into gas recirculating chamber R where the gases have their direction of flow reversed and pass into and forwardly through the first or inner bank of fire tubes F into the forward gas chamber 16. The gases in the chamber 16 have their direction of flow reversed and are directed into and flow rearwardly through the outer or second bank of fire tubes F' from which they discharge into a gas chamber or smokebox V. In the recirculating chamber R the reversal of the direction of flow and the distribution of the gases into the fire tubes F, is guided and aided by the concave inner surface or face 34a of the refractory material disk 34 which is mounted coaxial with the combustion tube 14 and the discharge mouth 23 through which the gases discharge into the chamber R.

While the flange 22 of the unit 20, which forms the peripheral side wall of the recirculating chamber R, is constantly subjected to the high temperatures of the gases discharged into the chamber R from the combustion tube 14, the major area of the external surface of this flange is water cooled by the body of water in the boiler, and the joint, which is preferably formed by welding, between the edge portion of the wall 12 around the opening 12a therein, and the exterior surface of the flange 22, is also the beneficiary of this water cooling, so that, strains and stresses to which this joint may be subjected due to contraction and expansion in the operation of the boiler, are maintained at a minimum. The only portion of the flange 22 which is not directly water cooled is the portion of relatively small width which projects rearwardly beyond the wall 12, but this portion is itself immediately proximate to the water cooled portion of the flange 22, and in addition is directly in contact with the fire and heat resistant material sealing ring 35. A construction in accordance with my invention, therefore, such as the construction and arrangement of the present example, reduces the difficulties hereinbefore discussed, which are encountered with prior constructions in which a separate ring member is utilized to form the dividing or separating wall between a gas recirculating chamber and a surrounding gas chamber or smokebox. The unit 20 with the flange 22 and with the combustion tube discharge mouth forming flange 23, formed integral with the base wall 21, provides a structure of extreme simplicity which can be readily manufactured, and which when assembled to form the construction and arrangement in accordance with my invention, reduces to a minimum structural failures due to contraction and expansion and other operating conditions encountered.

While in the preferred construction herein illustrated and described as an example, I have shown the head unit 20 as a separate member secured to the transverse end wall or crown sheet 12, my invention is not limited to such construction, as if desired or found expedient the wall 12 and unit 20 may be formed in one-piece or integral with a separate sealing ring forming member 24 secured or attached thereto to form a portion of the wall separating chambers R and V. In such construction the water cooling of the flange or wall 22 of the indented head is effective to minimize the effect on the sealing ring 24 and the attaching joint between such ring and the integral wall 12 and head 20, of

the high temperatures and the expansion and contraction to which such structure is subjected under operating conditions.

Further, attention is directed to the fact that my invention contemplates and includes the formation of the integral or one-piece wall 12 and indented head 20, with the sealing ring or wall 24, also formed integral therewith, in the form of a suitable annular bead or rib for sealing engagement with the wall formed by block 34, or other structure for sealing contact with such a ring 24.

The provision of the refractory material block or disk to form the rear wall of the recirculating chamber R, with its concave inner face or surface, materially aids in the reversal of the direction of flow and the distribution of the gases in the chamber. The provision of the fire and heat resisting material sealing ring 35 which engages and forms a sealing contact with the edge of the recirculating chamber side wall forming flange 22, insures a tight joint and an efficient seal between the chambers R and V, and further provides a sealing arrangement which is resistant to and will stand up under the temperature and other conditions encountered in the operation of the boiler.

It is also evident that various other forms, designs, arrangements and constructions of parts and elements, as well as combinations of parts and elements, might be resorted to without departing from the broad spirit and scope of my invention, hence I do not desire to limit my invention in all respects to the exact and specific disclosures hereof.

What I claim is:

1. In boiler construction, in combination, a boiler casing; an end wall disposed transversely of the casing and having an inwardly indented central portion of a diameter less than the internal diameter of said casing; said indented portion being comprised of, a wall disposed transversely of the casing and offset inwardly relative to said end wall, an annular flange extending laterally outwardly from said offset wall to and being joined with said end wall; said flange being extended a distance outwardly beyond said end wall at the side thereof opposite the inwardly offset wall; the offset wall of said indented portion having a gas discharge opening therethrough; a combustion tube in said casing at the inner side of said end wall and being connected to said gas discharge opening; a closure head for the outer side of said indented portion having a wall engaged at the inner side thereof with the outer edge portion of said outwardly extended flange in position closing the outer side of the space surrounded by said flange to form with said flange and said offset wall a gas circulating chamber therewithin; and means opening into said gas circulating chamber through said offset wall of the indented portion for conducting gases from said gas circulating chamber.

2. In boiler construction, in combination, a boiler casing; an end wall disposed transversely of the casing and having an inwardly indented central portion of a diameter less than the diameter of said casing; said indented portion being comprised of a wall disposed transversely and offset inwardly of the casing from said end wall, and an annular flange integral with said offset wall and being extended laterally outwardly therefrom to and being connected in fluid-tight relation with said end wall; said flange of the indented portion being extended a distance outwardly beyond said end wall, the offset wall of the indented portion having a gas discharge opening therethrough; a combustion tube extending longitudinally of said casing at the inner side of said offset wall and being connected to said gas discharge opening; a closure member for the outer side of said indented portion having a wall formed with a concave inner side in position closing the outer side of said indented portion to form with the flange and offset wall thereof a gas circulating chamber therewithin; a fire and heat resistant material sealing ring around the inner side of said closure member in position engaged with the outer edge of the outwardly extended portion of said flange to form therewith a substantially fluid-tight seal; and means opening into said chamber through the indented portion of said end wall, for conducting gases from said gas circulating chamber.

3. In boiler construction, in combination, a boiler casing; an end wall disposed transversely of the casing spaced a distance inwardly from the adjacent casing end; said end wall having an inwardly indented central portion of a diameter less than the diameter of said casing and being comprised of a wall disposed transversely of the casing and offset inwardly from said end wall, and an annular flange integral with said offset wall extended laterally and outwardly therefrom to and being connected with said end wall by a fluid-tight joint therebetween; said offset wall having a gas discharge opening therethrough; said annular flange of the indented portion being extended a distance outwardly beyond the side of said end wall opposite said offset wall; a combustion tube extending longitudinally of said casing at the inner side of and being connected to said discharge opening; a closure wall closing the outer end of said casing adjacent said end wall; a head structure extending inwardly from said closure wall of an external diameter less than the internal diameter of said casing to form an annular chamber therearound within the casing between said end wall and the outer end closure wall of said casing; said inwardly extended head structure including an inner wall of a diameter to close the outer side of the space within said flange to form therewithin a gas circulating chamber; the inner side of said head structure inner wall being engaged and forming a substantially fluid-tight joint with the outer edge of the outwardly projected portion of said annular flange; and means for conducting gases from said gas circulating chamber to said annular chamber.

4. In boiler construction, in combination, a boiler casing; an end wall disposed transversely of said casing and having an opening therethrough; a closing head mounted within and closing said opening through said end wall and being comprised of a body wall disposed transversely of said casing spaced inwardly of the casing a distance from said end wall, and an annular flange therearound extending outwardly from the side of said body wall adjacent said end wall; said flange having an external diameter substantially the same as the internal diameter of said end wall opening and being extended outwardly through said opening; said end wall being connected to and around the exterior of said flange in fluid-tight relation therewith; the body wall of said head unit being formed with a gas discharge opening therethrough and an inwardly extended flange surrounding and forming a continuation of

said opening; a combustion tube disposed longitudinally of said casing at the inner side of said body wall and being connected at one end to said inwardly extended flange of said body wall, an outer head at the end of said casing adjacent said end wall, said outer head including a refractory material wall engaged in sealing relation with the outer edge of said outwardly extended portion of the flange of said head unit closing the outer side of said head to form therewithin a gas circulating chamber; and means for conducting combustion gases from said gas circulating chamber.

5. In boiler construction, in combination, a boiler casing; an end wall disposed transversely of the casing spaced a distance inwardly from the adjacent casing end; said end wall having an inwardly indented central portion of a diameter less than the internal diameter of said casing and being comprised of a wall disposed transversely of the casing offset inwardly from said end wall, and an annular flange extended laterally and outwardly from said offset wall to and being joined with said end wall; said offset wall having a gas discharge opening therethrough; said annular flange of said indented portion being extended a distance outwardly beyond that side of said end wall opposite the offset wall of said indented portion; a combustion tube in said casing at the inner side of said offset wall and being connected to said discharge opening; a head structure closing the outer side of the space within said indented portion and being engaged and forming a gas-tight joint with the outer edge of the outwardly projected portion of said annular flange to form therewithin a gas circulating chamber; said head structure having an external diameter less than the internal diameter of said casing; a closure wall extending across the outer end of said casing adjacent said end wall to form an annular chamber within the casing around said head structure between said end wall and said closure wall; and means for conducting gases from said gas circulating chamber to said annular chamber.

6. In boiler construction, in combination, a boiler casing; an end wall disposed transversely of said casing and including an inwardly indented portion of less diameter than the internal diameter of said casing; said indented portion comprising an offset wall disposed transversely of the casing spaced a distance inwardly thereof from said end wall, and an annular flange integral with said offset wall and being extended laterally outwardly therefrom joining said end wall; the annular flange of said indented portion being extended a distance outwardly beyond the outer side of said end wall; said offset wall having a gas discharge opening therethrough; a combustion tube in said casing at the inner side of said offset wall and being connected to said

gas discharge opening; a fire and heat resistant material wall across the outer edge portion of said annular flange in sealing engagement therewith to seal off the space between said offset wall and flange to form therewithin a gas recirculating chamber; the inner side of said fire and heat resistant material wall being formed with a concave portion substantially coaxial with the opening through the offset wall of said indented portion; and means opening through the offset wall of said indented portion between the annular flange thereof and said combustion tube for conducting gases from said recirculating chamber.

7. In boiler construction, in combination, a boiler casing; an end wall disposed transversely of said casing spaced inwardly a distance from the adjacent casing end and including an inwardly indented portion having a diameter less than the internal diameter of said casing; said indented portion comprising, a wall disposed transversely of the casing offset inwardly from said end wall, and an annular flange extended laterally outwardly from said offset wall and being joined with said end wall; said annular flange being extended outwardly a distance beyond the outer side of said end wall; said offset wall having a gas discharge opening therethrough; a combustion tube in said casing at the inner side of said offset wall and being connected to said gas discharge opening; a closure head secured in position closing the outer end of the outwardly projected portion of said annular flange in sealing engagement with the outer edge portion thereof, said closure head, annular flange and inwardly offset wall together forming a gas recirculating chamber therewithin; and a closure wall structure in the end of said boiler casing adjacent said end wall forming a gas chamber within the casing surrounding the outwardly projected portion of said annular flange and said closure head thereon; and means in said casing at the inner side of said end wall opening into said gas recirculating chamber through said offset wall for conducting gases from said chamber to said surrounding chamber.

HENRY W. LYKE.

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FOREIGN PATENTS

Number	Country	Date
114,559	Australia	Jan. 16, 1942