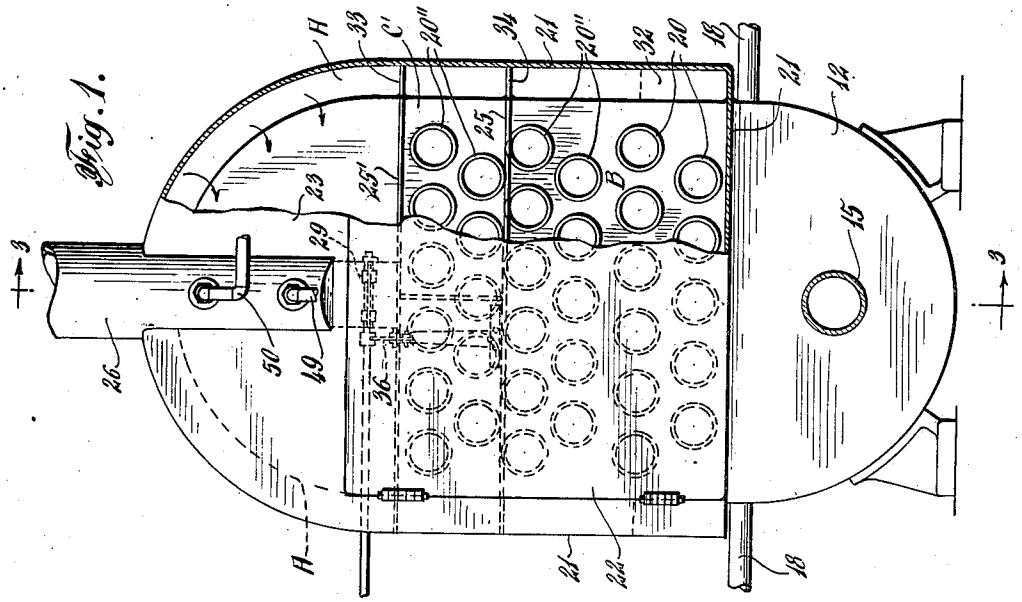
Jan. 28, 1941. R. PAYSON 2,230,087

BOILER

Filed Aug. 16, 1938 3 Sheets-Sheet 1

Fig. 1.



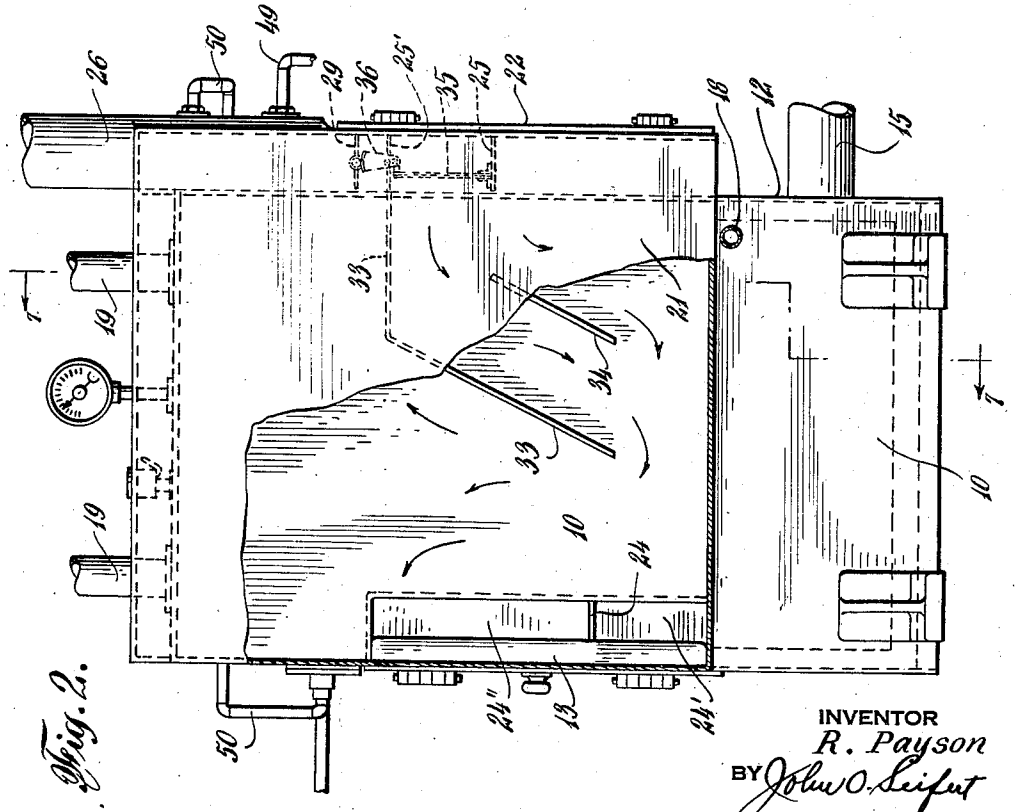


Fig. 2.

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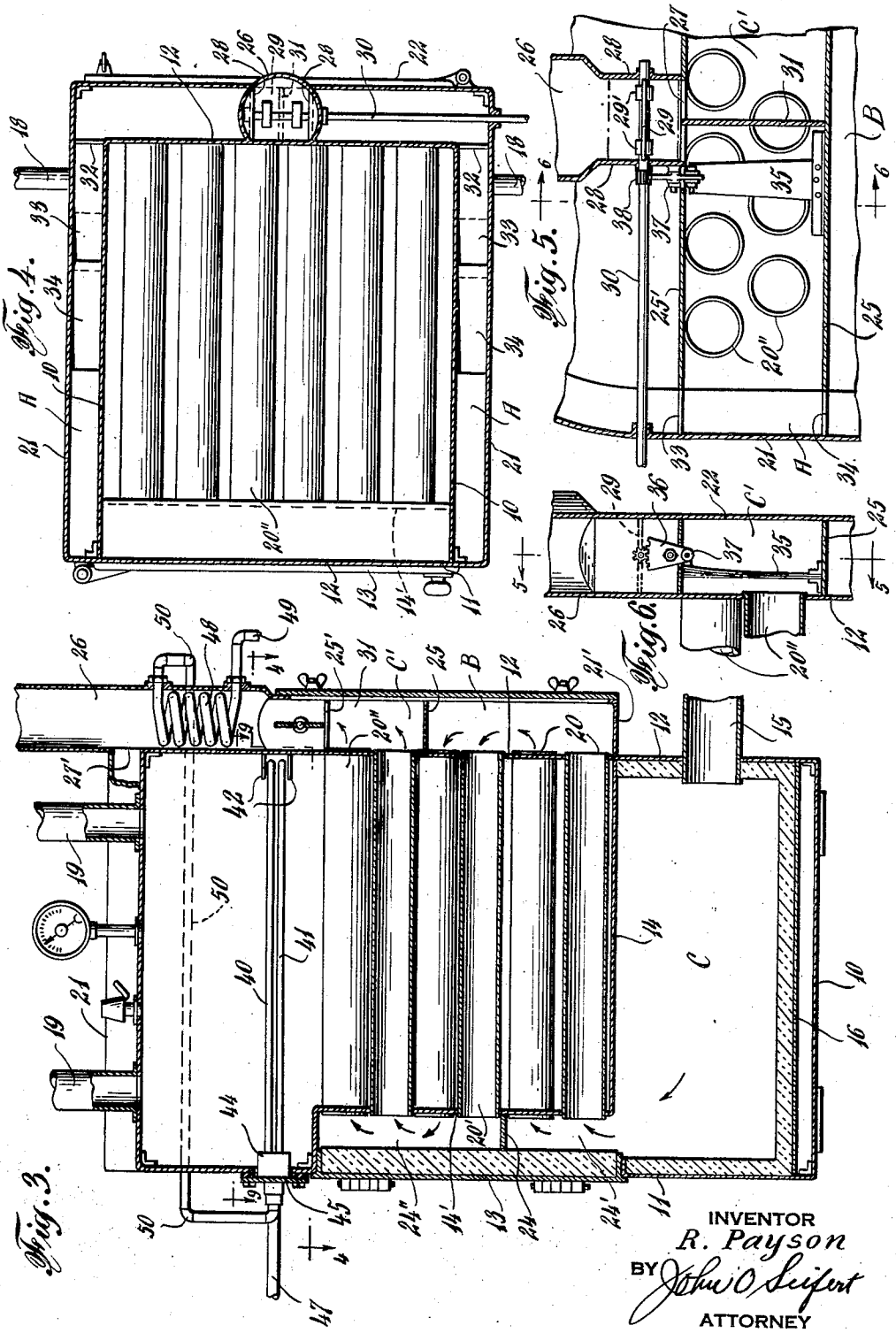

Fig. 3.

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BOILER

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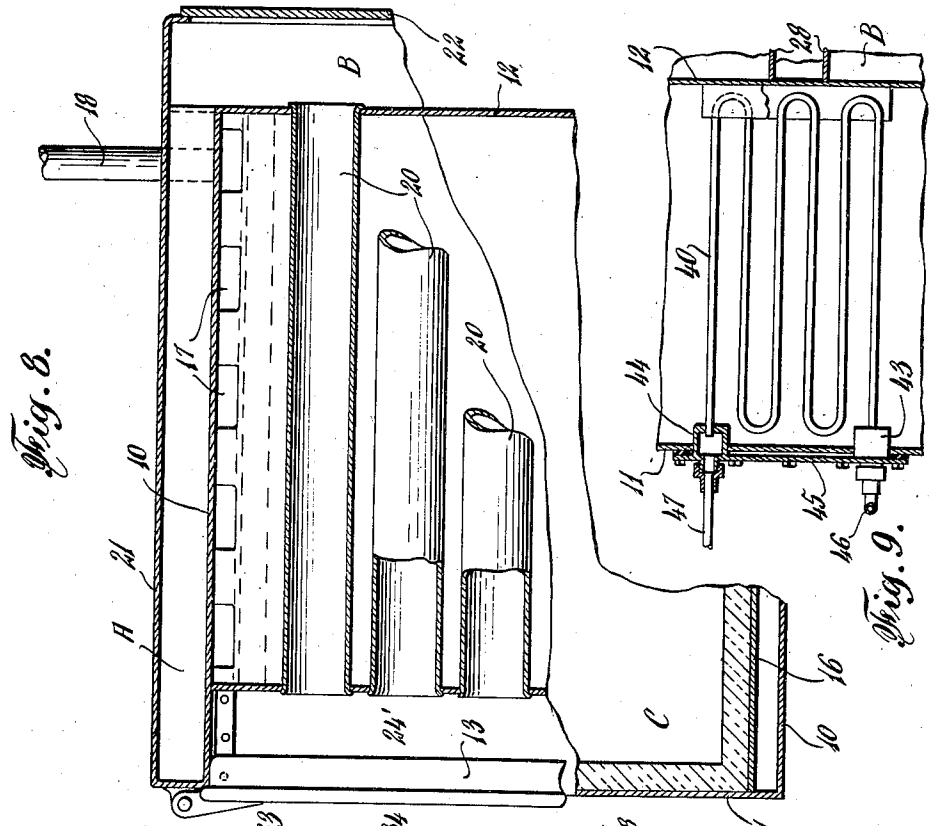

Fig. 8.

Fig. 9.

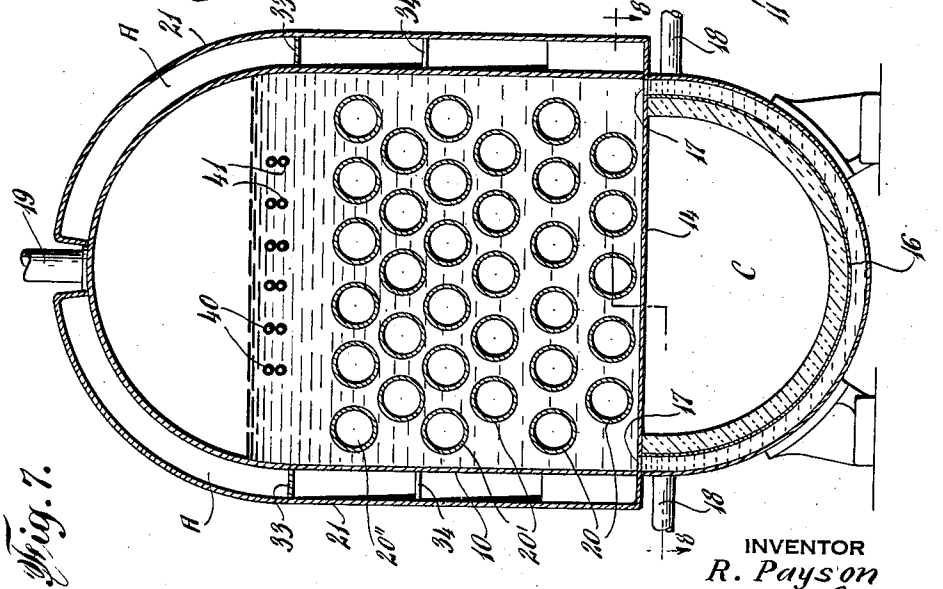

Fig. 7.

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UNITED STATES PATENT OFFICE

2,230,087

BOILER

Rudolph Payson, New York, N. Y.

Application August 16, 1938, Serial No. 225,159

4 Claims. (Cl. 122—76)

This invention relates to boilers for use in steam and hot water heating systems, wherein a fuel combustion chamber is combined with the boiler and the hot gases of combustion in their passage from the combustion chamber to the outlet for waste gases of combustion are adapted to traverse flues in the form of tubes extended through the boiler and secured at the ends in the end boiler sheets or plates whereby to transfer the heat of the gases of combustion to and heat the water and/or generate steam in the boiler.

It is the primary object of the invention to provide an improved construction and arrangement of boiler of this type that is highly efficient in use.

In boilers of this character it has been the practice to provide the combustion space with a water jacket connected in circulation with the boiler disposed relative to the opposite sides and sometimes the rear of the combustion chamber to utilize the heat of combustion in the combustion chamber to effect a preheating of the water in the boiler.

It is a further object of the invention to provide a boiler particularly adapted to be fired by a fluent fuel, such as oil or gas, and provide an improved combustion chamber combined in the boiler with a water jacket disposed about the sides and bottom of the combustion space.

Due to the incomplete combustion of the fuel and low temperature of the gases of combustion when starting combustion of fuel in the combustion chambers of boilers of this character and a possibility of creating gas pockets that may explode by rise in the temperature of the gases of combustion, the boiler flues are connected directly in communication with the outlet for the waste products of combustion and the outlet connected to a stack. However, when the boiler parts become warm or heated there is substantially a complete combustion of the fuel, particularly when utilizing oil or gas as fuel, with the result that a large amount of the hot gases, the heat of which has not been transferred to the boiler water, are exhausted through the stack with a consequent great waste of fuel.

It is another object of the invention to provide an improved construction of boiler by arranging the exterior of the boiler with a jacket for the passage of the hot gases of combustion, the jacket having an outlet in communication with the outlet for the waste gases of combustion and an inlet for hot gases of combustion and the provision of means operative to connect the boiler flues directly with the outlet for the waste gases of combustion during the starting of combustion and incomplete combustion of fuel in the combustion chamber and upon substantially complete combustion of the fuel to by-pass the hot gases of combustion through the jacket about the boiler and thus effect a more efficient transfer of the heat of the superheating of the steam when the boiler is arranged as a steam generating boiler.

A further object of the invention is to provide a boiler of this character wherein the means to control the by-passing of the hot gases of combustion to a jacket disposed about the boiler comprises a damper or valve, and the provision of thermostatically actuated means operative to normally actuate the damper to open the flues or passage for the hot gases of combustion to the outlet for the waste gases of combustion, and operative when it is heated by a rise in the gases of combustion to a predetermined temperature to actuate the damper to by-pass the hot gases of combustion through the boiler jacket.

In adapting boilers for heating water in a hot water supply it is the usual practice to heat a coil through which the water to be heated circulates directly by the water in the boiler, the cold water to be heated being delivered directly to the coil which serves to exchange the heat of the boiler water to the water circulating through the coil and thus constantly tending to reduce the temperature of the boiler water.

It is another object of the invention to provide improved means for use in connection with a boiler to heat water for a hot water supply and comprising a water circulating coil or tubes arranged in and heated by the boiler water and a coil arranged in the outlet means for the exit of the waste gases of combustion connected to a source of cold water supply and the coil in the boiler water to effect preheating of the water before it is delivered to the water heating coil or tubes in the boiler water. Other objects and advantages of the invention will hereinafter appear.

In the drawings accompanying and forming a part of this application,

Figure 1 is a rear elevation of a boiler embodying my invention, partly broken away to show the arrangement of tubes extended through and connected to the end plates of the boiler and the arrangement of the boiler jacket through which to by-pass the gases of combustion to the outlet for the waste gases of combustion.

Figure 2 is a side elevation looking at the right of Figure 1 with a portion of the boiler enclosing jacket broken away and showing deflectors for directing the flow of the gases of combustion therethrough.

Figure 3 is a sectional view taken on the line 3—3 of Figure 1 looking in the direction of the arrows.

Figure 4 is a cross sectional view taken on the line 4—4 of Figure 3 looking in the direction of the arrows.

Figure 5 is a sectional view taken on the line 5—5 of Figure 6 looking in the direction of the arrows and showing the thermostatically actuated means to actuate the damper to by-pass the gases of combustion through the boiler enclosing jacket.

Figure 6 is a sectional view taken on the line 6—6 of Figure 5 looking in the direction of the arrows.

Figure 7 is a sectional view taken on the line 7—7 of Figure 2 looking in the direction of the arrows.

Figure 8 is a sectional view taken on the line 8—8 of Figure 7 looking in the direction of the arrows; and

Figure 9 is a sectional view taken on the line 9—9 of Figure 3 and showing an arrangement of a water heating coil in and heated by the boiler water.

In carrying out the invention the boiler may be built up of sectional castings but is preferably constructed of sheet material such as boiler plate and the parts united by welding or otherwise. The boiler comprises a shell 10 of oblong form in longitudinal section having an arcuate inverted U shaped top and a U shaped bottom, with a wall or plate 11 at and closing the rear end of the shell and a wall or plate 12 at and closing the front end of the shell. The rear wall 11 is provided with an opening arranged with a removable closure, shown as hinged, having a lining of refractory material on the inner surface, as shown at 13 in Figure 3. The shell is separated into a boiler portion and combustion space by a transverse plate having a portion 14 extending in a horizontal plane from the front wall 12 adjacent to the closure for the opening in the rear wall 11 at substantially the juncture of the U shaped bottom portion with the side walls of the shell, the plate having a vertical portion 14' extending in parallel spaced relation to the closure 13 for the opening in the rear wall 11 to adjacent the juncture of the inverted U portion with the body of the shell, and then extends horizontally to the wall 11, arranging the portion of the shell above said plate as the boiler proper and the portion below the horizontal portion 14. As a combustion space C in communication with the space between the vertical portion 14' of the transverse plate and closure 13. The boiler may be fired with any suitable fuel but is preferably fired with a fluent fuel, such as gas or oil, and is shown as arranged with the air conduit 15 of an oil burner extended through the front wall 12 into the combustion space. A U shaped wall 16 is mounted in the combustion space in spaced relation to the U shaped bottom of the shell and in conjunction with the portion 14 of the transverse plate providing the combustion space with a water jacket extending about the sides and bottom of the combustion space and connected in water circulation with the boiler through opening 17 in the side marginal portions of the portion 14 of the transverse plate. To fill water into the boiler and return water, or condensation of steam, to the boiler the water jacket for the combustion space is provided with openings adapted for mounting pipes therein, as at 18, the one pipe being adapted to be connected with a source of water. The water is filled into the boiler substantially to the level shown in Figure 7. A drain outlet preferably is provided in the lower portion of the water jacket for the combustion space. The boiler is provided with water or steam outlet means, as at 19, leading from the top of the shell and is provided with a safety valve as well as a gauge, as shown in Figure 3.

A bank of horizontal tubes to constitute flues for the passage of the hot gases of combustion from the combustion chamber are extended through the boiler, the tubes being fixed at one end in openings in the vertical portion 14' of the transverse plate 14 and fixed at the opposite ends in openings in the front wall 12 of the shell. The tubes are shown as comprising six rows of laterally spaced tubes, although a greater number of rows of tubes may be used, arranged to provide a lower section 20 consisting of the two lower rows of tubes, an intermediate section 20' consisting of the next two rows of tubes, and an upper section 20'' consisting of the upper two rows of tubes for the passage of the hot gases of combustion through the successive sections of the tubes in series.

To arrange the bank of tubes to constitute a sinuous passage including three passes of the tubes for the hot gases of combustion there is provided a chamber at the outer side of the front wall 12 arranged with outlet means for the products of combustion adapted to be connected to a stack through which to exhaust the products of combustion. For this purpose a pair of walls or plates 21 are provided, which may be cast integral with the shell or comprise sheet metal plates secured to the shell, as by welding or otherwise. Each wall provides a jacket or jackets disposed about the sides and top of the shell. These walls 21 extend from the juncture of the bottom U shaped portion of the shell with the side walls of the shell to one side and adjacent the longitudinal center at the top of the shell. One end and the top and bottom marginal portion of said walls 21 are flanged laterally in the same direction and engage and secured, as by welding or otherwise, to the shell closing one end and the top and bottom of the jackets A. The walls 21 are of greater length than the shell and arranged with a front portion projecting beyond the end wall 12 of the shell, as shown in Figures 2 and 3. The space at the bottom of said projecting portions is closed by a wall or plate 21' of a width equal to the projecting portions of the walls 21 and extends between said walls. The lower portion of the space at the ends of said wall extensions is closed by a removable closure member, shown in the form of a hinged door 22, and the upper portion is closed by a wall 23 that may comprise extensions of the jacket walls 20, but preferably comprises a plate secured to said jacket walls. By this arrangement the closure 22 and wall 23 in conjunction with the end wall 12 of the shell form a chamber in communication with the ends of the tubes opening through the wall 12.

To cause the hot gases of combustion to pass in a plurality of passes through the bank of tubes, and shown as caused to pass in three passes through the tubes, the space between the portion 14' of the transverse plate 14 and rear wall 11 of the shell is separated by a plate 24 into two superposed compartments 24', 24'', the compartment 24' being in communication with the combustion space and also with the section 20 of the tubes, and the upper compartment 24'' connected in communication with the tube sections 20', 20''. The chamber at the outside of the front wall 12 is separated into two compartments B and C' by horizontal partitions 25, 25', the lower compartment B connecting the tube sections 20 and 20'. The upper compartment C' is in communi-

cation with the jackets A and outlet means for the products of combustion, shown as a pipe 26 extended centrally into the top of the chamber and in communication with the compartment C' through an opening 27 in the partition 25', walls 28 extended upwardly from the partition 25 at opposite ends of said opening and between the end wall 12 and plate 22 forming a passage in communication with the pipe 26. By this arrangement the hot gases of combustion are caused to pass from the combustion chamber through the lower tube section 20 to the lower compartment B, then pass in a reverse direction through the tube section 20' to the compartment 24 and then reversely through the upper tube section 20'' to the upper compartment C'. The jackets A are in communication with the opposite ends of the compartment C' and with the outlet pipe 26 through connections with the pipe 26, as shown at 27' in Figure 3.

Means are provided to control the opening 27 to open communication between the outlet means 26 and the chamber C' to permit the gases of combustion exiting from the tube section 20'' to pass through said opening to the pipe 26, and to close said opening and thereby cause said gases to pass into and through the jackets A to the outlet means 26 through the connections 27' of the jackets with the outlet means. This means comprises a closure in the form of a damper 29 having ears whereby it is mounted within the walls 28, as at 29', on a rod 30 extended between and rotatably supported in the walls 28, the rod extending through a shell 10 and jacket wall 21 whereby the damper may be manually adjusted to positions to open or shut off communication between the opening 27 and the pipe 26.

At the commencement of combustion of fuel in the combustion chamber with the boiler parts cold and a consequent low draft there is incomplete combustion of the fuel resulting in the creating and coating with carbon the walls of the flue through which the gases pass which retards the transfer of the heat of the gases of combustion through the walls of the flues to the boiler water and with a possibility of creating gas pockets that may explode in a rise of the temperature of the gases. To obviate this the damper 29 is adjusted to open the opening 27 to the outlet means, as shown in Figure 3, to permit the gases of combustion exiting from the tube section 20'' to pass through said opening 27 to the outlet means and stack and thereby increasing the draft through the boiler flues and exhaust of the products of combustion directly through the outlet means 26. When the boiler parts become heated or hot with a consequent more complete combustion of the fuel and practically eliminating the creating of carbon the damper is adjusted to close the opening 27, as shown in Figures 4, 5 and 6 and thereby cause the gases of combustion exiting from the tube section 20'' to pass from the compartment C' to the jackets A and from the latter to the outlet means 26 through connections 27' and effecting a transfer of the heat of the gases of combustion to the boiler water and steam above the water level through the boiler shell 10.

The gases exiting from the tube section 20'' are directed to the jacket A when the damper is adjusted to shut off the outlet pipe 26 from the opening 27 by a vertical wall 31 extending transversely of the compartment C' and intersecting the opening 27, as shown in Figure 5.

To prevent the gases of combustion exiting from the lower tube section 20 to the jackets A walls 32 are extended transversely of the lower portion of the jackets at the front ends thereof, said walls extending upwardly from the bottom of the jackets to the partition wall 25 of the compartment B. To cause the gases of combustion entering into the jackets A to flow through the lower portion of the jackets, deflectors 33, 34 are arranged in said jackets, the deflectors, in the form of walls, extending transversely of the jackets. The deflector 33 has a horizontal portion arranged in the plane of and extending from the partition wall 25' for the compartment C and then declines downwardly from said horizontal portion to adjacent the bottom of the jackets, as shown in Figure 2. The deflector 34 commences at a point intermediate the horizontal portion of the deflector 33 and extends downwardly in parallel and spaced relation to the declining portion of deflector 33. By the declining arrangement of the deflectors there is provided a pair of passages having an inlet opening to the compartment C' and outlets opening to adjacent the bottom of the jackets A.

As stated, the damper is adjusted to open communication between the outlet pipe 26 and the opening 27 in partition 25' at the commencement of the combustion of fuel in the combustion chamber and is adjusted to shut off communication between the opening 27 and outlet pipe 26 when the boiler parts become heated with a consequent practically complete combustion of the fuel, and to effect automatic actuation of the damper there is provided thermostatically actuated means to actuate the damper. This means comprises a temperature responsive element or member 35 comprising plates of material having different coefficients of expansion fixed at one end upon and extending upwardly from the partition 25 with the opposite end adjacent the partition 25'. The upper end of the member 35 is pivotally connected to a toothed sector 36 (Figure 6) pivotally mounted on a bracket on the partition 25', as at 37, the member 35 being connected to the sector at the side of its pivotal support opposite the teeth of the sector. The teeth of a sector mesh with the pinion 38 fixed on the damper carrying rod or shaft 30, as shown in Figure 5.

The temperature responsive element 35 normally positions the damper 29 to connect the compartment C' in communication with the outlet means 26, as shown in Figure 3, the temperature responsive element assuming the position shown in dotted lines in Figure 6. The parts are in this position at the commencement of the combustion of fuel in the combustion chamber. As the temperature of the gases of combustion rises the element 35 is heated and moved to the position shown in full lines in Figure 6 and thereby rocks the sector and through the connection of the sector with the pinion 38 rotates the rod 30 and thereby actuates the damper to position to close the opening 27, as shown in Figures 5 and 6, and thereby cause the gases of combustion to pass into the jacket A. It will be obvious that the actuation of the damper is gradual and corresponds to the gradual increase in the temperature of the gases and heating of the temperature responsive element 35.

To adapt the boiler for heating water for a hot water supply, a coil or coils, shown in the form of a pair of reversely bent pipes 40, 41, are arranged in the boiler preferably immersed in the water therein, the pipes at one end of the bends engaging between ledges 42 extended inwardly from the end wall 12 of the shell 10, as shown in Figure

3. One end of each tube is connected to a chamber in a box **43** and the other end to a chamber in a box **44**, the boxes being arranged integral with and extended from a face of a plate-like member **45** mounted on the end wall **11** of the shell **10** with the boxes extended through openings in said wall into the boiler, as shown in Figure 9. Water is circulated through said pipes by connecting one box, such as the box **43**, to a pipe **46** which may comprise the water inlet pipe, and connecting to the other box **44** a pipe **47** which may comprise the outlet pipe for the heated water connected to a storage tank. The connection of the pipes **46**, **47** to the boxes **43**, **44** may be as shown in section of the connection of pipe **47** to box **44** in the upper portion of Figure 9.

In heating water for a hot water supply by boiler water it is the usual practice to connect one end of a coil or coils, such as the end connected to the pipe **46**, to an inlet pipe connected directly with a water main. This admits water to the coil in a cold condition which tends to chill the water in the boiler and thus reducing the efficiency of the boiler. Means are therefore provided to preheat the water supplied to the coils or pipes **40**, **41** and is effected by utilizing the waste products of combustion exiting through the outlet means. For this purpose a coil **48**, as shown in Figure 3, is arranged in the conduit of the outlet means **26** with the opposite ends of the coil extended through openings in said conduit. The one end **49** of the coil is adapted to be connected to a pipe leading from the water main, and the opposite end of the coil is connected through the piping **50** with the inlet pipe **46** to the coils **40**, **41**. The heat of the products of combustion exiting through the outlet means is transferred through the coil **48** to the water circulating therethrough effecting a preheating of the water that is supplied to the coils **40**, **41**.

It will be obvious that various modifications may be made in the construction and arrangement of the parts without departing from the scope of the invention and that portions of the invention may be used without others and come within the scope of the invention.

Having described my invention, I claim:

1. In a boiler, a sheet metal shell of oblong form in vertical section, vertical closures at the front and rear ends of the shell, a metal plate extending transversely of the shell having a vertical portion extending in parallel and spaced relation to an end closure of the shell and arranging the shell with a water space above said plate and a combustion chamber below the plate and the space between the vertical portion of the transverse plate and the one end closure of the shell providing an uptake for the combustion chamber, a bank of horizontal tubes extending through the water space of the boiler leading from the uptake of the combustion chamber through the opposite end closure of the shell, means connected to and co-operating with the end closure of the shell through which the tubes lead to provide a chamber in communication with the tubes, outlet means for the products of combustion in communication with said chamber, and horizontal transverse partitions in said chamber and the uptake of the combustion chamber constructed and arranged to cause the hot gases of combustion to flow from the combustion chamber in series through successive sections of the bank of tubes to the outlet means.

2. In a boiler, a shell of oblong form in vertical section rounded at the top and bottom and having closures at the front and rear ends, a metal partition extending transversely of the shell arranged to form the shell with a water space above said partition and a combustion chamber in the rounded bottom extending from the front closure to and in conjunction with the rear closure of the shell providing the combustion chamber with an uptake at the rear thereof, superposed rows of tubes extended through the water space of the boiler leading from the uptake of the combustion chamber through the closure at the front end of the shell for the passage of the hot gases of combustion from the combustion chamber, a jacket spaced from and in conjunction with the front closure of the shell forming a chamber for the gases of combustion in communication with the tubes and having an outlet in the top for the waste gases of combustion, an outlet pipe connected to the outlet from said chamber, horizontal transverse partitions in said gas chamber and in the uptake of the combustion chamber separating said gas chamber and said uptake into passes adapted to cause the gases to flow in a multiple of passes in series through the tubes from the combustion chamber to the outlet, and means for controlling the connection of the outlet pipe with the outlet of said gas chamber.

3. In a boiler as claimed in claim 2, a sheet metal partition extending from the transverse partition relative to and interiorly spaced from the sides and bottom of the combustion chamber providing a jacket in communication with and constituting a continuation of the water space of the boiler, and said jacket having a water inlet to the water space of the boiler.

4. In a boiler, a shell of oblong form in vertical section rounded at the top and bottom and having closures at the front and rear ends, a plate extending transversely of and arranging the shell with a water space above the plate and a combustion chamber below the plate, said plate having a vertical portion arranged in parallel spaced relation to and co-operating with the rear closure of the shell to provide the combustion chamber with an uptake at the rear end thereof, a chamber arranged at the outer side of the front end closure of the shell arranged with outlet means for the products of combustion, a bank of rows of horizontal tubes extending transversely through the water space of the boiler leading from the uptake of the combustion chamber through the front closure of the shell, a partition extending transversely of the uptake of the combustion chamber shutting off the upper sections of the bank of tubes from direct communication with the combustion chamber and connecting said tube sections in communication with each other, and a transverse partition separating the chamber at the front closure into superposed compartments the lower compartment connecting the lower sections of the bank of tubes in communication with each other and the upper compartment connecting the upper section of the tubes in communication with the outlet means, and said partitions connecting the tubes in a series of passages for the flow of the hot gases of combustion from the combustion chamber to the outlet means.

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