April 18, 1933. W. DOBLE 1,903,807

BOILER

Filed Dec. 23, 1929

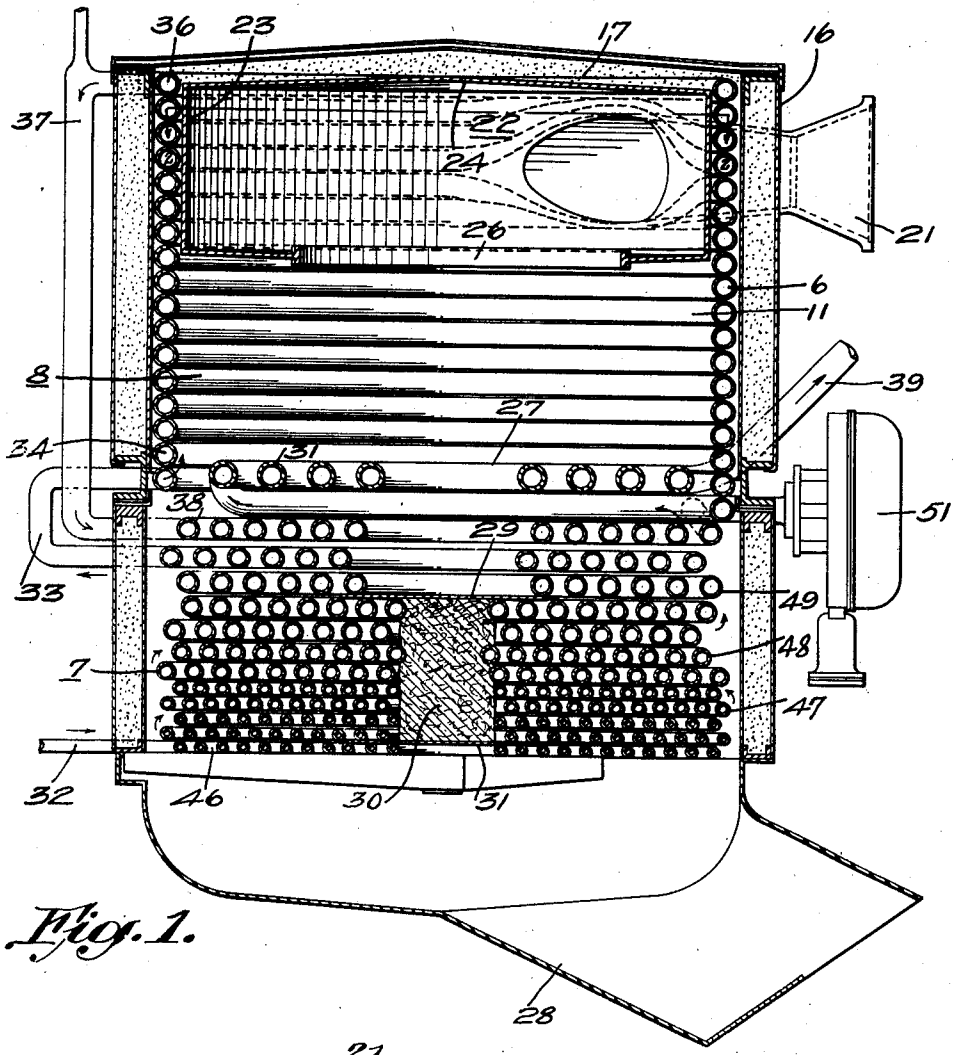


Fig. 1.

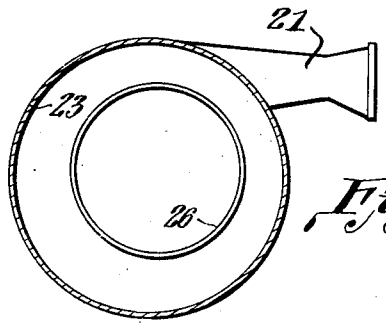


Fig. 2.

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UNITED STATES PATENT OFFICE

WARREN DOBLE, OF EMERYVILLE, CALIFORNIA, ASSIGNOR TO DOBLE STEAM MOTORS CORPORATION, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE

BOILER

Application filed December 23, 1929. Serial No. 415,997.

My invention relates to devices primarily intended for the thermal treatment of a fluid, such as the evaporation of water into steam.

Under certain operating conditions it is desired to have a device compact in size and relatively light in weight which is capable of evaporating a fluid under conditions of relatively high temperatures and pressures. One form of such a device is that sometimes termed a flash boiler or, more appropriately, a series tube forced circulation boiler. Such a boiler is typified by the use of a relatively long tube which receives heat from a suitable source to convert the water into steam. Water is injected into one end of a tube and is forced thru it in thermal contact with the tube so that during its passage it gradually absorbs heat from the provided source. The water is thus raised to its boiling point whereupon, with the absorption of additional heat, it passes into the vapor state. Depending upon the quantity of heat supplied and the length of the tube, the steam generated may be subjected to further heat so that it becomes superheated. In this condition it is usually led away to some form of engine to be utilized for performing work.

In automotive work I have employed such a boiler to generate steam under relatively high temperatures and pressures. However, I have found that in this practice varying demands are made upon the boiler for steam and, as a consequence, the output of the boiler is being constantly varied. Thus, sometimes the boiler is called upon to deliver steam under full output. At other times the demand is very light and but a small amount of steam is withdrawn from the boiler. Under this mode of operation numerous difficulties have arisen. Thus, when the steam flow is stopped after a period of operation, the residual heat contained in the fire box is radiated and is gradually absorbed by the tube so that the temperature of the steam within the tube rises, the steam becoming superheated to a high degree. This results in a deleterious effect upon the metal of the tube and a depositing of carbon from oil which may be present. The generation of steam from water in the tube and the superheating of this steam also occasions an unwarranted rise of steam pressure when there is no demand for steam.

It is an object of my invention to provide a series tube boiler that will deliver steam of substantially uniform characteristics under the desired pressure and temperature.

Another object of my invention is to provide a manner of boiler construction in which little mass other than the fluid heating surface is subject to the heat of combustion of the fuel.

Another object of my invention is to provide an improved manner of boiler construction so that boilers having certain desirable operating characteristics may be produced upon a commercial scale.

My invention possesses other advantageous features, some of which with the foregoing will be set forth at length in the following description where I shall outline in full that form of the boiler of my invention, which I have selected for illustration in the drawing accompanying and forming a part of the present specification. In said drawing I have shown one form of boiler embodying my invention, but it is to be understood that I do not limit myself to such form since the invention, as set forth in the claims, may be embodied in a plurality of forms.

In the drawing, Figure 1 is a diagrammatic showing of the boiler of my invention in transverse section and Figure 2 is a cross section of the firebox on the line 2—2 of Figure 1.

The boiler of my invention may be briefly characterized as comprising a relatively long tube having certain predetermined characteristics and being wound into coils about and adjacent to a fire box which is capable of retaining but little heat.

In the preferred embodiment of the invention as disclosed in the drawing, the boiler comprises a relatively long tube 6 wound into the spiral coils generally designated at 7 and into a helical coil generally designated at 8. The helical coil encloses a space 11 to which reference will presently be made. Surrounding the several tubes is a light metal cylindrical shell 16 which in-

cludes a refractory material 17 to afford the desired degree of heat insulation. The cylindrical shell is conveniently disposed with its axis vertical.

A combustible mixture of fuel and air is introduced through a venturi 21 extended to discharge the mixture tangentially into a firebox 22 provided in the space 11. This firebox, in accordance with my invention, is conveniently constructed of a very light material as sheet metal. It further comprises a usually cylindrical wall 23 coaxially situated with respect to the shell 16 and to which is secured a conical head 24 and an apertured conical plate 26. The firebox is preferably situated to provide a combustion chamber in the space 11 between the plate 26 and upper coil 27 of the spiral coils 7. The combustible mixture which is introduced through the tangential venturi in the firebox rotates therein as it burns. Subsequently it is discharged in a spiral manner into the combustion chamber where the combustion is completed. The gases then pass downwardly over the coils 7 and are discharged through a conveniently provided exhaust hood 28. By providing the firebox with the tangential inlet the path of flame travels throughout the firebox and combustion chamber is lengthened so that efficient combustion is obtained, while the turbulence set up by the whirling of the gases and their passage through the hole 26 favor and bring about thorough combustion of the fuel.

It is to be noted that the apertured conical plate 26 serves as a nozzle so that the products of combustion, burning fuel and uncombined fuel and air are mixed together before passing into the space 11. It is further to be noted that the aperture in the plate 26 is offset with respect to the vertical axis of the boiler. I prefer that this offset be provided to cause a uniform distribution of flow of gases. With a tangential entry of the fuel and air mixture the tendency for the gases to spill over to a greater extent on one side of the aperture than on another is material. This is obviated by suitably offsetting the aperture.

In the preferred form of the invention I provide a wall 29 extending across the hole left at the center of the spiral coils to prevent the gases from flowing though the hole and to force them to pass down between the tubes forming the spiral coils. The hole at the center of each spiral coil is caused by the inability to bend the tube comprising the coil to a very small radius. Consequently, what opening is left at the center of the spiral coils is covered by the plate 29 which blocks the flow of gases. The hole beneath plate 29 is filled with asbestos, indicated at 30, and retained in place by plate 31.

Feed water introduced through inlet 32 from a suitable force feed pump passes successively through the various spiral coils comprising those designated generally at 7. After the water has passed through these coils it rises through connection 33 to the helical coils 8. Preferably the connection is made to the lowermost helical coil 34 finally emerging from the uppermost coil 36 into conduit 37 which conveys it to a spiral coil designated as 38. After passing through the coil 38 the fluid passes into that spiral coil previously designated as 27 from which it is withdrawn into conduit 39 to be taken away to an engine.

It is to be noted that water introduced into the lowermost coil is subject to thermal contact with the relatively cool products of combustion. Further, as the water progresses through the boiler it successively advances into thermal contact with hotter gases, thus insuring that the most efficient boiler operation is secured together with the most uniform generation of steam. The helical coils absorb heat by radiation from firebox 23 and by radiation and convection from flame burning in the combustion space 11. Because of the flow of heat from the firebox 23, its temperature is maintained sufficiently low so that it may be constructed of a relatively light gauge of sheet metal. Ordinarily such light gauge metal subjected to the high temperature occasioned by the burning fuel would burn out very quickly. In previous practice it has been deemed necessary to construct a firebox of a relatively heavy metal, usually a casting of a very expensive alloy. Such a firebox was not only disadvantageous because of its great weight but also because of the large amount of heat stored in the great mass of metal which caused overheating of the boiler tube after the boiler was shut down. Another disadvantage presented by the heavy firebox was that when starting up from the cold, a considerable time lag was occasioned before steam generation took place because of the great quantity of heat which the firebox had to absorb before steam generation began. This disadvantage likewise operated when the cessation of demand for steam occurred for the heat contained in the box radiated and gradually baked out and destroyed the tube. With the light firebox these disadvantages have been overcome since the light box is almost immediately heated up to a temperature favoring combustion and the heat of combustion thereupon becomes available for the generation of steam. Upon a cessation of the demand for steam a relatively small amount of heat is left to be radiated to the adjacent coils and what little is radiated, is absorbed by the helical coil with no appreciable rise in its temperature.

From a construction viewpoint, the substitution of a light firebox for the heavy

one also possesses many advantages. Thus the sheet metal construction is relatively light and need not have heavy supports for it. Further, the entire weight of the boiler assembly is reduced.

In operation, the small mass of the firebox makes the burner operation and the steaming in the tubes approximately synchronous, reducing to a small value the lag between steam generation and engine demand. This is particularly desirable inasmuch as it makes for almost immediate response to a demand for steam. In automotive practice this is an extremely important feature for an instantaneous application of power is often not only desirable but necessary.

The gases ejected from the firebox through the apertured conical plate follow a gyratory path as they continue into the combustion space 11. The first tube with which they contact directly is the coil 27 which is usually filled with superheated steam. The hot gases give up a portion of their heat to the tube and pass to the tubes below.

The contacting of the gases with the superheater coil 31 causes them to give up some of their heat and, consequently, to shrink in volume and so drop in velocity. To overcome this effect and to maintain the heating value of the gases despite the fact that they first contact with the superheater coil, I preferably arrange the other tubes in the bank so that a high velocity of the gases is maintained as they progress through the bank. One manner of effecting this is by obstructing the passage in increasing amounts in the direction of the gas flow so that, despite the dropping temperature of the gases and their consequent contraction, the lessening in cross-sectional area maintains the velocity at about the same rate. This arrangement is well exemplified in the drawing in which the interstices and the extent of the several convolutions of the coils 7 are arranged to provide for the desired effect upon the gases. In this connection it is to be noted that the cross sectional area available for the passage of the gases adjacent to coil 27 is relatively great compared to that provided by the last of the series of coils 7 into which the feed water is injected. This tends for an equalization of the heating rate provided for each of the several coils and in steaming up to allow steam to form in the lower coils before the coil 27 is overheated. Such steam formation forces water and steam toward coil 27, preventing overheating and consequently the boiler is prompt in steaming up.

In accordance with my invention I am enabled to provide a boiler suitable for the generation of steam under a pressure of 2000 pounds or more and having a temperature of 1000° F. with some 360° of superheat. This boiler is capable of evaporating about 1500 pounds of water per hour. As a typical boiler of my design weighs but five hundred pounds and is only 22 inches in diameter and 40 inches in height, it is to be appreciated that the boiler of my construction is a decided advancement of the art.

It is also within my invention to form the boiler in such fashion that the rate of heat transfer to the tube from the gases favors prompt steaming up from cold. In this connection, the lowermost spiral coils designated as 46 are preferably formed of a tube having a wall thickness of a minimum value to withstand the calculated boiler pressure together with the safety factor employed. It is usually desirable to provide the coils with a relatively light wall since this imposes the minimum delay in allowing the heat to pass into the water due to the relatively small mass of metal to be heated when the boiler is being steamed up. The upper coils as 27 are of greater wall thickness which affords a delay in the rise of temperature when steaming up, thus allowing the lower coils to become active and throw steam and water up to the upper coils which in turn prevents overheating of the upper coils.

The internal diameter of the tube is varied as the tube progresses through the boiler so that accommodation is had for the increase of velocity due to the expansion and generation of steam from the heated fluid. Thus tubes 47, 48 and 49 are of larger diameter than tube 46. By providing a tube of increasing size a larger wall mass is provided so that greater heat storage is afforded in the upper coils. The characteristics of the steam generated, under these conditions, tend to be constant and to fluctuate less with changes in the demand for steam. The added wall thickness in the upper convolutions of the tube also serves to absorb heat more slowly when the boiler is started from cold thus allowing the lower tubes to become active and to generate steam causing heated water and steam to pass up into the upper coils where the process of steam generation continues.

To provide for the control of the boiler I have provided a control means 51 which is actuated by suitable mechanisms placed in contact with the boiler steam in the boiler tube so that the temperature and pressure may be maintained at predetermined values.

I claim:

1. A boiler comprising a cylindrical boiler shell, a fire box in one end of said shell, a fluid tube having a plurality of convolutions through which fluid flows serially in the other end of said shell, the planes of said convolutions lying transversely of said shell, a cylindrical portion of said tube surrounding said fire box and receiving fluid from said convolutions, and an additional convolution disposed intermediate said fire box and said first named convolutions and

receiving fluid from said cylindrical portion.

2. A boiler comprising a long tube into one end of which feed liquid is pumped and from the other end of which vapor issues arranged in the form of a cylindrical coil to confine a space and a plurality of spiral coils, a cylindrical metal firebox arranged within said cylindrical coil and adapted to receive a fuel mixture, said metal fire box having an outlet hole in one end adapted to discharge flame into the space confined by said cylindrical coil, said spiral coils being arranged adjacent said cylindrical coil and adapted to lie in the path of products of combustion leaving the space confined by said cylindrical coil.

3. A boiler comprising a cylindrical jacket housing, a helical coil confining a space, a plurality of spiral coils, a cylindrical metal fire box disposed within said helical coil having a tangential fuel mixture inlet in its cylindrical surface, and a flame outlet in one end of said firebox arranged to discharge flame into the space confined by said helical coil, said spiral coils arranged to lie in the path of the products of combustion leaving the space confined by said helical coil.

4. A boiler comprising a cylindrical jacket within the upper portion of which is a helical coil having its axis substantially coincident with the axis of the jacket, a plurality of spiral coils having their axes substantially coincident, the said coincident axes being substantially coincident with the axis of said jacket, a cylindrical fire box having upper and lower covers with an inlet aperture arranged tangentially in its cylindrical surface and an outlet aperture in said lower cover, said fire box having its axis substantially coincident with the axis of said jacket, the helical coil enclosing a combustion space beneath said fire box into which flame from said outlet aperture projects, said spiral coils lying beneath said helical coil and positioned to lie in the path of products of combustion from the space confined by said helical coil.

5. A boiler comprising a long tube into one end of which feed fluid is forced and from the other end of which heated vapor issues, said tube being formed into a plurality of spiral coils and a juxtaposed cylindrical coil, all of said coils having their axes substantially coincident, a cylindrical fire box having upper and lower covers positioned in the upper portion of said cylindrical coil, said cylindrical coil and said fire box having their axes substantially coincident, and a fuel mixture inlet in said fire box, the lower cover of said fire box having a flame outlet aperture therein, the fire box and the cylindrical coil forming a combustion space, said spiral coils lying in the path of products of combustion which issue from said combustion space.

6. A boiler comprising a cylindrical boiler shell having an opening in one end thereof, a cylindrical fire box within the other end of said shell, means for admitting a combustible into said fire box, said fire box having an outlet therein through which products of combustion flow in a direct path to said opening in said shell, a water tube having a plurality of substantially planar convolutions arranged transversely of and extending substantially entirely across said shell in the path of said products of combustion, said convolutions being spaced from said fire box to provide a combustion chamber, and an extension of said tube arranged in a cylindrical form surrounding said fire box.

7. A boiler comprising a cylindrical boiler shell having an opening in one end thereof, a fire box formed of continuous, thin sheet metal within the other end of said shell, means for admitting a combustible into said fire box, said fire box having an axial outlet therein through which products of combustion flow substantially axially of said shell in a direct path to said opening in said shell, a water tube having a plurality of convolutions extending substantially entirely across said shell and across said path of the products of combustion, said convolutions being axially spaced from said fire box to provide a combustion chamber, and an extension of said tube arranged in cylindrical form surrounding said combustion chamber and said fire box.

In testimony whereof, I have hereunto set my hand.

WARREN DOBLE.