

March 2, 1943.

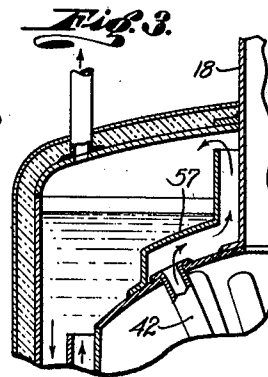
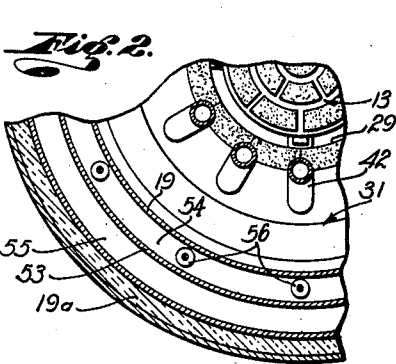
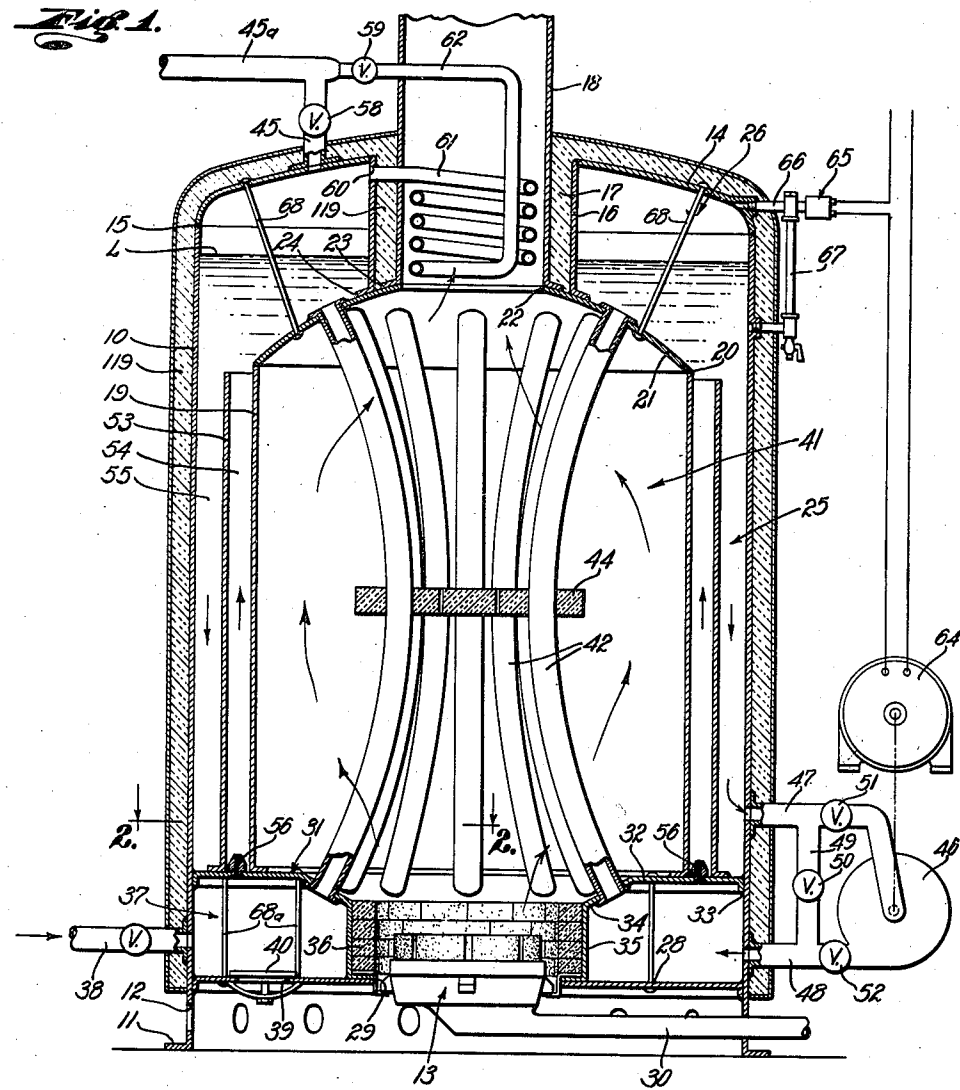
J. E. BRANTLY

2,312,622

STEAM BOILER

Filed Jan. 22, 1940

2 Sheets-Sheet 1



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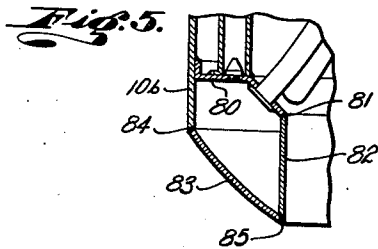
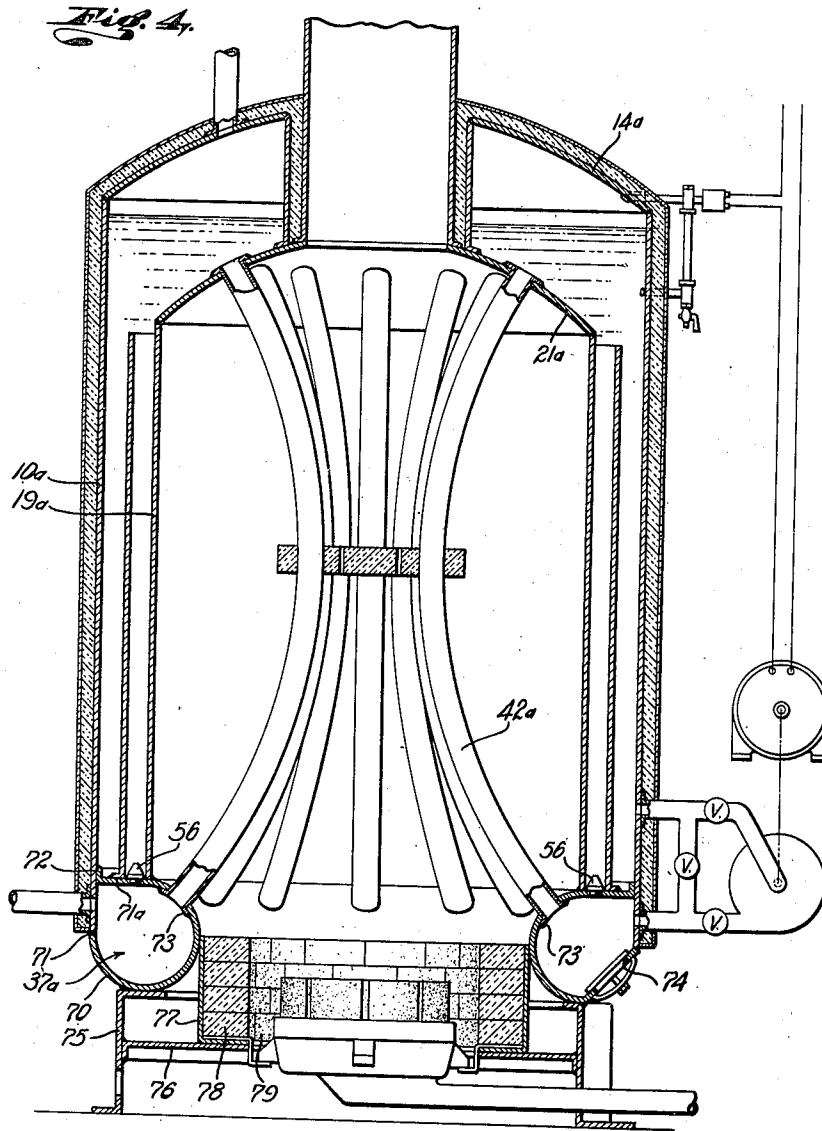
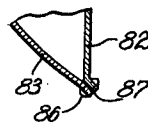


Fig. 6.



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UNITED STATES PATENT OFFICE

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STEAM BOILER

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2 Claims. (Cl. 122-166)

This invention has to do with improvements in steam boilers, particularly of a relatively lightweight and portable type adapted, for example, to oil field service, although in its broad aspects the invention contemplates boilers of various types and uses embodying the present features of construction. This application is a continuation-in-part of my copending application Serial Number 210,896, now Patent No. 2,189,443, Feb. 6, 1940, on Steam boiler.

The invention may be characterized as relating to a vertical type boiler comprising an interior fire box shell surrounded by and enclosed within a spaced outer shell so as to form an annular water leg in direct exposure to the fire box wall, and a steam chamber above the water leg and between the top portions of the fire box and outer shells. This form of boiler construction affords maximum heating efficiency, and therefore requires minimum boiler size and weight for given horse power steam generation, in that the fire box or heating zone is enclosed or enveloped within the water and steam chambers, thus requiring that the fire box heat will be transferred to the water and steam without opportunity for radiation or other loss to the atmosphere.

In its preferred form the present boiler is provided with water tubes extending upwardly within the fire box from a water chamber at the bottom of the water leg and fire box, the tubes serving to maintain an upward water circulation from the water chamber to the upper portion of the water leg and to convert to steam a substantial portion of the water flowing through the tubes. Provision may be made for maintaining rapid circulation of water along the outer surface of the fire box wall to promote high rates of heat transfer, by discharging water in high velocity streams from the water chamber directly into and upwardly within the lower portion of the water leg, and further if desired, by maintaining return circulation from the water leg into the water chamber. Those features having to do with direct water circulation between the water chamber and the water leg are more particularly dealt with and claimed in the parent application referred to above, the present application being primarily concerned with the more general features of construction of the boiler that are independent of circulation between the water chamber and water leg.

From structural as well as operation standpoints the present boiler presents many advantages not possessed by the usual and conventional steam boilers. As will later develop, it is pos-

sible to minimize and, if desired, to entirely dispense with stay-bolts and other usual structural requirements, because of the shape and form of the boiler parts and their assemblage in the construction. Also it is possible to employ structural elements such as the fire box and outer shells, in the form of cylindrical and curved or spherical segments, all of which are readily available at relatively low cost and are particularly adapted to standardized, easily assembled and strong construction.

All the above mentioned features of the invention, as well as various additional objects and details will be understood to better advantage without necessity for further preliminary discussion, from the detailed description to follow. Reference is had throughout the description to the accompanying drawings in which:

Fig. 1 is a view in vertical section showing a typical embodiment of the invention;

Fig. 2 is a fragmentary section on line 2-2 of Fig. 1;

Fig. 3 is a fragmentary view illustrating a variational form of certain parts of the boiler;

Fig. 4 is a view similar to Fig. 1 illustrating another and preferred embodiment of the invention; and

Figs. 5 and 6 are fragmentary views showing certain modifications with respect to the form and construction of the water chamber.

Referring first to Fig. 1, the boiler comprises a vertically extending cylindrical shell 10 that may have any suitable base, shown typically as a flange 11 with openings 12 for the admission of air to the burner 13. The shell 10 has an arcuate cross section top closure 14 welded at 15 above the normal water level L, to the shell 10 and formed integrally with an inner wall 16 annularly spaced at 17 from the stack 18. The outer shell structure may be suitably insulated by a layer of insulating material 19 which may also fill the space 17 surrounding the stack.

Supported within and annularly spaced from the outer shell 10 is a cylindric fire box shell 19 welded at 20 to an arcuate cross section top 21 having a stack opening 22 and welded or otherwise secured at 23 and 24 to the bottom flanges of the stack and the surrounding wall 16. The space at 25 between shells 10 and 19 forms what is termed an annular water leg, in direct exposure to the outer surface of the fire box shell, the water normally standing at a level L overlying the top 21 of the fire box within the annular steam chamber 26. Thus the fire box is entirely enclosed, except for the burner opening and stack outlet

22, within the steam chamber, water leg and the later described inlet water chamber, to provide for maximum transfer of heat through the fire box shell to the water being heated.

The floor plate 28 within the base of the outer shell 10 has a central opening 29 to receive a burner or assembly of burners, shown conventionally as a burner unit 13, to which fuel is supplied through pipe 30. The fire box shell is supported on an annular wall 31 having an upper horizontal portion 32 secured at 33 to shell 10, an inclined portion 34, and a downwardly extending section 35 lined with fire brick 36 above the burner opening 29. Wall 31 together with the floor plate 28 forms an annular water chamber 37 to which the feed water is delivered through the valved inlet line 38. Water chamber 37 is accessible for cleaning or to permit access to the lower ends of the water tubes through one or more handholes 39 normally closed by cover plates 40.

The combustion chamber 41 within the fire box contains a suitable arrangement of water tubes 42 preferably in circularly spaced form as illustrated, the tubes being expanded at their upper ends within fire box top wall 21, and at their lower ends within the inclined portion 34 of the water chamber wall 31. The water tubes 42 have segmental circular curvature, substantially as illustrated, and extend directly in the path of the combustion gases flowing from the burner 13 to the flue 18. A baffle 44 interposed within the nest of tubes at substantially their longitudinal centers, causes the rising combustion gases to be deflected outwardly below the baffle toward the cylindric shell 19, the gases then converging above the baffle in passing to the stack. Impingement of the hot gases against and along the fire box wall 19 intensifies heating of the shell and increases the heat transfer through the shell to the water in the annular water leg 25.

Water introduced to chamber 37 flows upwardly through the tubes 42 and is discharged into the annular steam chamber 26, the latter having an outlet 45 positioned well above the normal water level L. A continuous circulation of water from the water leg 25 into the feed water chamber 37, and then upwardly along the outer surface of the fire box shell 19, is maintained by a suitable pump, diagrammatically indicated at 46. Water is taken by the pump, preferably at a point or points toward the lower end of the water leg, through pipe 47 and is discharged through pipe 48 into the chamber 37. A by-pass line 49, having a normally closed valve 50, may be provided in order that if it is not desired to maintain positive or mechanical circulation of the water, the pump may be shut down, valves 51 and 52 closed, and the valve 50 opened to permit convection or thermo-siphonic circulation through the by-pass line. I preferably provide within the water leg an annular baffle 53 spaced at 54 and 55 from the fire box and outer shell 10, in order that rapid upward circulation of water may be maintained along the surface of the fire box, and the water then recirculated downwardly to the pump inlet without interference with the upwardly flowing stream.

The combined fresh feed and recirculated water are forced through the water tubes 42 and also through circularly spaced nozzles 56 which discharge the water upwardly in high velocity streams within space 54 along the outer surface of the fire box shell 19. The pump 46 maintains

a forced circulation of water from the nozzles at sufficient velocity to continuously remove from the surface of the shell 19 steam bubbles and super-heated water films that otherwise would diminish the heat transfer rate. Where the boiler is designed for relatively low pressure steam generation, the lower extent of the stack 18 may form the inner wall of the annular steam chamber 26, but if extremely high pressure steam is to be generated, it may be desirable to remove the stack from exposure to the steam, and thus avoid overheating that portion of the steam chamber wall about the stack. Accordingly, as shown in Fig. 1, wall 16 may serve as the inner steam chamber wall so that all portions of the steam chamber shell are contacted by water and removed from direct heat transference from the combustion gases discharged through the stack. As an alternative, I may in effect water jacket the bottom portion of the flue 18 within the steam chamber, as shown in Fig. 3, by providing an annular baffle or joint 57 overlying the upper ends of the tubes 42 and directing the water discharged from the tubes upwardly along the surface of the stack as indicated by the arrows. The water spills from the upper edge of the baffle 57 back into the steam chamber, and by direct contact with the stack, prevents it from becoming overheated.

Further heating economies may be effected by utilizing the heat contained in the combustion gases flowing through the stack to superheat the steam. Thus by closing valve 58 and opening valve 59, the steam may be discharged at 60 from the top of the steam chamber 26 through a superheater coil 61 within which the steam passes counter-flow to the combustion gases and is discharged through pipe 62 to the outlet line 45a.

The rate of water circulation within the boiler may automatically be controlled in accordance with the steam pressure so that as the steam pressure exceeds a predetermined limit, the water circulation rate, and consequently the rate of steam generation, will be reduced; and conversely as the steam pressure falls below that predetermined limit. To accomplish this object, I may regulate the speed of operation of the water circulating pump in accordance with the boiler steam pressure by any suitable type of automatic control, various forms of which are known and in common use. For example, the pump 46 may be driven by an electric motor 64, the speed and supply of current to which may be automatically regulated by any suitable pressure responsive control device, conventionally illustrated at 65, connected at 66 with the boiler steam chamber at the top of the water gage 67. The motor and pump speeds are thus controlled to automatically reduce the rate of water circulation within the boiler under the influence of the pump when the steam pressure becomes excessive, and to increase the water circulation rate when the steam pressure drops.

In the operation of the boiler, the water is heated and converted to steam in flowing through the tubes within the fire box, and also in being maintained in a state of circulation within the water leg directly adjacent the outside of the fire box shell. By providing forced recirculation through the tubes and within the water legs, it is possible to maintain maximum heat transfer rates from the combustion gases to the water, and by virtue of the jacketed fire box construction, to utilize a maximum of the heat content of the combustion gases. Because of the greater heat-

ing efficiency afforded by either or both of these features, it is made possible in designing a boiler for given horse power rating to substantially reduce the size and weight, as well as the cost of the boiler, as compared with other boilers of corresponding horse power.

This general type of boiler design has distinct structural advantages in that it permits the use of prefabricated parts of standard shapes that can be obtained and assembled at relatively low cost, and which when assembled provide a self-supporting boiler construction that does not require the usual expedients such as numerous and structurally complicated arrangements of stay bolts, for their support. In the form of the invention shown in Fig. 1, it may be desirable to provide a limited number of stay bolts 68 to strengthen both the crown sheet 21 and the dome sheet 14, and also stay bolts 68a interconnecting and strengthening sheets 32 and 28. Otherwise the assembly of shells and other parts of the boiler are self-supporting. The interior parts of the boiler, including the water tubes 42, are made easily accessible for inspection, cleaning or repair simply by removing the top portion 14 of the outer shell (or dome). Scale may be removed from the inside of the tubes 42 by reaming them from their upper ends and removing the heavier scale that drops through the tube to the water chamber 37, through the handholes 39.

The embodiment of the invention shown in Fig. 4 is generally similar to the described form, but has certain preferred features by reason of the particular form and construction of the boiler parts and the resultant ability of the assembly to be self-supporting without the necessity for stay bolts or other additional supporting or reinforcing members. Here the outer shell 10a and the fire box shell 19a have top walls 14a and 21a in the form of segmental spherical shells which, by reason of their curvature, are structurally preferable and capable of greater facility and economy in fabrication. Thus the entire shell assemblies may be made from cylindric wall sections and segmental spherical top sections.

The water chamber 37a also may be made in essentially the form of an annular tube consisting of a shell 70 welded at 71 to the lower end of the cylindric shell 10a and having an inwardly extending flattened portion 71a secured to the shell at 72. The nozzles 56 are tapped through the flattened portion 71a of the shell and the segmental circular water tubes 42a are expanded at 73 into the inner curved wall of the water chamber shell. As in the first described form of the invention, a suitable arrangement of manholes 74 may be provided for gaining access to and removing sediment from the water chamber. Shell 70 is supported on a base 75 having an intermediate floor 76 carrying an annular wall 77 lined with fire brick 78 about the burner opening 79.

By reason of the curved tubular form of the water chamber shell 70, the latter has sufficient structural strength to support the boiler load (or internal pressure) without necessitating the use of stay bolts or other reinforcement. The curved shape of the water chamber is of further advantage in that sediment or scale accumulating within the chamber may be more easily removed since the sediment tends to accumulate on the curved bottom of the shell from which it may be flushed or otherwise removed through the manhole openings 74.

Fig. 5 shows a further variational form of water chamber shell of non-circular tubular form, but nevertheless of considerable structural strength, consisting of a horizontally and inwardly inclined plate 80 welded at 81 to an annular section 82, the latter being joined to the lower end of the outer boiler shell 10b by a curved annular plate 83 welded to the boiler shell and section 82 at 84 and 85. Instead of employing a weld at 85, the joint may be formed by rivets 86 extending through the lower flanged edges of members 82 and 83 and through a gasket 87 placed between them.

I claim:

1. In a boiler, the combination comprising a wall forming a vertically extending fire box, an outer wall spaced from said fire box to form a steam chamber thereabove, a discharge gas conduit extending upwardly from the fire box through said steam chamber and said outer wall, means for heat insulating the outside of said conduit from the steam in said chamber, an annular water leg surrounding and directly exposed to the sides of the fire box wall, means forming a water chamber at the bottom of said fire box, water tubes extending from said water chamber upwardly within the fire box through its top wall, and means for passing combustion gases upwardly into said fire box, and the discharge gas conduit.

2. In a boiler, the combination comprising a cylindric wall forming a vertically extending fire box and having a substantially segmental spherical top, an outer wall spaced from said fire box to form a steam chamber thereabove and an annular water leg surrounding and directly exposed to the sides of the fire box wall, means forming a water chamber at the bottom of said fire box, segmental circularly curved water tubes converging toward the center of the fire box and extending continuously from said water chamber upwardly within the fire box through its top wall, a transverse baffle within the fire box between the upper and lower ends of said tubes and at the convergent portions of the tubes, means for passing combustion gases upwardly into said fire box, and means for discharging the gases from said fire box through the top of said outer wall.

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