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WELDED THIN STEEL BOILER

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Fig. 1.

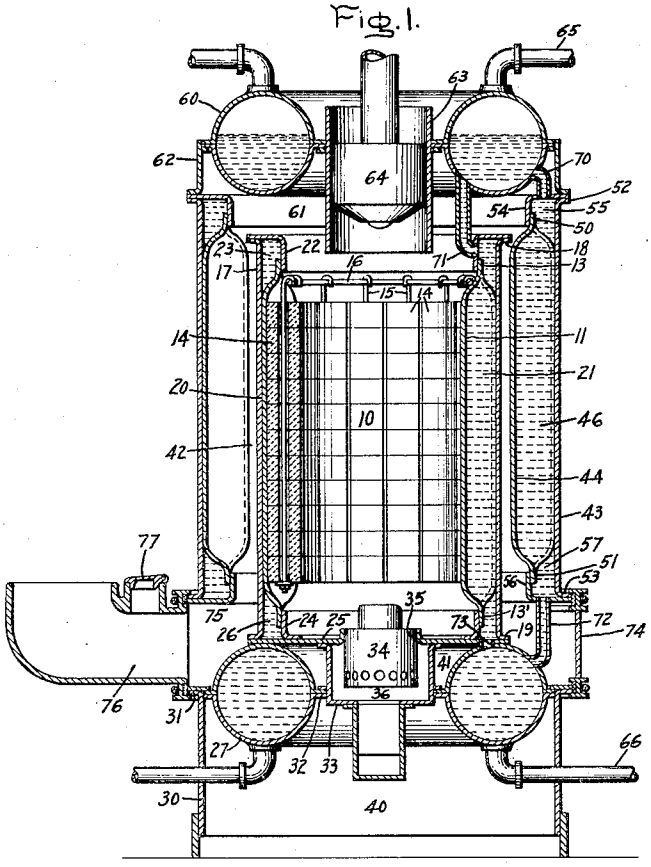
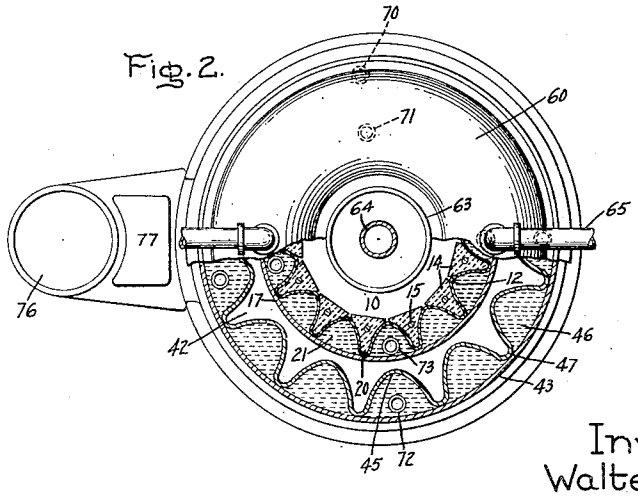


Fig. 2.



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WELDED THIN STEEL BOILER

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10 Claims. (Cl. 122—161)

This invention relates to boiler furnaces, particularly of the welded steel, domestic heating type, and has for its principal object an improved construction for obtaining increased lightness and ease of handling without sacrificing strength and safety, and for securing at the same time increased heating capacity and efficiency with a minimum volumetric displacement.

More specifically, an object of this invention has been the provision of an improved boiler furnace, having sufficient capacity for installation in an ordinary domestic hot water or steam heating system, which may be transported as a unit through doors and like openings and may be installed without special foundation in a small space.

Another object has been the provision of an improved design for an internally fired boiler of welded steel construction having a water-backed combustion chamber and secondary heat absorption passage, whereby a maximum of heat transfer area is provided with a minimum of overall size.

A further object of this invention has been the provision of a simple and inexpensive unitary boiler having sufficient capacity for installation in a domestic heating system, which is so designed that it will be strong and safe and yet may be constructed of such thin sheet metal that it will be very light in weight and portable.

It is customary to construct boiler walls of relatively thick metal, not only to provide sufficient strength but to insure a safety factor of thickness so that corrosion over a period of time will not weaken the structure to a dangerous degree. It is preferable to construct the boiler walls of corrosion resistant material but it is impractical to do so, due to excessive cost of non-corrosive metal, unless the metal is in the form of very thin sheets. Hence it has been a still further object of this invention to produce a design for a boiler wherein very thin non-corrosive sheet metal may be used practically, and wherein sufficient strength is insured by preforming the various pressure resisting walls of the boiler to the contours which they will tend naturally to assume when the boiler is under pressure.

An additional object of this invention has been the provision of an improved combustion chamber lining.

It is well known that a hollow sphere is the best form of vessel for resistance to internal pressure. In such a vessel the stresses set up in the walls by the pressure are equal in all directions and the strength of the unit is determined solely by the tensile strength of the material of which the walls are constructed. Furthermore, the internal pressure will tend to cause the vessel to retain its true spherical form, so that the walls will be self-supporting without the use of auxiliary bracing. However, it is impractical to design a boiler in the form of a true sphere due to construction difficulties encountered and to the fact that the heat transfer area obtained for a given volume is small. A close approximation to the advantageous characteristics encountered in the spherical form of vessel may be obtained by a boiler construction wherein the various pressure resisting walls are of a shape closely approximating that which they would naturally tend to assume under internal pressure which would result in all parts thereof being subjected solely to pure tensile stresses. We have kept in mind the above-outlined considerations in designing an efficient and practical boiler wherein curved or arched contours are used in the construction of the walls of all of the water and vapor chambers of our improved boiler furnace. The advantages of such construction will be more fully set forth hereinafter.

Our invention will be described and shown herein in its preferred embodiment as incorporated in a vertical type boiler furnace wherein combustion may be produced in a manner such as that set forth in the copending application of Aldo Macchi, Serial No. 505,867, filed December 31, 1930, which application is assigned to the assignee of the present invention. However, it is to be understood that we have so described and shown our invention for purposes of illustration only, and it will be apparent that various features thereof may be employed in other embodiments where their peculiar characteristics make it advantageous to do so.

In the accompanying drawing Fig. 1 is a sectional elevation of the essential elements of our improved boiler furnace in its preferred embodiment, and Fig. 2 is a plan view partially in section showing more clearly the configuration of the pressure resisting walls and the arrangement of the combustion chamber lining.

Referring to the drawing, the combustion chamber 10 of the boiler furnace is of elongated substantially cylindrical shape as defined by the hollow thin sheet metal shell 11 which forms the walls therefor. Longitudinally extending corrugations 12, of a configuration later to be discussed, are formed around the entire periphery of the shell 11 with the ends of the corrugations

flattened as shown at 13 and 13' to form an annular flange at each end of the shell.

Since one of the principal objectives of our invention has been the design of a boiler which is of relatively small size, we have found it desirable to secure a maximum heat transfer surface for a minimum of combustion chamber size. This objective we have attained by the use of a corrugated combustion chamber wall whereby the heating surface of the chamber is materially increased for a given size over that which would be possible were the walls of a plain cylindrical form. We have further conserved space by constructing the heat resisting lining for the combustion chamber in the form of sectional refractories 14 of such shape that they may be seated in the internally facing concave portions of the corrugations 12 with their inner surfaces substantially flush with the internal periphery of the combustion chamber wall, thereby reducing the overall dimension for a given combustion chamber diameter. These refractories are supported on hangers 15 suspended from ring 16 which rests upon the shoulder formed by the annular flange 13 at the upper end of the shell 11. The combustion chamber lining provided by the refractories seated in each of the corrugations is continuous except for the small vertically extending spaces as shown which are provided to take care of expansion. It is to be noted that due to the tapered cross-sectional form of the refractories, a maximum depth of heat resisting material is interposed between the combustion zone and the bottom surfaces of the corrugations where there is the least water backing, thus affording, as is desirable, a maximum protection at these points.

Tightly telescoped about the shell 11 is a non-corrugated cylindrical thin sheet metal shell 17, having external flanges 18 and 19 respectively at the upper and lower ends thereof, which cooperates with the shell 11 to form a water storage tank backing the combustion chamber. This water storage tank is divided into a plurality of water legs 21 as defined by the externally facing concave portions of the corrugations 12 in the inner shell 11. The shell 17 is securely joined to the shell 11 along the external surfaces or apexes of each of the respective corrugations by welding or other suitable means as shown at 20. The upper end of the water storage tank formed by the shells 11 and 17, hereinafter called the inner tank, is closed by means of a flanged ring 22 joined by welding or other suitable means to the flanged ends 13 and 18 of the shells 11 and 17 respectively, thus forming a header 23 which provides communication at their upper ends between the individual water legs 21 of the inner tank. Joined to the lower flanged end 13' of the shell 11 is a flanged ring 24 which is joined to and cooperates with a circular plate 25 to close the lower end of the combustion chamber. Said plate 25 extends outwardly past the ring 24 and is joined to the flanged end 19 of the shell 17. By the cooperation of the lower ends of the shells 11 and 19, the ring 24 and the plate 25, there is formed a closure for the lower ends of the inner tank and also a header 26 providing communication between the lower end of the individual water legs 21 of the inner tank.

The inner tank above described is supported upon a water storage header 27 and in axial alinement therewith. The header 27 in turn is mounted upon the circular base ring 30 by means of the flanged joint 31. The water storage header 27 is formed of thin sheet metal in the shape of a torus or annular hollow tube having a circular cross-section for reasons hereinafter set forth. The inner circumference of the torus is provided with a flange 32 upon which is mounted, centrally of the torus and coaxially with the combustion chamber, a conduit 33 for supplying air from any suitable source to the combustion chamber through an air nozzle conventionally shown at 34. Said nozzle depends from the flanged centrally located opening 35 in the combustion chamber closure plate 25 into the air chamber 36 of the conduit 33 and is adapted to discharge a stream of air centrally into the combustion chamber.

The base ring 30 forms a dead air space 40 below the water storage header 27 and a second dead air space 41 is formed between said header 27 and the combustion chamber closure plate 25. Thus any heat radiated downwardly from the combustion chamber will serve to preheat the water in the header 27, and any further loss of heat through the bottom of the furnace is materially reduced by the dead air space 40.

A second water storage tank is concentrically disposed about the previously described inner tank and spaced therefrom as shown at 42. This second tank comprises a pair of telescoped substantially cylindrical thin sheet metal shells 43 and 44, the inner one of which, 44, is provided with longitudinally extending corrugations 45 which cooperate with the outer shell 43 to divide the water storage chamber formed therebetween into a plurality of individual water legs 46. Shells 43 and 44 are securely joined together by welding or other suitable means at their points of contact, that is, along the external surfaces or apexes 47 of the corrugations 45. The upper and lower ends of the corrugated shell 44 are flattened to form circular flanges as shown at 50 and 51 respectively, while the upper and lower ends of the shell 43 are provided with flanges 52 and 53 respectively. A flanged ring 54 is joined to the upper flanged ends 50 and 52 of the shells 44 and 43 respectively and cooperates therewith to form a circular header 55 providing communication between the upper ends of the individual water legs 46, and a similar flanged ring 56 cooperates in a like manner with the lowered flanged ends 51 and 53 respectively of the shells 44 and 43 to form a header 57 providing communication between the lower ends of the water legs 46.

The space 42 between the inner and outer tanks provides a secondary heat absorption passage for the gases from the combustion chamber. Due to the corrugated outline of the shell 44 which forms the outer wall of the secondary passage, the heat absorption surface will be sinuous providing the advantage of a large transfer area for a relatively small diameter as was similarly pointed out in connection with the shell 11.

Supported vertically above the water storage tanks and coaxially with the combustion chamber is a steam header 60 in the form of a hollow, thin stainless steel torus. In order that a combustion gas distribution chamber 61 may be formed to provide communication between the combustion chamber 10 and the secondary heat absorption passage 42, the steam header is spaced a sufficient distance above the upper ends of the water storage tanks by means of a spacing ring 62 mounted upon the upper end of the outer tank. However, it is obvious that the steam header may be mounted directly upon the upper end of the outer tank and that the upper end of the inner

tank may be made low enough to provide a space for gases to pass over the end thereof and below the steam header into the secondary heat absorption passage 42.

A hollow tube 63 is fixedly supported in the centrally located opening of the steam header to provide for the mounting therein of a fuel burner head such as that conventionally shown at 64. The nozzle of the burner head 64 is so positioned that it may discharge fuel downwardly and centrally into the combustion chamber where the fuel upon uniting with the air discharged upwardly from the air nozzle 34 will produce combustion in the manner set forth in the previously referred to Macchi application, Serial No. 505,867.

The steam header 60 is provided with outlet pipes 65 for supplying steam therefrom to a heating system or other device, and the water storage header 27 is provided with inlet pipes 66 for the return of water from the heating system or other device to the boiler or for supplying water from outside means. Conduits 70 and 71 provide for circulation between the steam header 60 and the upper headers 55 and 23 of the outer and inner tanks respectively, while conduits 72 and 73 similarly provide for circulation between the water storage header 27 and the lower headers 57 and 26 of the outer and inner tanks respectively. By these means communication is assured for circulation of steam or water between all of the individual water legs of the water storage tanks and the steam and water headers.

At the lower end of the heat absorption passage 42 is provided a combustion gas chamber 75 enclosed within the ring 74. From the combustion gas chamber 75 the gases may pass into the exhaust passage 76 which may be provided with an explosion safety door conventionally shown at 77.

In the construction of our improved boiler furnace we have secured strength and rigidity as well as lightness in weight by preforming the walls of the various pressure containers, such as the steam and water storage headers and the concentric water storage tanks, to the contours which they will tend to assume when subjected to pressure which are, broadly speaking, those contours which approach a hollow sphere or its nearest equivalent, a hollow cylinder.

The walls of the individual water legs of the concentric water storage tanks are of a curved construction very closely approximating a half cylinder. Thus all portions of the walls of the water legs are placed in approximately uniform tension when the boiler is in operation and the internal pressure will further tend to cause the walls of the water legs to assume a curved or arched contour. An additional self-strengthening effect is produced by the cooperation of the corrugated shell with the surrounding plain cylindrical shell. As a result of our improved design we are enabled to use in the construction of all pressure resisting walls an attenuated sheet metal of a thickness much less than is normally required in the construction of boilers. We prefer to use sheet steel of a thickness in the neighborhood of $\frac{1}{16}$'' as contrasted to a thickness in the neighborhood of $\frac{1}{4}$'' which is used in general practice. Due to the design employed, the various elements of our boiler will retain their shapes without auxiliary bracing even though very thin sheet metal is used in the construction thereof. This results in a great saving in weight without a sacrifice of strength and safety.

In order that the thin walls of our boiler will not become weakened by corrosion we use stainless steel in our preferred embodiment. However, it is obvious that any other similar corrosion resisting sheet metal may be used.

Further keeping in mind the advantages of the spherical contour in the design of pressure containers, we have formed the steam header 60 and the water storage header 27 in the shape of hollow tori or annular tubes of circular cross-section. The walls of these two headers are, therefore, subjected to uniform stress under internal pressure and are self-supporting, which enables us to use thin, stainless steel, in the construction thereof as in the construction of the walls of the concentric water storage tanks. An additional advantage is secured in our preferred embodiment in that the central openings in the torus shaped headers afford convenient means for installation of the fuel burner head and secondary air supply means.

It will be seen that as a result of the design herein described and illustrated, we are enabled to construct a boiler furnace which has the requisite strength and safety, yet is sufficiently small and light in weight that it may be transported as a unit, moved through doors and like openings, and installed without special foundation in locations where the available space is small.

It is obvious that various modifications may be made in the preferred design of our improved boiler furnace as herein described and illustrated without departing from our invention, and such modifications are intended to be included within the scope of the appended claims in which we point out with particularity those features which we believe to be novel.

What we claim as new and desire to secure by Letters Patent of the United States, is:—

1. In a boiler furnace, a container for water to be heated including in combination a hollow sheet metal shell naving longitudinal corrugations, a second sheet metal shell telescoped about said first shell and contacting therewith along the apexes of said corrugations to form a plurality of individual water legs, said shells being joined along the lines of contact therebetween and said corrugations being of curved contour so that all portions of the metal walls forming said water legs will be subjected to tension when the water therein is expanded by heating, and means providing separate headers at each end of said shells in communication with the ends of said individual water legs.

2. In a boiler furnace, means for containing water to be heated including in combination a tank comprising a substantially cylindrical sheet metal shell having longitudinl corrugations of curved contour and a second substantially cylindrical non-corrugated sheet metal shell telescoped about said first shell and joined thereto along the apexes of said corrugations to form a plurality of individual water legs, and a pair of hollow torus-shaped header members disposed one adjacent each of the opposite ends of said shells with connecting means between said tank and said members providing communication between the ends of said individual water legs and the interiors of said members, whereby substantially all portions of the walls of said water containing means are under tension when the water therein is expanded by heating.

3. In a furnace, means for forming a water backed combustion chamber wall including an annular sheet metal shell surrounding the furnace combustion zone and having corrugations

of curved contour to provide a sinuous heat transfer wall for the combustion chamber, a secon non-corrugated sheet metal shell surrounding said first shell and contacting therewith along the external apexes of said corrugations to form a plurality of individual water legs, and a plurality of refractory members seated in the inwardly facing depressions of said corrugations said refractories having tapered cross sections to fit said depressions and substantially fill the same whereby the respective portions of the sheet metal of said first shell are heat insulated in inverse proportion to the amount of water backing behind the same.

4. In a boiler furnace, the combination of a vertically disposed substantially cylindrical sheet metal casing forming a combustion chamber with opposite openings in the ends thereof, said casing having longitudinal corrugations of curved contour, a second substantially cylindrical sheet metal casing telescoped about said first casing and contacting therewith along the apexes of said corrugations to form a plurality of individual water legs, a plurality of refractory members having a tapered cross section of such configuration that said members fit into the inwardly facing depressions of said corrugations and substantially fill the same, means for removably supporting said members in seated positions in said depressions, means for supplying water to said water legs, means for closing the lower one of said openings in said combustion chamber, and a fuel burner nozzle disposed in the upper one of said openings to discharge fuel downwardly into the combustion chamber.

5. In a boiler furnace having a combustion chamber, means for forming a water and steam pressure chamber including in combination a substantially cylindrical sheet metal shell surrounding the combustion chamber and having longitudinal corrugations of curved contour, a second substantially cylindrical non-corrugated sheet metal shell telescoped about said first shell and securely joined thereto along the exterior apexes of said corrugations and cooperating with the exteriorly concave portions of said corrugations to form a plurality of individual water legs, a hollow torus-shaped member disposed at one end of said combustion chamber and in axial alignment with said shells and means providing communication between the interior of said member and the ends of said water legs.

6. In a boiler furnace having a combustion chamber, a water chamber including a plurality of nested spaced apart tanks surrounding the combustion chamber, each of said tanks comprising a pair of telescoped hollow sheet metal shells, the inner shell of each one of said tanks having corrugations of curved contour and being joined respectively to the outer shell of each one of said tanks along the exterior apexes of said corrugations to form a plurality of individual water legs, and header means at each end of said tanks providing communication between the ends of the water legs of said tanks.

7. In a boiler furnace having a combustion chamber, the combination with a plurality of concentric vertically disposed water storage tanks surrounding the combustion chamber and spaced apart to form flue passages therebetween in communication with the combustion chamber at one end, each of said water storage tanks including contacting concentric sheet metal shells joined at their ends and at their points of contact, the inner of said shells having longitudinal corrugations cooperating with the outer of said shells to form a plurality of communicating water legs, of header means comprising a pair of hollow annuli disposed respectively one above and one below said water storage tanks and coaxially therewith, means for providing communication between said header means and said water legs, and fuel burner means vertically disposed in the center of the upper one of said annuli and adapted to discharge fuel downwardly into the combustion chamber.

8. A boiler furnace having a combustion chamber and comprising concentrically nested water tanks surrounding the combustion chamber and spaced apart to provide a combustion gas passage therebetween communicating with one end of the combustion chamber, a pair of hollow torus shaped header members disposed one adjacent each of the opposite ends of said tanks and coaxially therewith, and conduit means between said tanks and said header members to provide for circulation therebetween.

9. A boiler furnace comprising means for forming a water backed combustion chamber including a pair of nested contacting sheet metal shells surrounding the furnace combustion zone, the inner one of said shells having longitudinal corrugations of curved contour securely joined to the outer one of said shells along the external apexes of the corrugations and cooperating with the outer one of said shells to form a plurality of individual water legs, means for forming a water backed secondary heat absorption chamber communicating with said combustion chamber at one end including a second pair of nested contacting sheet metal shells, the inner one of said second pair of shells providing within the interior thereof a passage for combustion gases from the combustion chamber and having longitudinal corrugations of curved contour securely joined to the outer one of said second pair of shells along the external apexes of the corrugations and cooperating with the outer one of said second pair of shells to form a plurality of individual water legs, and means connected to the ends of said water legs for providing communication therebetween including water and steam header members of tubular construction having circular cross sections.

10. A boiler furnace comprising a cylindrical combustion chamber having individual water backed heat absorbing elements disposed around the sides thereof, said elements comprising inner and outer curved metal walls preformed to be under tension upon generation of internal pressure in the elements, a secondary heat absorbing chamber communicating with the combustion chamber at one end thereof and extending adjacent the other end thereof and having individual water backed heat absorbing elements disposed around the sides of said secondary heat absorbing chamber, said second mentioned elements comprising inner and outer curved metal walls preformed to be under tension upon generation of internal pressure in the elements and conduits communicating between the elements around the combustion chamber and the elements around the secondary chamber adjacent the ends of the combustion chamber.

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