July 18, 1933.

H. JEZLER

1,918,397

FIRING OF STEAM BOILERS

Filed Feb. 27, 1931

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Fig. 2.

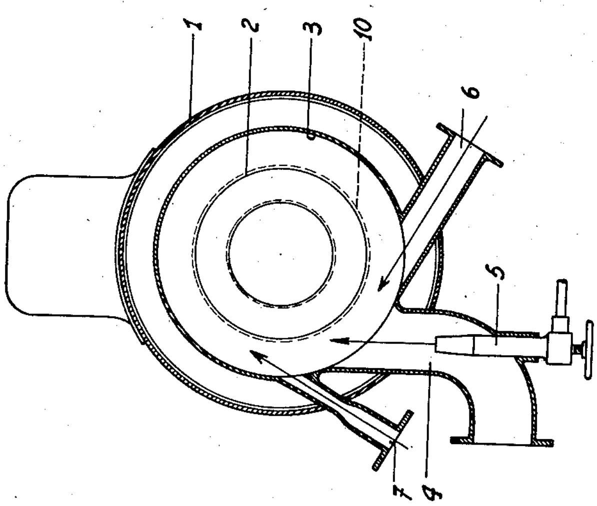

Fig. 1.

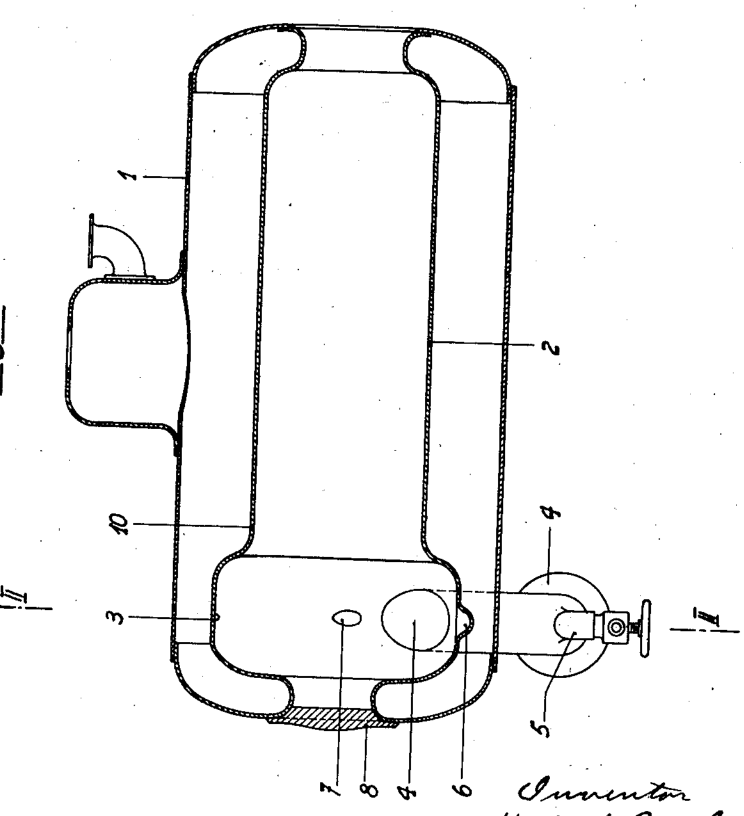

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Fig.3.

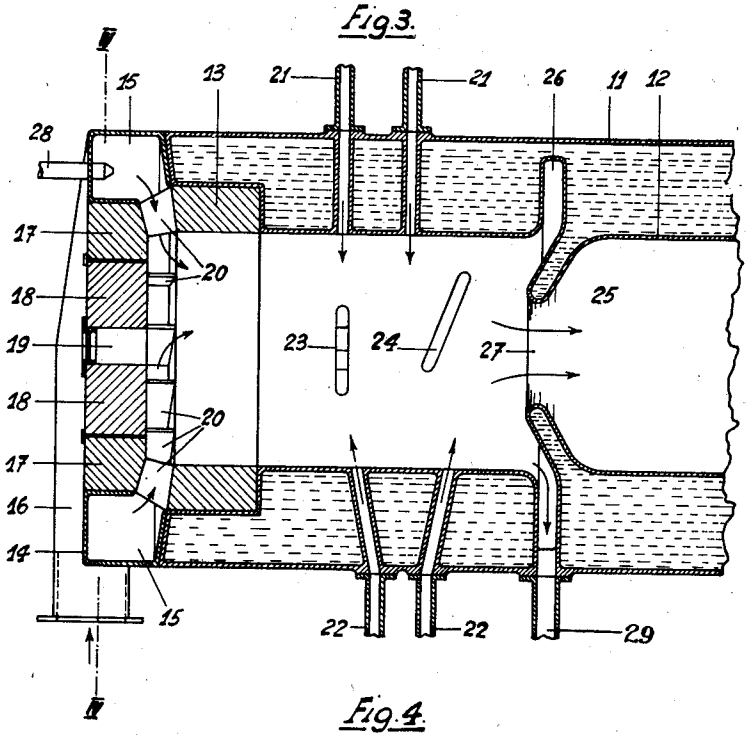

Fig.4.

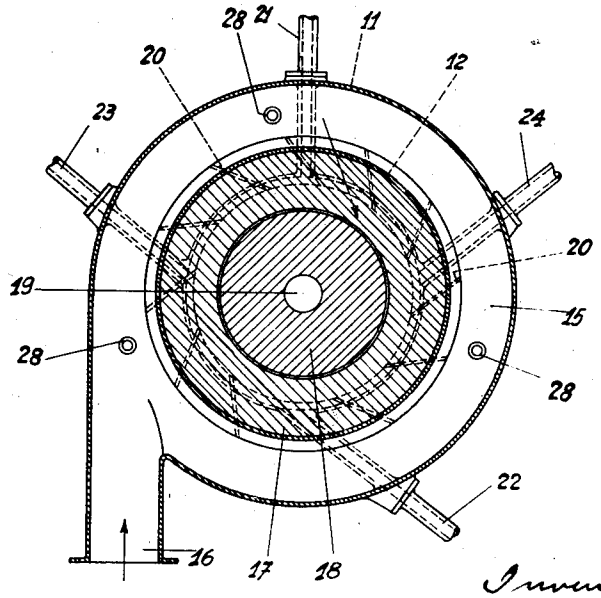

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Fig. 5.

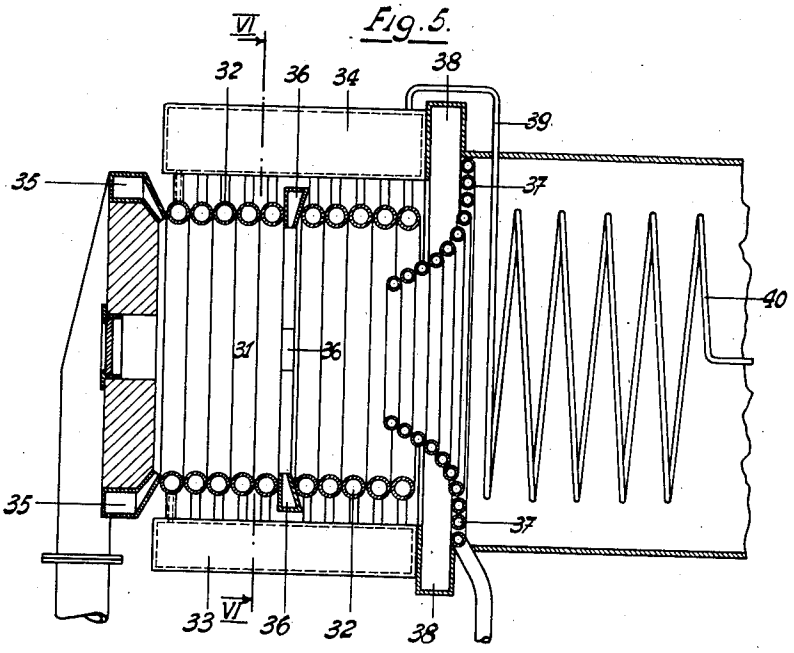
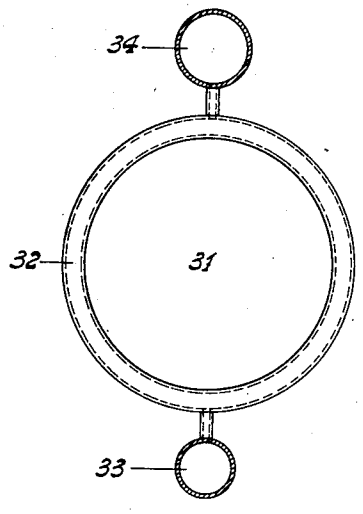


Fig. 6.



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Patented July 18, 1933

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UNITED STATES PATENT OFFICE

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FIRING OF STEAM BOILERS

Application filed February 27, 1931, Serial No. 518,761, and in Switzerland March 5, 1930.

The invention relates to high pressure steam boilers.

The main object of the invention is to improve the thermal efficiency of boilers while simultaneously reducing the size of such boilers.

A further object of the invention is to improve the rate of heat transmission in boilers.

I attain these and other objects as hereinafter pointed out by an improved mode of firing boilers.

According to the present invention the improved method consists in driving the gases of combustion at very high speed over the walls to be heated. It has been observed that with increase in speed of the hot gases the rate of heat transmission rapidly increases and may assume very high values.

I attain a very high speed of the hot gases within a comparatively small sized boiler by setting the gases in rapid rotation within a tubular combustion space. The rotating gases are forced closely against the wall as a result of centrifugal action and progress moreover in axial direction at a speed which may be varied according to the fuel used, according to the variations in load, or according to any other requirement. As the combustion takes place in an incandescent rotating gaseous mass with great turbulence and with intense radiation against the walls, a very high efficiency is attained.

In carrying out my invention there is provided a cylindrical boiler internally fired with pulverized fuel (or liquid fuel or gaseous fuel may be used) the fuel and the air being introduced under pressure by nozzles arranged tangentially to the cylindrical combustion space. Any suitable number of nozzles may be used and they may be arranged at any suitable position to initiate and to maintain a turbulent rotary stream of hot gases advancing in the direction of the axis of the boiler and being throttled thereby by suitable means. Steam, additional fresh air, additional fuel, etc. may be introduced in the rotating mass. The stream of the gases may follow a helical or a spiral path, and the advancing speed of the rotating gas may be varied by varying the angle at which the gases enter the combustion space. To improve the efficiency further an outlet is provided for the solid products of combustion, said products being thrown out for instance through said outlet by the centrifugal action of the rotating gas.

In the accompanying drawings examples of boiler constructions for carrying into effect the method according to the invention are shown diagrammatically.

Fig. 1 is an axial section through a boiler showing the new method of firing with oil.

Fig. 2 is a cross-section on line II—II of Fig. 1 through the combustion space of the boiler.

Figs. 3 and 4 show another boiler adapted to be used for carrying out my invention; Fig. 3 is an axial section through the boiler and Fig. 4 is a section on line IV—IV of Fig. 3.

Fig. 5 illustrates an axial section through another form of boiler construction for carrying out my invention, and

Fig. 6 is a cross-section taken on line VI—VI of Fig. 5.

In a drum boiler 1, (Figs. 1 and 2) is fitted a cylindrical flame tube 2. The flame tube widens out at one end of the boiler to form a cylindrical combustion space 3 into which a combustion air inlet 4 with a fuel nozzle or burner 5 is tangentially directed. On the outer periphery of the combustion space there is provided an auxiliary air inlet 6, and a live or exhaust steam nozzle 7. The manhole of the combustion space is closed by a cover 8. For particular purposes, as for example for the insertion of water tubes and superheating pipes, the flame tube may have a larger internal diameter for example corresponding to the dotted outline 9. It is only essential in this case that there should be left a collar 10 so that a cylindrical combustion space remains to receive the continuously rotating mass of heating gas.

The process of combustion in the combustion space of the boiler and in the flame tube connected therewith is as follows:

The ignited combustion mixture is ejected

from the tangentially arranged nozzle into the combustion space of the boiler with great speed, pulverized combustible solid bodies, liquid fuel or gases being used as fuel.

The burning gases set in rapid rotation are forced closely against the walls of the vessel as a result of the centrifugal action taking place. The increase in pressure of the glowing gas against the wall, and the increase in speed of said gas serve to increase the degree of heat transmission.

With increase in speed of rotation of the glowing gas, under the influence of the roughness of the combustion space wall, the turbulence is also increased, whereby the transmisison of heat is also increased.

As the combustion takes place in a glowing rotating mass of gas, a very high temperature is reached and thereby an intense radiation against the walls of the vessel is effected.

Since a further supply of fresh mixture constantly passes into the combustion space, the rotating heating gases flow over into the flame tube, where the pitch of their spiral course increases the further they get away from the combustion space. In order to influence the combustion by the supply of secondary air, there are provided one or more tangentially directed auxiliary air inlets. The jet of live or of exhaust steam into the heating gas current by means of one or more nozzles takes place for the following reasons. The steam mixes with the highly heated gas current, and acts to accelerate the chemical reaction, whereby a good combustion of the soot takes place and the boiler walls remain clean. Furthermore, the steam is blown near the place where the most powerful combustion reaction takes place so that the walls of the combustion space do not become overheated at this point. The streams of air and/or steam which are admitted in a tangential direction intermediate of the ends of the combustion chamber thus serve to regulate the combustion, to regulate the axial advance of the flames, and to accelerate the rotating movement of the flames and maintain such movement to the end of the combustion chamber.

The combustion space may be partly lined with a refractory material as for example carborundum, or the like, or with fire resisting metal as shown in Fig. 3.

The heating, in accordance with the present invention, may in some cases be used in combination with other known heating means or methods.

In the second example shown in Figs. 3 and 4 the boiler 11 is provided with a cylindrical flame tube 12, one end of the boiler being recessed and refractory material 13 covering the wall of said recess. The burner 14 comprises an annular channel 15 with a pipe 16 by which the fuel is introduced. Within a ring 17 arranged and held by the channel 15 a door 18 is arranged, said ring 17 and door 18 being constructed of refractory material. A hole 19 serves for ignition purposes, and is closed in a well known manner with a window of transparent material. The channel 15 is provided with vanes 20 which may be movable or rigid. The vanes 20 direct the fuel tangentially around the centre of the combustion space preferably at a steep angle with reference to the axis of the combustion space. The fuel forced into the combustion space ignites in coming in contact with the hot gases of combustion. To start the firing of the fuel an ignition device may be inserted through hole 19. According to the position of the vanes the entering fuel flows in a more or less close spiral path in the direction of the longitudinal axis, the flame rotating around the hollow cylindrical wall, and traveling in the direction of the axis at a speed varying according to the position of the vanes 20. To control the combustion, auxiliary fresh air and live steam is forced into the rotating burning fuel by nozzles, 21, 22, or slots 23, 24. By introducing auxiliary air and live steam the combustion is not only aided but the flow of the combustion gases may be influenced. For instance the pitch of the helical path in which the gases flow may be varied and therefore the speed in which the gases proceed in axial direction through the boiler may be affected by the use of such auxiliary air or live steam. Complete combustion may be attained in a very short space by means of the present invention.

To free the gases from the solid products of combustion use is made of centrifugal force. In the boiler a water-cooled ridge 27 projects into the path of the rotating gases and forms an obstacle to the flow thereof in axial direction. In front of said ridge 27 an annular pocket 26 is arranged adapted to receive the solid particles thrown off by the rotating gases. The particles collected in said pocket may be removed by a pipe 29. In place of the annular pocket a row of slots or holes may be provided. The ridge 27 throttles the flow of gases, and by natural or artificial draught the gases may be sucked through the reduced opening formed by said ridge and the heat of the gases may be utilized behind said ridge 27 for any purposes whatever.

If oil is used as fuel nozzles 28 are placed in the channel 25 whereby the oil is finely dispersed in the air forced into the combustion chamber.

The new method of firing may be used, not only to generate or superheat steam, but for ovens or any other purposes where very intensive radiation of heat is required.

The cross-section of the combustion cham-

ber is preferably circular but may be oval or otherwise.

Another boiler to which the new principle is applied is shown in Figs. 5 and 6.

The combustion chamber 31 is formed by a number of circular pipes 32 connected by short tubular connections on one side to a water feed chamber 33 and on the upper side with a collecting chamber 34. The firing is effected as described above, the fuel being introduced by the burner 35. The ignited fuel proceeds in helical lines at a great speed over the pipes 32, the gases being pressed by centrifugal force against said pipes. Auxiliary air in introduced by an annular hollow ring having nozzle 36. Live steam instead of air may be fed through one or more of said nozzles. The screen 37 throttling the axial flow of the gases consists of water pipes which may be connected to a water feed device and the water can be preheated therein. The solid particles are thrown off by centrifugal action into a collecting chest 38. The steam raised in the collector 34 passes through a coil 40 and is superheated thereby by the escaping gases. A boiler as shown may be used for locomotives. The pressure within the pipe 32 is kept high to prevent ebullition practically no steam being generated in said tubes. The tubes being constantly water cooled do not get overheated at the very high temperature of the rotating gases.

I wish it clearly understood that I do not limit my invention to the particular device as shown and described but what I claim and wish to secure by U. S. Letters Patent, is:—

1. A method of heating a liquid in a boiler having a combustion chamber of circular section, the wall of which is in contact with the liquid to be heated, including the steps of introducing combustion gases at high velocity tangentially into said chamber, and projecting a stream of gas at high velocity into said chamber substantially tangentially to said wall, whereby a spiral-like gas current is created near the periphery of said chamber, and the hot combustion gases in said chamber are caused to follow said current.

2. A method of heating a liquid in a boiler having a combustion chamber of a circular section, the outside wall of said combustion chamber being in contact with the liquid to be heated, including the steps of delivering hot combustion gases at high speed tangentially into said chamber, whereby said gases are forced against the cylindrical surface of said combustion chamber, and made to follow a helical path along said surface, obstructing the spiral passage of the gases at a section in said chamber, causing the solid residues entrained in said combustion gas to separate from said gas by the centrifugal force of said rotative action, and collecting said residues at said section.

3. A method of heating a liquid in a boiler having an annular water chamber encircling the heating chamber, which includes the step of projecting combustion gases at high temperature from points outside of the peripheral wall of said heating chamber inwardly of said heating chamber and substantially tangentially to said wall at such velocity as to cause said gases to be dynamically forced against said wall and to advance along the wall in a helical path of low pitch.

4. A method of heating the wall of a chamber of circular section which includes the steps of projecting combustion gases at high temperature from points outside of said wall inwardly of said wall and substantially tangentially thereof at such velocity as to cause said gases to be dynamically forced against said wall and advance along the wall in a helical path, and introducing one or more streams of fluid, such as air or steam, tangentially through said wall along said path.

5. A method of heating a cylindrical wall, which includes the steps of projecting combustion gases at high temperature from points outside of said wall inwardly of said wall and substantially tangentially thereof at such velocity as to cause said gases to be dynamically forced against said wall and advance along the wall in a helical path, and accelerating the helical flow of said gases by introducing one or more other gaseous mediums at high velocity through said wall tangentially thereof along the path of flow of said gases.

6. A method of heating a cylindrical wall, which includes the steps of projecting combustion gases at high temperature from points outside of said wall inwardly of said wall and substantially tangentially thereof at such velocity as to cause said gases to be dynamically forced against said wall and advance along the wall in a helical path, and retarding the axial advance of said gases.

7. The method of heating a liquid in a boiler having a heating chamber of circular section formed by liquid tubes located adjacent to each other and arranged around said heating chamber, including the steps of projecting gases at high temperature into said heating chamber substantially tangentially thereof and at such velocity as to cause them to be dynamically forced against the wall of said liquid chambers and to advance in a helical path in said heating chamber, and introducing jets of a gaseous medium, such as air or steam, tangentially to said heating chamber between two adjacent liquid chambers.

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