Aug. 18, 1931. W. D. LA MONT 1,819,470

STEAM GENERATOR

Filed Jan. 22, 1927 2 Sheets-Sheet 1

Fig. 1.

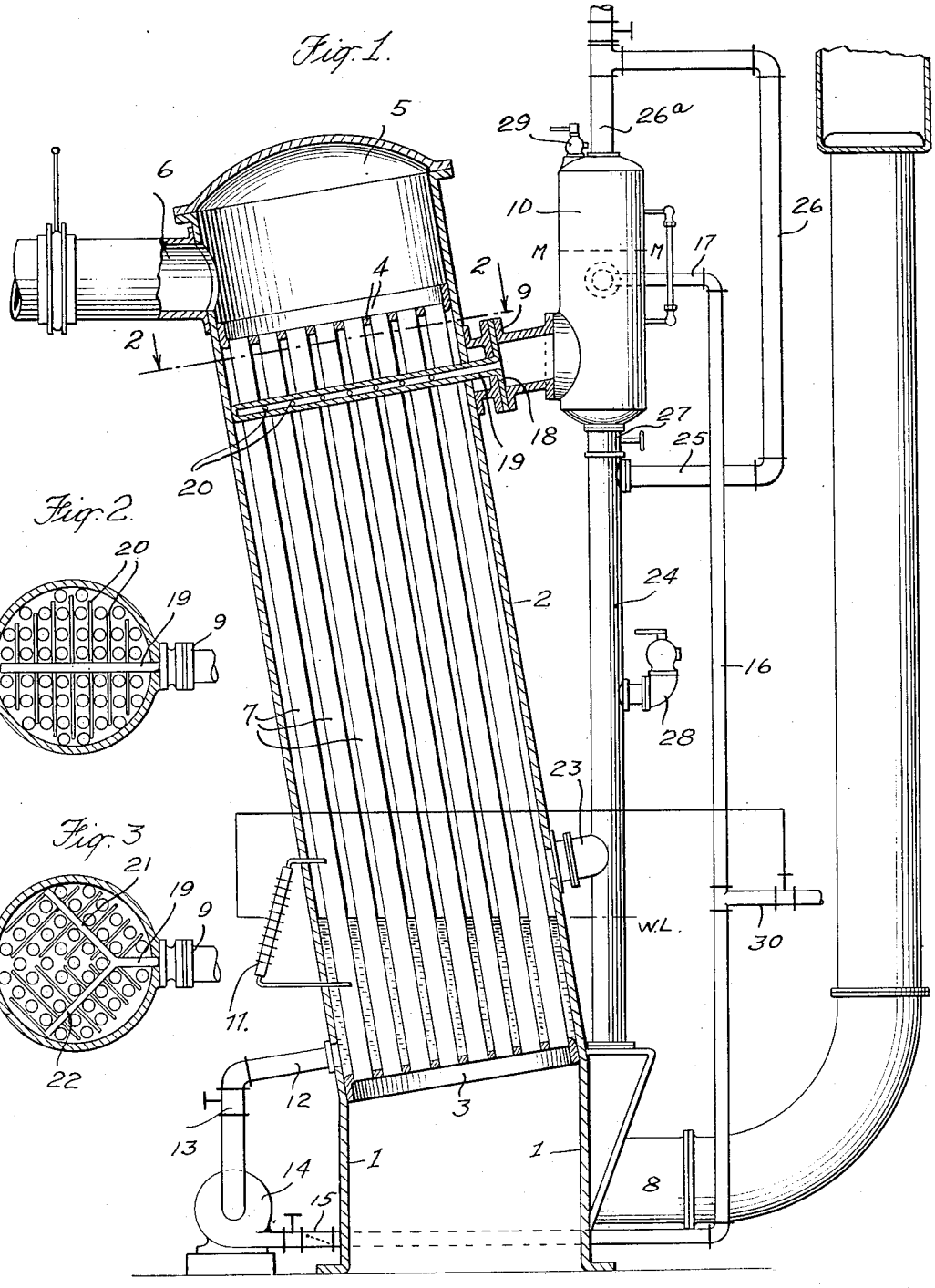


Fig. 2.

Fig. 3

INVENTOR
WALTER DOUGLAS LAMONT
BY
Newell & Spencer
ATTORNEYS.

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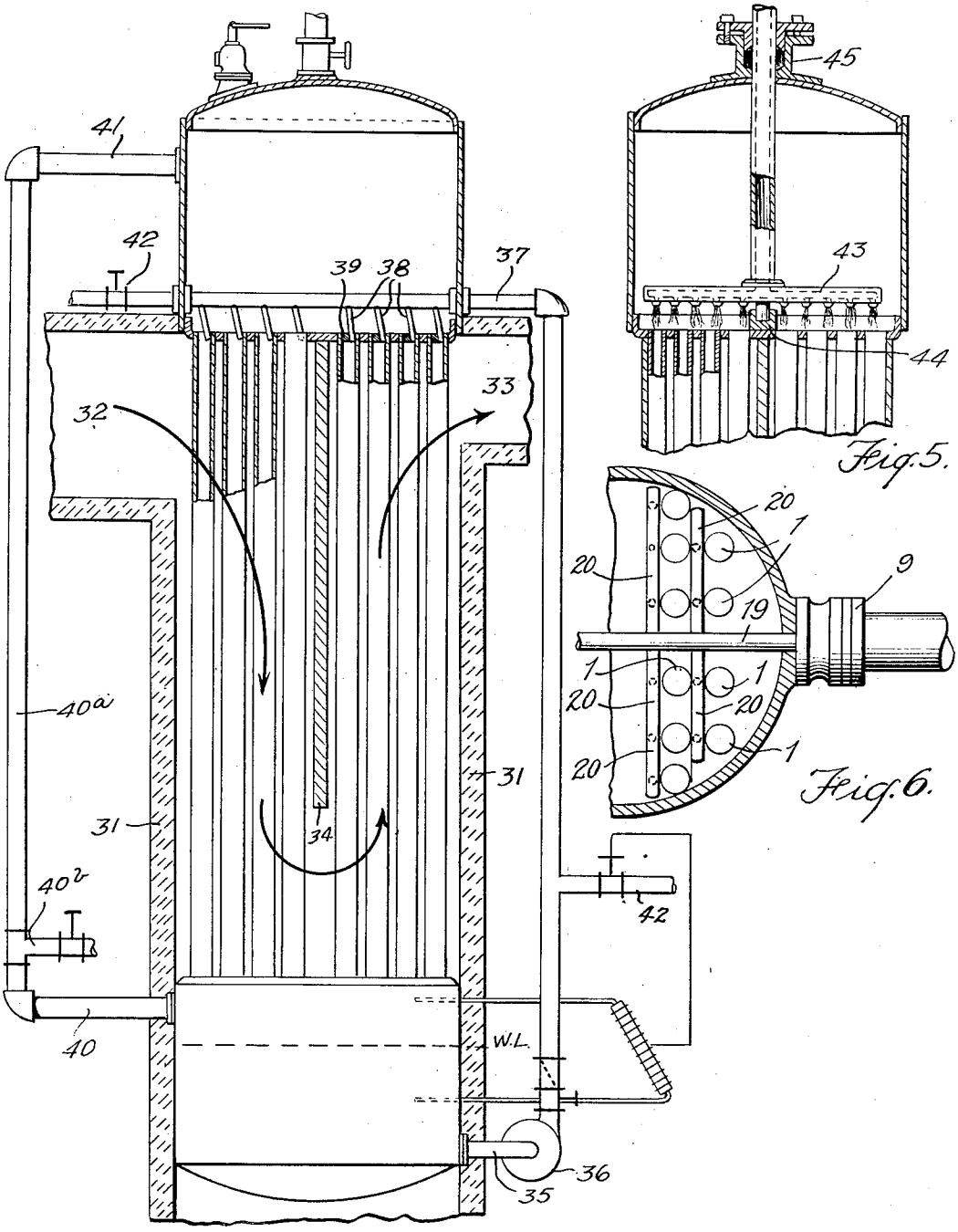


Fig. 4

Fig. 5.

Fig. 6.

INVENTOR
WALTER DOUGLAS LA MONT
BY
Newell & Spencer
ATTORNEYS.

Patented Aug. 18, 1931 1,819,470

UNITED STATES PATENT OFFICE

WALTER DOUGLAS LA MONT, OF LARCHMONT, NEW YORK, ASSIGNOR TO LA MONT CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

STEAM GENERATOR

Application filed January 22, 1927. Serial No. 162,770.

This invention relates to means for increasing the efficiency of existing types of steam generating units with comparatively slight changes in the mechanical arrangements and construction of parts already present in such units.

In the novel process of generating steam disclosed in my Letters Patent No. 1,545,668, July 14, 1925, and also in my co-pending application, Serial No. 32,064, filed May 22, 1925, I insure the rapid exchange of heat between the heating medium and water from which the steam is to be generated, by continuously effecting a positive circulation of the water in a predetermined path, which path includes steam generating elements in which the water in the form of a gravity film on one side of the walls of these elements is exposed to heat conducted through these walls from the heating medium traveling over the opposite sides of the walls.

In my co-pending application, Serial No. 79,096, filed January 4, 1926, I have utilized the principle of heat exchange described in said patent and application in combination with various types of existing boilers and while in said application, I have claimed the combination of the boilers of various types with the auxiliary means employing the principles of heat exchange disclosed in the patent and co-pending application, first above referred to, in the present application I disclose and claim various improvements in the arrangement of boilers of well known type, apart from the combinations claimed in said application 79,096, and, therefore, this application may be considered as a continuation in part and an improvement on some of the types of boilers disclosed in said latter application.

In boilers of existing types in which steam is generated from water boiled in substantial masses including boilers of both the fire tube and water tube type, reliance is had largely upon convection currents for circulation of water within the boiler with the result that such boilers do not utilize the heat supplied to the heat exchanging surfaces very efficiently.

Moreover, the water level is above the generating portion of the tubes and since the steam is taken from above the water level, it comes into contact for a considerable portion of its path with unevaporated water, resulting in a wet steam. Again portions of the heating surfaces are at times insulated from the water by bubbles of generated steam which adhere to these surfaces. These bubbles must expand to such size that their buoyancy overcomes the pressure of the water at the depth at which they are formed before they detach themselves from the surface of the tube. It follows from this that with many large steam bubbles clinging to the hot surface of the tube the amount of wetted surface would be decreased, the rates of heat transfer would also be decreased and there would be greater danger of burning the tubes at such points of bubble formation.

In the present invention, a fire tube or a water tube boiler is made to generate steam more efficiently with but slight modification of these boilers as usually constructed. For instance, the water level is carried to such a point that the tubes are uncovered for substantially their entire length. In fact, only enough water is normally present as will secure an adequate head on the suction side of the pump, which pump is used to deliver water to the tubes near their top. The quantity delivered and mode of delivery is such, that it flows along the surface of the tubes in the form of a film and the amount is regulated so that it is greater than the generating capacity of the heating surfaces along which it passes so that it is not necessary for all the water to be evaporated as any excess merely drops to the lower portion of the boiler where it is recirculated and again supplied to the tops of the tubes.

The steam generated from such a film readily frees itself and may be taken from the boiler either from the top or near the bottom just above the water level or both.

For the purpose of illustration, I have shown two different types of boilers rearranged on the principles set forth above with the changes in construction necessary to produce the advantageous results pointed out.

In the drawings,

Figure 1 represents a fire tube boiler of the ordinary type modified in such a way as to embody my invention;

Fig. 2 is a section on the line 2—2, Fig. 1, showing the manner in which the water is distributed to the outside surfaces of the boiler tubes;

Fig. 3 is a similar view, but showing a modified form of distribution connections;

Fig. 4 illustrates my invention applied to a water tube boiler;

Fig. 5 shows a modified form of device for distributing water to the upper ends of the tubes of such a boiler, and

Figure 6 is an enlarged plan view of a portion of Figure 2 to show the orifices in the tubes 20.

Referring to Fig. 1, there is shown a fire tube boiler adapted to utilize waste heat gases, although the gases might instead be supplied from below. Supports 1 rise from a suitable base and the boiler 2 is supported thereon in a slightly inclined position, said boiler having the usual bottom plate 3 and top plate 4 and dome 5. In the form illustrated, the hot gases enter the upper portion of the boiler through a conduit 6 and pass down through the fire tubes 7 and thence are conducted to a pipe 8 which leads to a stack.

In such a boiler, as ordinarily constructed and used, the water level reaches nearly to the top of the boiler and steam is ordinarily taken from an opening near the top such as designated by the numeral 9, such steam passing into a chamber 10 from which it would be conveyed by suitable pipes to the place where it was to be used for power, heating or other purposes.

In applying the principles of my invention to a boiler of this type, I carry the water level to a point near the bottom of the boiler, as indicated by the letters "WL" in the figure, said water level being maintained by an automatic control indicated conventionally by the numeral 11. This water level may be carried even lower than indicated, if desired. Below the water level, I provide a connection 12 leading through a valve 13 to a pump 14 preferably of the centrifugal type, which delivers water taken from the boiler by means of pipes 15, 16 and 17 to the chamber 10. This water then passes to the connection 9 and through an opening in a diaphragm 18 to a distributing conduit 19.

Thus the chamber 10, instead of receiving steam from the boiler as it would do when the boiler is used in the old way, receives the water to be supplied to the upper portions of the tubes. The conduit 19 is shown in Fig. 2 as forming the center of distribution of the water and from which conduit lead a number of pipes 20 for supplying water to the walls of the fire tubes 7, the size of the openings and the pressure being such that water is delivered to the tubes near their top in quantity greater than the steam generating capacity of the tubes so that the tubes are supplied with a film of water throughout substantially their entire length, but any water in excess of that converted into steam is collected at the bottom of the boiler to be recirculated by the pump.

In Fig. 3, the conduit 19 is formed of two branches just after entering the boiler, these branches being indicated by the numerals 21 and 22 and from which run smaller supply pipes directly serving the tubes.

The generated steam is taken from the boiler just above the water level through a connection 23 and passes to a pipe 24, thence through a branch pipe 25 to the pipe 26 which communicates with a pipe 26*a*, leading from the chamber 10. A valve 27 located in the pipe 24 above the branch 25 prevents steam from entering the chamber 10 when the system is used to generate steam according to the principles of my invention. A safety valve 28 is also provided in addition to the usual safety valve 29 which latter is a part of the customary installation. Feed water may be supplied to take the place of the water evaporated, at any suitable place in the circulating system. In the present instance, I have shown a feed water connection 30 tapped into the pipe 16.

With the construction shown, the steam pressure at the top and bottom of the boiler is equalized by the connection from the pipe 24 through 25 and 26. The pump 14 is designed to maintain a predetermined head of water in the chamber 10 as at M—M and since this is well above the level of the supply openings 20 there is always water in sufficient amount to insure adequate supply at all times and allows for any variation in the quantity of water delivered by the pump.

The boiler shown in Fig. 4 is of the water tube type and a boiler of this type heated from waste heat gases has been selected for the purpose of illustration. To this end, a casing 31 may be provided having an entrance opening 32 and an exit 33, there being a baffle plate 34 to cause the hot gases to descend around a portion of the tubes and ascend on the other side of the baffle plate. Here the water level has been carried below the ends of the boiler tubes and the pump connection 35 is tapped into the boiler below the water level. The pump 36 delivers the boiler water to a pipe 37 from which it is distributed to the inside of the tubes by nozzles 38 and passes down in the form of a film as described in my Patent 1,545,668, already referred to. Here again, the quantity of water supplied is greater than the steam generating capacity of the tubes, but less than sufficient to fill the space between the heat exchanging surfaces of the tubes so that steam may flow through the tubes unrestricted by any considerable quantities of water.

In the particular embodiment shown in Fig. 4, I have shown plugs 39 inserted in the tops of some of the tubes and filling the opening except for the water inlet nozzles 38, so that no steam can pass out of the tops thereof. Several of these tubes are shown at the right of the baffle plate in Fig. 4. Other tubes, however, do not have these plugs and some of these are shown to the left of the baffle plate. It is not, however, to be understood that the invention is limited to the construction shown as all of the tubes may be supplied with plugs or none, as desired. In the form shown, however, the water in those tubes which are supplied with plugs flows down while the steam must also flow in the same direction. The hot gases, however, go upwardly and thus flow counter to the direction of water flow. As a result of this counterflow there is a greater heat differential between the water and the gases with a resultant increase in the rapidity and efficiency of heat exchange. Here the steam generated from the film of water directed against the inside of the tubes may pass down some of the tubes and up other tubes, or some of it may pass down and some of it may pass up in the same tubes or both kinds of circulation may go on at once. To permit this flexible condition of flow, there is provided a pipe 40 leading from the space below the tubes and above the water level, said pipe being connected through pipes 40*a* and 41 with the steam drum at the top of the boiler. This equalizes the pressure so that the steam generated in the tubes which are open both at the top and bottom may pass in either direction along said tubes. Steam may be taken directly from the pipe 40*a* at 40*b* or from the steam drum, as desired.

Feed water may be supplied through a connection 42 directly to the pipe 37 or at any other point in the circuit.

In Fig. 5, the arrangement for supplying water to the tubes is somewhat different and in this instance is effected by a revolving sprayer 43 supported at 44 in the boiler head and also by a bearing 45 at the top of the boiler head. This sprinkler may be revolved in any suitable manner, the water being delivered to the top of the pipes and flowing over their edges and down their sides as in the construction described under Fig. 4.

The invention herein described is not limited to the particular types of boilers shown, but may be applied with suitable changes in constructions to other boilers wherein water is boiled in substantial masses.

Having thus described my invention, what I desire to secure by Letters Patent of the United States and claim is:

1. Method of operating a boiler of the type having water tubes connected at their ends to a drum which normally contains a large part of the volume of water within the boiler and in which is normally maintained a water level adjacent the upper portions of the heat transferring surfaces of the boiler whereby said heat transferring surfaces are normally substantially completely covered with the water of said volume of water within the boiler and in which the generated steam is normally discharged above said water level, which consists in maintaining a volume of water within the boiler having a water level at such a point that the tubes are uncovered for substantially the entire extent of their heat transferring surfaces, supplying water to the interior surfaces of the tubes so that it flows thereover under the action of gravity in quantity in excess of the steam generating capacity of the tubes but less than sufficient to fill the space between their surfaces, discharging said excess water after passage over the tubes to said volume of water, and causing the gases used to furnish the heat for steam generation to flow in a direction counter to the flow of water over the heat transferring surfaces.

2. Method of operating a boiler having heat exchanging tubes connected at their ends to members forming heads of a drum which normally contains a large part of the volume of water within the boiler and in which is normally maintained a water level adjacent the upper portion of the heat transferring surfaces of the boiler whereby said heat transferring surfaces are normally substantially completely covered with the water of said volume of water within the boiler and in which the generated steam is normally discharged above said water level, which consists in maintaining a water level at such a point that the tubes are uncovered for substantially their entire length, supplying water to the upper portions of the heat transferring surfaces of the tubes so that it passes thereover in the form of a film under the action of gravity, the quantity supplied being greater than the steam generating capacity of the tubes but less than sufficient to fill the space between the heating surfaces, causing the steam generated in the boiler to be discharged therefrom at a point adjacent the lower end portions of the heat transferring surfaces of the tubes, and causing the gases used to furnish the heat for steam generation to flow in a direction counter to the flow of the steam and water over the surfaces of the tubes.

3. The combination with a boiler having water tubes connected to upper and lower drums, of means comprising a system of conduits mounted within the upper drum to distribute the water to the upper end portions of the heat transferring surfaces of the tubes in quantity restricted so as to cause it to flow over the tube surfaces under the action of gravity while leaving the space within the tubes free for the steam generated, means

connected to draw water from the lower drum and deliver it to said distributing means, means connected to said lower drum for discharge of the steam generated, and means for maintaining the level of water in the lower drum below the point of connection of said steam discharge means.

4. The combination with a boiler having water tubes connected to upper and lower drums, of means comprising a system of conduits mounted within the upper drum to distribute the water to the upper end portions of the heat transferring surfaces of the tubes in quantity restricted so as to cause it to flow over the tube surfaces under the action of gravity while leaving the space within the tubes free for the steam generated, means connected to draw water from the lower drum and deliver it to said distributing means, means for discharge of the steam generated, and means for maintaining a level of water above the point at which water is drawn from the lower drum while leaving uncovered substantially the entire extent of the heat transferring surfaces of the tube.

5. The combination with a boiler of the type having water tubes inclined to the horizontal and connected to a drum at their upper ends, of means mounted within the drum to distribute water to the heat transferring surfaces of the tubes in quantity greater than the evaporation but restricted so as to cause it to flow over said surfaces under the action of gravity while leaving space within the tubes for the steam generated, means for maintaining a volume of water at such a point that substantially the entire extent of the heat transferring surfaces are uncovered by said volume of water so that the excess water may flow thereinto, means connected to draw water from said volume and deliver it to said distributing means, and means for causing the gases used to supply the heat for steam generation to flow in counter-flow relation to the flow of water over the surfaces.

Signed at New York, New York this 21 day of January, 1927.

WALTER DOUGLAS LA MONT.