Aug. 3, 1937. O. HARTMANN 2,088,905

BOILER

Filed April 18, 1935

Fig. 1.

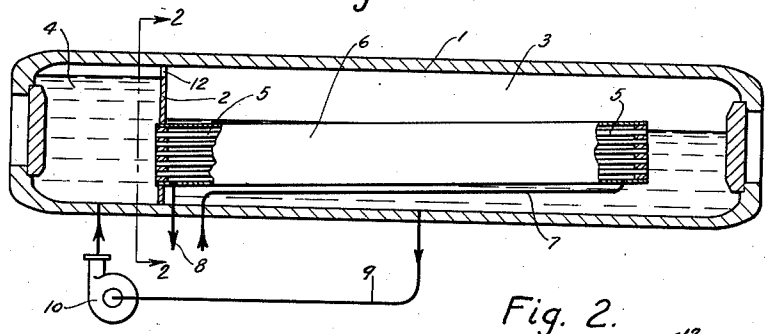


Fig. 2.

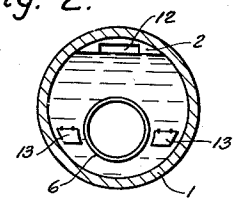


Fig. 3.

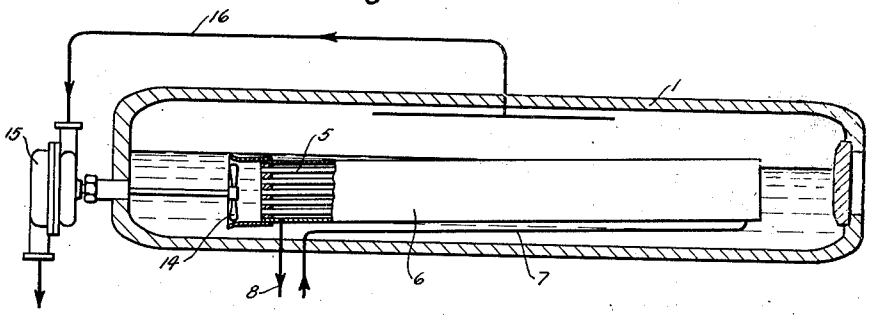
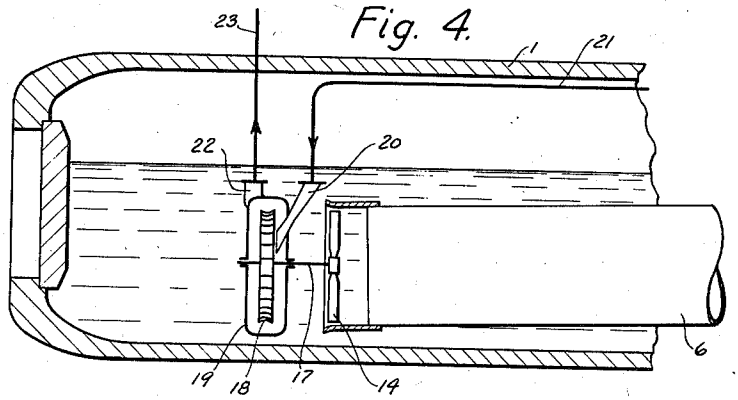


Fig. 4.



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BOILER

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4 Claims. (Cl. 122—32)

The invention relates to indirectly heated steam generators with a heat delivering body located inside of a drum in which the steam for use is generated, this heat-delivering body having the form of a drum with tubes extending through it. In order to provide for a large heating surface in a small space in case of a drum of relatively small diameter, the evaporating tubes must be made very long, which means that they can be given only a slight inclination from the horizontal. When boilers of this type are called on to furnish steam at a high rate, the resistance to the flow through the long tubes is so large that the supply of water becomes insufficient on account of the small static head. The heating surface is therefore insufficiently and inefficiently utilized.

In order to use the heating surface to the best advantage even at high ratings, the liquid to be evaporated is, in accordance with the present invention, subjected to a forced circulation through the evaporating tubes. This results in the total heating surface being kept wetted by the liquid to be evaporated and the heat transfer from the heating medium on the outer side of the evaporating tubes to the liquid to be evaporated thus being enhanced. The invention therefore makes it possible to use a smaller evaporating surface for a given maximum rating and therefore a smaller boiler drum.

As long as the natural circulation is sufficient, that is during periods of low loads, the circulating pump does not need to be put into action. This is the case also when the boiler is being fired up. Neither does a temporary stoppage of the circulating pump necessitate a shut down, because the natural circulation within the closed path of the heating medium is independent of whether the pump operates or not and the natural circulation which occurs through the evaporating tubes of the evaporating drum when the pump is stopped results in some evaporation although it may be less than the maximum possible evaporation. According to one advantageous form of the invention, a small part within the space of the evaporating drum is separated from the larger space by a partition, the evaporating unit lying in the larger part, but the ends of the evaporating tubes communicating with the smaller part. Water is taken from the larger part of the space by means of the circulating pump and forced into the smaller part. The pressure in this smaller part is chosen higher than that in the larger part by an amount such that even though the evaporating tubes are only slightly inclined, all portions of these tubes will be supplied with water. In order to prevent the pressure in the small part from becoming undesirably high, a small overflow opening is provided in the upper part of the partition which may, if desired, be provided with a flap valve which automatically opens toward the larger part but is normally closed when the pump is in action. In order to insure automatic circulation when the circulating pump is not in action, valves are further provided in the partition which automatically open toward the smaller space as soon as the circulating pump is stopped. Through the opening thus provided, water from the larger space is free to pass to the smaller space and then to enter the evaporating tubes.

In the drawing Fig. 1 shows a longitudinal central section through an indirectly heated boiler drum equipped to provide for forced circulation in accordance with the present invention. Fig. 2 is a cross-section on line 2—2 of Fig. 1. Figs. 3 and 4 show in longitudinal section a boiler drum with two further forms of the invention.

In the illustrative example of the invention shown in Fig. 1, the inside of the indirectly heated boiler drum 1 is sub-divided by partition 2 into a larger part 3 and smaller part 4. In the larger part 3 there lies the element 6 which has the form of a drum provided with evaporating tubes 5 extending longitudinally through it. This inner drum 6 is slightly inclined with respect to the horizontal. The lower or entrance ends of the evaporating tubes 5 open from the smaller part 4 of the drum. The water level in the part 3 of the drum is kept at a point such that the heating element 6 extends just slightly above this water level. Heat is delivered to the evaporating tube 5 by a circulating heating medium which is delivered into the drum-shaped heating body 6 by means of a pipe 7 and leaves it by means of the pipe 8, ordinarily in condensed form. The heating medium is heated by means of heating coils located in a furnace, these parts not being shown.

From the larger part 3 of the boiler drum a conduit 9 extends to the smaller part, this conduit including a circulating pump 10. This pump takes boiler water from the space 3 and forces it into the space 4 and into the evaporating tubes 5 opening from this smaller space. As a result, the water level in this space will rise as compared with that in space 3. The highest point to which this water level in space 4 can rise in the form of Fig. 1 is determined by the overflow opening 12 in the partition 2. However, this smaller space may also be kept completely filled if desired. In the lower part of the partition there

are provided the flap valves **13** (see Fig. 2) which open in a direction toward the space **4** and which may, if desired, be loaded and which are kept closed by means of the higher pressure prevailing in space **4** as long as the circulating pump operates. These flap valves **3** open automatically as soon as the circulating pump **10** stops so that the water can flow through the open valves from space **3** to space **4**. There is then an automatic circulation from space **4** through the evaporating tubes **5** to a space **3** and thence back through the openings in partition **2** to space **4**.

In the illustrative example shown in Fig. 3 the forced circulation through the evaporating tubes **5** of the evaporating units **6** is generated by means of a propeller pump whose propeller **14** is arranged in front of the lower end of the evaporating element **6**. The pump is actuated by means of a steam turbine **15** arranged outside of the boiler drum **1**, all of the steam generated in drum **1** or a major portion of it flowing through this turbine with only a slight pressure drop. The connection leading from the steam space of drum **1** to the turbine **15** is indicated at **16**. Obviously the pump may be actuated by any other motor.

In order to avoid the stuffing box required if the pump shaft extends out through the wall of drum **1**, the actuating motor may be placed inside of the drum. Such an arrangement is shown in Fig. 4 where a set of blades is mounted on the pump shaft, the propeller being driven either by the steam leaving the drum or by the feed water entering it. The pump is shown at **14**, and the turbine wheel **18**, mounted on the shaft **17**, is located in a closed housing **19**. To the nozzle **20** is connected the steam supply pipe **21** which takes the steam from the steam space of the drum, and to the outlet **22** is connected the pipe **23** which carries the steam through the wall of the drum to the point of consumption.

I claim:

1. In apparatus of the class described, the combination of a boiler drum, a partition dividing it transversely into decidedly unequal spaces, a cylindrical evaporating body within the larger part of the drum and slightly inclined to the horizontal and extending generally lengthwise of the drum, tubes extending lengthwise through the evaporating body and communicating at their lower ends with the smaller space and at their upper ends with the larger space and a circulating pump arranged and connected to take liquid from the larger space and deliver it to the smaller space.

2. Apparatus according to claim 1, and further comprising check-valves in the partition opening in a direction toward the smaller space, said check-valves opening automatically when the pump stops so that natural circulation can occur at such times.

3. In a high-pressure steam generator, a substantially horizontal evaporator drum of relatively small diameter and comparatively great length, and providing space in the lower portion for water to be evaporated and space in the upper portion for steam generated, a heating element in the shape of a closed cylinder having tubes extending through it parallel to its axis and lying lengthwise in the water space, means to conduct a fluid heating medium into the inter-tubular space at a point adjacent to one end of the heating element, means to remove it at a point adjacent to the opposite end, and propelling means within the water to be evaporated arranged to cause the water to circulate through the tubes of the heating drum.

4. In a high-pressure steam generator, a substantially horizontal evaporator drum of relatively small diameter and comparatively great length, and providing space in the lower portion for water to be evaporated and space in the upper portion for steam generated, a heating element in the shape of a closed cylinder having tubes extending through it parallel to its axis and lying lengthwise in the water space, means to conduct a fluid heating medium into the inter-tubular space at a point adjacent to one end of the heating element, means to remove it at a point adjacent to the opposite end, and propelling means arranged to cause the water which is to be evaporated to circulate through the tubes of the heating drum.

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