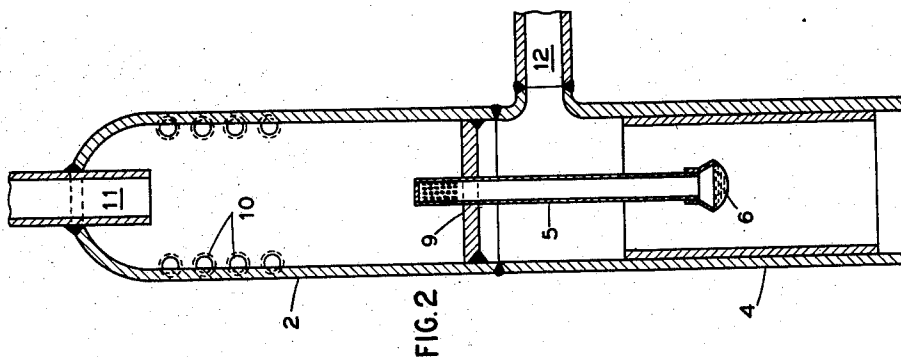
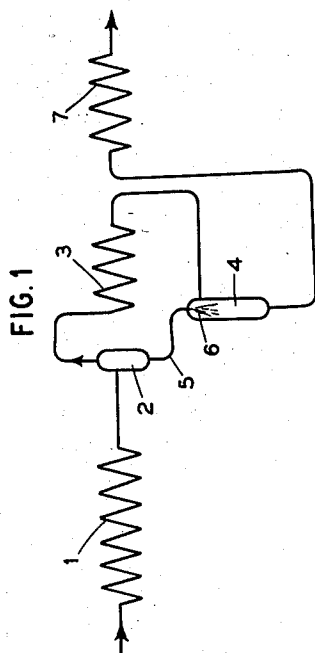


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ONCE-THROUGH VAPOR GENERATOR

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ONCE-THROUGH VAPOR GENERATOR

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This invention relates to forced flow, once through, tubular boiler units. In the generation of steam during forced flow through a gas heated tube system the greatest difficulties are experienced in the part in which the last remnants of water are evaporated, the so called transition zone. It is known to protect this part by disposing it in a region of relatively low flue gas temperature. This however, entails distributing the injurious effects over a larger heating surface. As an alternative, feeding with surplus water and the use of a separator has been adopted. The whole of the surplus water may be discharged if the percentage used is not too great. Otherwise water is returned to the feed pump. Since the separator makes a transition zone unnecessary, the difficulties connected with such a zone are avoided.

The invention includes a method and apparatus for generating and superheating vapor in a once through type vapor generator wherein a major portion of the thermal energy required for complete vaporization is transmitted to the vaporizable fluid in one portion of the unit and the highly heated fluid is completely vaporized by the admixing of a sufficient quantity of vapor in a contact heat exchanger.

By heating the transition zone with superheated steam the difficulties normally experienced with a transition zone are to a great extent eliminated. Moreover, this solution possesses the advantage that operation may be without surplus water.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which are illustrated and described preferred embodiments of the invention.

In the drawings:

Figure 1 is a diagram illustrating an embodiment of the invention.

Figure 2 is a sectional elevation of the upper part of a combined separator and direct contact heat exchanger.

In Figure 1, water is supplied by a feed pump (not shown) to a tube system 1 exposed to furnace gases, and in this first vaporizing stage is heated to the temperature of vaporization and is largely evaporated. The steam and water mixture enters a separator 2 in which the water is separated, in known manner from the steam by centrifugal force or the force of gravity.

The steam flows through a superheater 3 heated by the furnace gases into a direct contact heat exchanger or mixing vessel 4 comprising a second vaporizing stage, which is also connected to the bottom of the separator 2 by a pipe 5 fitted with a spraying device 6. The pressure drop across the superheater 3 is available for effecting spraying of the water. The outlet from the mixing

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vessel 4 leads to a further superheater 7 heated by the furnace gases.

During operation, the steam discharged from the separator 2 to the superheater 3 is superheated to such a temperature that the residual water discharged from the separator to the mixing vessel 4 is completely evaporated so that all of the steam in saturated or superheated state and at the same temperature flows to the superheater 7 in which the steam is heated to the desired temperature of superheat.

If desired, a single pressure vessel divided by a fluid tight partition may be used for the separator and direct contact heat exchanger of Figure 1, and Figure 2 illustrates such a vessel suitable for use in the boiler of Figure 1.

In Figure 2 the separator 2 is formed as a tube having a lower end closed by a plate 9 welded in position. In the side of the tube are tangential inlets 10 for the steam and water mixture, and the upper end of the tube is of dished form and is provided with a steam outlet pipe 11 projecting axially within and of considerably smaller diameter than the tube to which it is welded. Extending through and carried by the plate 9 is the axially arranged pipe 5, provided at its upper end with a sieve and at its lower end with the spraying device 6.

The mixing vessel 4 is also formed as a tube of the same diameter as the separator tube and the lower end of the separator tube is welded to the upper end of the mixing vessel tube. Nearer its upper end the tube of the mixing vessel is formed with a steam inlet nozzle 12 and at its lower dished end (not shown) the tube is formed with a steam outlet. The tube adjacent the spraying device 6 is internally lined.

A surface separator or a separator operating through mass or centrifugal action, of suitable known form may be arranged to act upon the steam generated in the mixing vessel before the steam flows to the superheater 7.

Generally the separator and direct contact heat exchanger will be arranged outside the boiler casing in proximity to the sections of heating surface associated therewith. In some instances a plurality of separators and direct contact heat exchangers may be arranged in parallel with one another.

The invention may be applied to an existing forced flow, once through boiler having a transition zone by utilizing the transition zone as a superheater of the steam which effects evaporation of the residual water.

In the above description no mention has been made of the regulation of the supply of feed water, of heating, of constant water level or of final steam temperature, as methods of effecting such regulation are known.

While in accordance with the provisions of the statutes, there is illustrated and described herein specific embodiments of the invention, those skilled in the art will understand that changes may be made in the form of the invention covered by the claims, and that certain features of the invention may sometimes be used to advantage without a corresponding use of the other features.

What is claimed is:

1. In a once-through type vapor generator including a heat source, a conduit presenting heating surfaces wherein a vaporizable fluid is heated until there is a vapor-liquid mixture consisting of predominantly vapor and the last remnants of liquid, a vapor-liquid separator receiving and separating said vapor-liquid mixture, a vapor superheater supplied with and arranged to superheat the separated vapor, a contact heat exchanger, means conducting the separated last remnants of liquid and a sufficient quantity of said superheated vapor to the contact heat exchanger to effect the complete evaporation of said last remnants of liquid, and means conducting

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dry vapor from said heat exchanger, whereby solids in said liquid become entrained in the dry vapor.

2. In a once-through type vapor generator including a heat source, a conduit presenting heating surfaces wherein a vaporizable fluid is heated until there is a vapor-liquid mixture consisting of predominantly vapor and the last remnants of liquid, a vapor-liquid separator receiving and separating said vapor-liquid mixture, a vapor superheater supplied with and arranged to superheat the separated vapor, a contact heat exchanger, said vapor-liquid separator and contact heat exchanger arranged in a single divided pressure vessel, means conducting the separated last remnants of liquid and a sufficient quantity of said superheated vapor to the contact heat exchanger to effect the complete evaporation of said last remnants of liquid, and means conducting dry vapor from said heat exchanger, whereby solids in said liquid become entrained in the dry vapor.

3. In a once-through type vapor generator including a heat source, a conduit presenting heating surfaces wherein a vaporizable fluid is heated until there is a

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vapor-liquid mixture consisting of predominantly vapor and the last remnants of liquid, a vapor-liquid separator receiving and separating said vapor-liquid mixture, a primary vapor superheater supplied with and arranged to superheat the separated vapor, a contact heat exchanger, means conducting the separated last remnants of liquid and a sufficient quantity of said superheated vapor to the contact heat exchanger to effect the complete evaporation of said last remnants of liquid, means conducting dry vapor from said heat exchanger, and a secondary superheater in contact with the heat source and connected to said heat exchanger for the final heating of the vapor issuing from said heat exchanger.

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