Nov. 25, 1941. G. WÜNSCH 2,263,687

VAPOR GENERATOR OR BOILER

Filed May 6, 1939 2 Sheets-Sheet 1

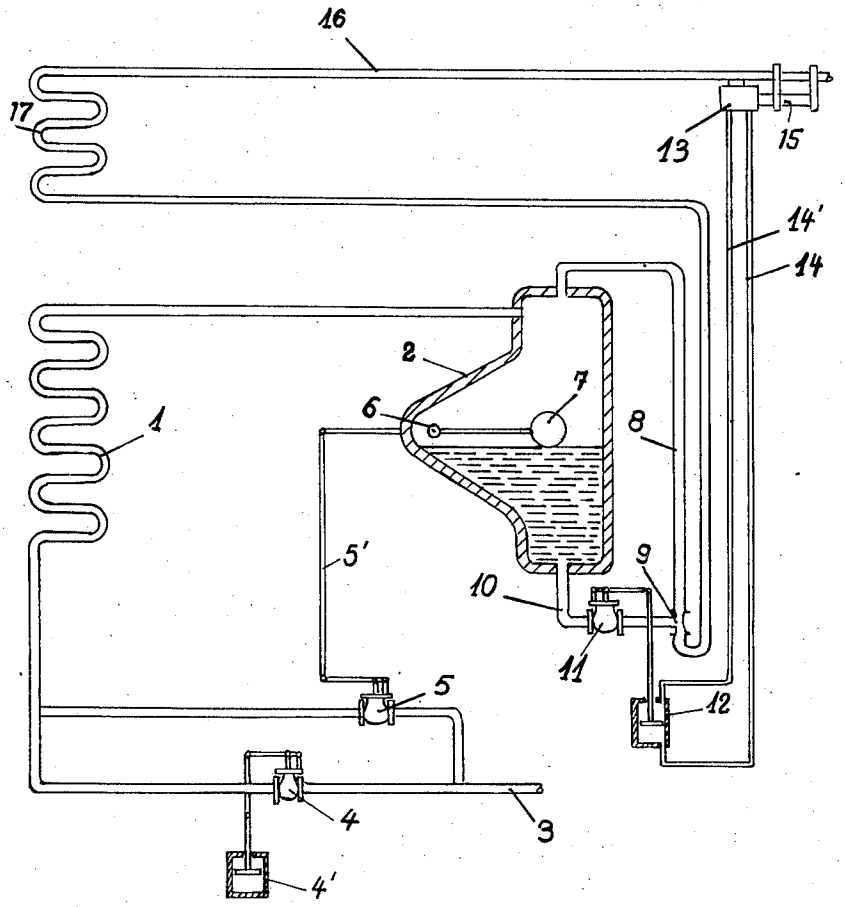


Fig. 1

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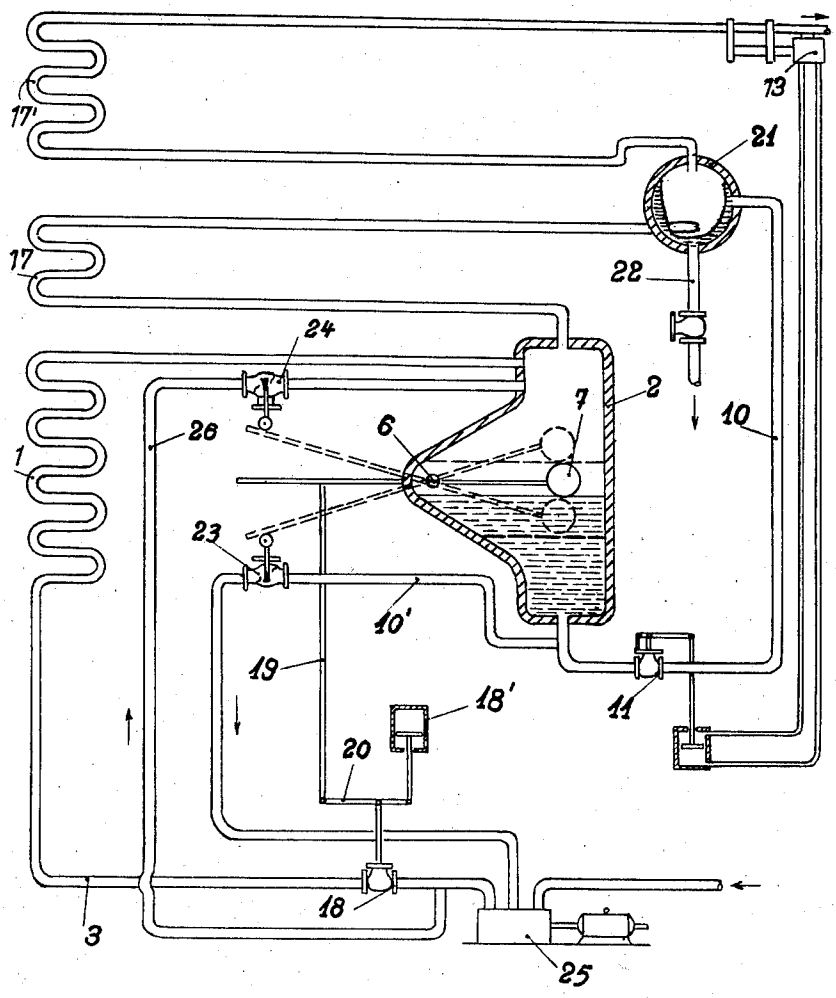


Fig. 2

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Patented Nov. 25, 1941

2,263,687

UNITED STATES PATENT OFFICE

2,263,687

VAPOR GENERATOR OR BOILER

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Application May 6, 1939, Serial No. 272,249
In Germany May 7, 1938

18 Claims. (Cl. 122—451)

This invention relates to that kind of vapor generator or boiler which includes a water reservoir at or towards the end of the vaporising section.

The operation of "once-through" or "through flow" vapor generators or boilers of the usual construction, introduces the difficulty that in practice it is not possible so to balance the quantity of feed water to the heating of the furnace that the steam produced has the desired temperature. Every small variation in the stoking of the furnace, every fluctuation in the steam pressure and every change in the feed pressure destroys the equilibrium of the operation, and makes its appearance as undesirable fluctuations in the steam temperature. An accidental increase in the superheating effect, caused for instance by the use of fuel of a different califoric value, and the consequent increase in temperature of the steam, raise the resistance to flow in the steam section of the boiler thus reducing the amount of feed water which can be admitted. This produces a still further increase in the steam temperature, so that these usual generators or boilers are liable to a certain amount of instability.

In these earlier generators or boilers an even greater drawback is met with, viz. that the control of the quantity of feed water, which is for example effected by a temperature and/or load regulator, can only be effected with a large degree of lag. In view of filling-up or congestion processes which take place in the vaporizing section of the boiler, and which are still partly unexplained, it is in practice impossible to control the operating conditions in the boiler merely by regulating the supply of feed water, as theoretically should be possible. When variations occur in the load, the lag in the effect produced by the increase of feed water results in an undesirable displacement of the zone of conversion in the boiler, i. e. a variation in the length of the superheater and a fluctuation in the steam temperature. On the other hand if attempts are made by varying the quantity of feed water to displace the zone of conversion, i. e. to vary the effective length of the superheater, for the purpose of regulating the steam temperature, the time lag of the effect of extra or decreased feed water makes this kind of regulation, which is theoretically conceivable and is regarded as a particular advantage of "once-through" boilers, practically useless. Experience has indicated that a regulation of the feed water does not affect the water content of the steam at the end of the vaporization section and thus the effective length of the superheater of the boiler.

These defects are to some degree removed by the provision of a water reservoir in the boiler or generator at or towards the end of the vaporizing section, as has previously been done.

In some of the boilers of this kind, however, water level regulators were provided for controlling the feed such that the level of the water in the reservoir remained constant, the excess conserved water flowing away or being returned to the feed pump.

In another prior proposal the inventor caused the varying of the water level in the reservoir by a steam temperature-responsive control of a discharge conduit and in such a way that a greater or smaller portion of the collected water was carried away by the steam and thus regulated the temperature of the latter. This form of regulation of the steam temperature has the drawback that the amount of water carried off by the steam is dependent on the water level in the container. However, this water level only varies comparatively slowly when the discharge conduit is regulated, and the smaller the degree of excess feed the slower the change in the water level. In the case of the boilers without an excess feed, this method of regulation is entirely useless.

Thus the quantity of conserved water which is carried off by the steam for cooling the latter is only effective a considerable time after the steam temperature has altered, this lapse of time being still greater as the excess feed to the boiler is smaller.

In accordance with this invention there is provided a through flow boiler including a tubular vaporizing system, a water reservoir arranged in the said vaporizing system, means for maintaining the water level in said reservoir substantially constant said reservoir having a water discharge conduit leading into the said tubular vaporizing system of the boiler, water discharge regulating means for said discharge conduit, and steam temperature sensitive means disposed so as to be responsive to the temperature of the steam produced by said vaporizing section of the boiler and adapted to control the regulation of the said water discharged regulating means.

Thus the water in the reservoir is not, in this invention, carried off by the steam in an amount correlated to the temperature-dependent water level, as in the aforesaid prior proposal, but is

added directly to the steam through the temperature-controlled discharge conduit.

The cooling water is added from the reservoir to the steam for the purpose of regulating the temperature thereof in response to the steam temperature impulse without any time delay and independently of the degree of over-feed. Thus the invention is also applicable for use with boilers which only operate with a small excess feed sufficient for navigation purposes, and in boilers of this nature it is only by using the present invention that it is possible to obtain a regulation of the steam temperature which is independent of the above-mentioned "filling-up" phenomena.

A further advantage is secured by using the present invention. "Once-through" boilers normally have a very small feed capacity which, in the main, is determined by the quantity of boiling water in relation to the steam produced per unit time. The additional quantity of water present in the reservoir, which for example is ½% of the output per hour ensures a sufficient feed capacity for the majority of purposes.

The conserved water can be added to the steam by arranging that the level of the water in the reservoir is above the part at which the discharge conduit opens into the part of the boiler beyond the reservoir. Alternatively a drop in flow pressure which is present (and which may be artificially increased) between the reservoir and the opening of the discharge conduit into the boiler can be utilized. This latter arrangement has the advantage that a quantity of water proportional to the quantity of steam flowing is automatically withdrawn by suction from the discharge conduit.

The reserve water may be supplied to the boiler tubular system in a steam cooler of suitable construction, but preferably one in which the separation of water is effected by a centrifugal action. This enables salts to be deposited from the steam, and these can be drained off periodically.

The accompanying drawings diagrammatically illustrate two embodiments of the invention, which are here given by way of example only.

In the drawings Fig. 1 is a diagrammatic view of the vaporization section of a "once through" boiler having this invention applied thereto, and Fig. 2 is a similar diagrammatic view of a modified arrangement according to the invention.

In these drawings, 1 designates generally the vaporization section of a "once-through" or "push through" boiler or vapor generator and this section of the boiler is connected to a reservoir in the form of a centrifugal water separator 2.

In the embodiment of the invention illustrated in Figure 1, the vaporizing section of the boiler is fed with water through a feed conduit 3 containing a main feed water valve 4. A second feed water valve 5 is arranged in shunt with the valve 4, and the latter is controlled by a servomotor 4' which is operated by a feed water regulator of conventional form, the latter being omitted from the drawings to avoid unnecessary complexity.

Arranged in the separator 2 is a float 7 which is mounted on an arm pivotable about the point 6, and this float 7 is adapted to operate the valve 5 through a suitable mechanical connection, e. g. 5'. Alternatively the valve 5 could, of course, be operated by a water level regulator which is designed to bring into action an auxiliary power source controlling the valve.

The boiler is continued beyond the water separator 2 in the form of a tube 8 of looped shape, the lower bend of this loop being located at a lower level than the bottom of the separator 2. This tube 8 includes a Venturi nozzle 9, and a discharge pipe 10, connected to the bottom of the separator 2, communicates with this Venturi nozzle.

A valve 11 inserted in the line 10 controls the flow of liquid in the latter, and this valve 11 is adapted to be adjusted by the piston of a servomotor 12. The two sides of this piston are connected by conduits 14 and 14' to a temperature regulator 13 of known construction. This regulator includes a thermostatic member 15 which is so arranged as to be subjected to the heat of steam leaving the boiler through a steam consumption line 16, whereby the member 15 enables the temperature of the steam as it leaves the boiler to be estimated.

Finally, a superheated section of the boiler lies between the loop 8 and the steam line 16.

The boiler which is described above with reference to Figure 1 of the accompanying drawings functions in the following manner.

A part of the feed water required by the boiler passes thereto through the valve 5 in the shunt line. The control of the valve 5 exerted by the float 7 in accordance with the water level in the separator 2 is such that this level remains the same with the water at a predetermined height.

A certain amount of water continually escapes from the separator 2, through the discharge pipe 10 and the valve 11, into the tube 8 and thus affects the amount of water in the steam, i. e. the effective length of the superheater section 17. As soon as the steam flowing through the superheater 17 becomes too hot, the temperature regulator 13 opens the valve 11 and allows an increased quantity of water to flow into the tube 8. In the result, the water level falls in the separator 2 and the float 7 consequently causes a correspondingly increased opening of the valve 5.

Since the separator 2 contains a considerable volume of water, it is of no disadvantage if the effect of the extra supply of water to which the valve 5 is set is not apparent in the separator 2 until some time has elapsed. The reserve of water leaving the separator 2, which reserve determines the water content of the steam flowing through the loop 8, is on the contrary immediately available, and in view of the comparatively small size of the superheater section 17, the steam temperature changes practically without any lag.

This arrangement permits a balance to be set up between the reserve water discharged through the pipe 10 and the proportion of the feed water flowing through the valve 5.

The fact that the point at which the pipe 10 is connected to the separator 2 is at a higher level than the point at which this pipe enters the loop 8 ensures that the reserve water is positively passed into this loop, even if only quite a small quantity of steam is present therein.

The Venturi nozzle 9 produces a fall in the flow pressure in the pipe 10 which is greater according as the quantity of steam passing through the tube 8 is greater.

Referring now to Figure 2, the vaporizer 1 is here supplied with water through a valve 18 which is under the dual control of a servomotor 18' of a feed water regulator (not shown), and a lever system 19 which is operatively connected to the float 7 in the water separator 2. This dual control is effected through a known form of sum-

mation lever system denoted 20 in the drawings.

In contradistinction to the arrangement illustrated in Figure 1, the discharge pipe 10 connected to the underside of the separator 2 here communicates with a steam cooler 21 which is connected up between two superheater stages 17 and 17' in the steam line. The cooler 21 comprises a spherical vessel into which a rectilinear extension of the superheater 17 opens tangentially. The pipe 10 is also tangential to the condenser 21 adjacent its point of connection thereto.

By this means an annular circulation of water is set up in the condenser 21, and the steam from the superheater 17 has to pass through this before it can enter the superheater stage 17'. This centrifugal action has, therefore, the result that only dry steam passes to the superheater 17'.

The residual water which accumulates in the cooler 21, and which will of course contain various salts, can be drained off, from time to time, through a valve-controlled sludge pipe 22.

As in the first embodiment described, a valve 11 is arranged in the pipe 10 and is controlled through a servomotor 12 by a temperature regulator 13.

Now neglecting the difference in level between the water separator 2 and the steam cooler 21, which difference can conveniently be made zero in constructing the plant, the pressure in the cooler 21, is less than in the separator 2 because of the fact that the superheater 17, which sets up a certain amount of resistance to the flow of the steam, lies between them. Thus the fall in pressure in the superheater 17 also affects the valve 11 through the pipe 10. This fall in pressure is also however, a measure of the quantity of steam flowing through the superheater 17 and if the quantity of steam is doubled, a four-fold drop in pressure occurs in the superheater 17. Thus the differential pressure effective at the valve 11 rises to the same extent, so that a double quantity of water enters the condenser 21 if the valve 11 is not shifted. Thus the steam will automatically withdraw a proportionate amount of cooling water through the unadjusted valve 11 without any time lag. Consequently, the temperature regulator 13 has only to compensate minor and slowly-recovering fluctuations when variations occur in the load.

Two further valves 23 and 24 are controlled by the float 7 in the water separator 2. The valve 23 is located in an auxiliary discharge conduit 10' connecting the discharge pipe 10 to a suitable pressure stage in a feed pump 25 supplying water through the conduit 3 to the boiler. The valve 24 is located in an inlet conduit 26 which is branched off the water feed conduit 3 in front of the valve 18 and opens into the upper portion of the separator 2. Immediately the water level in the separator 2 becomes too high, the float 7 opens the valve 23 and permits water to flow back through conduit 10' to the feed pump 25. On the other hand, if the water level falls too far, the valve 24 is automatically opened and the reserve of water in the separator 2 is immediately supplemented via the conduit 26.

The valves 23, 24 and 18 can, of course, be otherwise controlled, for example by means of water level regulator with an auxiliary source of power. A water level-differential pressure system can be used for controlling the water level regulator.

An evaporator cooler of known construction can be used in place of the cooler 21 with its centrifugal separating construction. The use of a condenser instead of the erstwhile usual injector nozzles for the cooling water has the advantage that a means for producing the injection pressure is no longer required.

What I claim is:

1. A through flow boiler including a tubular vaporizing system, a water reservoir arranged in the said vaporizing system, means for maintaining the water level in said reservoir substantially constant, a superheating tubular system, a water separating steam cooler in said superheating system, a water discharge conduit leading from the said reservoir to the said steam cooler, water discharge regulating means for said discharge conduit, and steam temperature sensitive means disposed so as to be responsive to the temperature of the steam produced by said vaporizing section of the boiler and adapted to control the regulation of the said water discharge regulating means.

2. A boiler according to claim 1 wherein the said water separating steam cooler comprises a centrifugal separator.

3. A push-through boiler comprising a tubular vaporizing system, a tubular superheating system, a water reservoir between and connecting together the vaporizing and superheating systems, conduit means for discharging water from the said reservoir into the tubular system of the boiler beyond the reservoir, valve means for regulating the discharge of water by said conduit means, a steam temperature responsive device adapted to control said discharge regulating valve and means for maintaining the level of the water in the said reservoir substantially constant.

4. A through flow boiler comprising a tubular vaporizing system, a tubular superheating system, a water reservoir between and connecting together the vaporizing and superheating systems, conduit means for discharging water from the said reservoir into the tubular system of the boiler beyond the reservoir, valve means for regulating the discharge of water by said conduit means, a steam temperature responsive device adapted to control said discharge regulating valve, a feed water regulating valve associated with the feed water supply system, and means responsive to the level of water in the said reservoir and adapted to effect a variation in said feed water regulating valve on a variation of said reservoir water level occuring.

5. A through flow boiler comprising a tubular vaporizing system, a tubular superheating system, a water reservoir into which the said tubular vaporizing system discharges, an auxiliary feed water supply line in shunt with the main feed water supply line, a main feed water regulating valve in the main feed line, an auxiliary feed water regulating valve in the said auxiliary line, feed water regulator means controlling the said main feed water regulating valve, a float in said reservoir adapted to control said auxiliary feed water regulating valve in accordance with the level of the water in the reservoir, a looped steam tube leading from the steam space of the said reservoir to the said superheating tubular system, a water discharge conduit leading from the said reservoir to the said looped steam tube and communicating with the latter, the said looped steam tube having its lower bend below the level of the bottom of the said reservoir, and the said water discharge conduit entering the looped steam tube at a level lower than that at which it leaves the said reservoir, means adjacent the entry of the said water discharge conduit into

the looped steam pipe to ensure a fall in steam pressure at this position below the pressure within the said reservoir, a water discharge regulating valve in said water discharge conduit, means for operating this valve, and a temperature sensitive device disposed so as to be responsive to the temperature of steam at the end of the tubular superheating system of the boiler and adapted to control the said water discharge regulating valve operating means.

6. A through flow steam generator comprising a tubular vaporizing system, a tubular superheating system, a water reservoir into which the said tubular vaporizing system discharges, an auxiliary feed water supply line in shunt with the main feed water supply line, a main feed water regulating valve in the main feed line, an auxiliary feed water regulating valve in the said auxiliary line, feed water regulator means controlling the said main feed water regulating valve, a float in said reservoir adapted to control said auxiliary feed water regulating valve in accordance with the level of the water in the reservoir, a steam tube leading from the steam space of the said reservoir to the said superheating tubular system, a water discharge conduit leading from the said reservoir to the said steam tube and communicating with the latter, means adjacent the entry of the said water discharge conduit into the said steam tube to ensure a fall in steam pressure at this position below the pressure within the said reservoir, a water discharge regulating valve in said water discharge conduit, means for operating this valve, and a temperature sensitive device disposed so as to be responsive to the temperature of steam at the end of the tubular superheating system of the boiler and adapted to control the said water discharge regulating valve operating means.

7. Apparatus for controlling the operation of a vapor generator having a once-through vapor passage receiving liquid at one end and delivering vapor at the other end, comprising in combination a liquid separator arranged in the zone of evaporation of said passage, means for maintaining the liquid level in said separator substantially constant, a liquid discharge conduit leading from a point below the liquid level in said separator to the vapor part of said passage, liquid discharge controlling means for said discharge conduit and means responsive to the temperature of the vapor in the vapor part of said passage for actuating said liquid discharge controlling means.

8. Apparatus as set forth in claim 7 in which the mouth of said liquid discharge conduit is disposed at the same or at a lower level than the mean liquid level in said separator.

9. Apparatus as set forth in claim 7 in which the mouth of said liquid discharge conduit is disposed at a point of the vapor part of said passage at which the pressure due to the pressure drop in said passage is smaller than the pressure in said separator.

10. Apparatus as set forth in claim 7 in which the mouth of said liquid discharge conduit is arranged at a pressure reducing device disposed in the vapor part of said passage beyond said separator so as to cause the separated liquid to be drawn through said liquid discharge conduit.

11. Apparatus as set forth in claim 7 in which the mouth of said liquid discharge conduit is disposed at a flow resisting device arranged in the vapor part of said passage beyond said separator so as to cause the separated liquid to be drawn through said liquid discharge conduit.

12. Apparatus for controlling the operation of a vapor generator having a once-through fluid passage receiving liquid at one end and delivering vapor at the other end comprising in combination a liquid separator arranged in the evaporation zone of said passage, means responsive to variations of the liquid level in said separator, a main liquid supply controlling valve for controlling the liquid supply to said passage, an auxiliary supply control valve arranged in shunt with said main valve and connected to be adjusted by said liquid level responsive means, a liquid discharge conduit leading from a point below the liquid level in said separator to the vapor part of said passage, liquid discharge controlling means for said discharge conduit and means responsive to the temperature of the vapor in said vapor part of said passage for actuating said liquid discharge controlling means.

13. Apparatus for controlling the operation of a vapor generator having a once-through fluid passage receiving liquid at one end and delivering vapor at the other end comprising in combination a liquid separator arranged in the evaporation zone of said passage, a liquid discharge conduit leading from a point below the liquid level of said separator to the vapor part of said passage, liquid discharge controlling means for said discharge conduit, means responsive to the temperature of the vapor in the vapor part of said passage for actuating said liquid discharge controlling means, first liquid supply control means for the liquid supply to said passage, second liquid supply control means, means responsive to the variations of the liquid level in said separator for actuating said second liquid supply control means if the liquid level in said separator deviates from a predetermined value.

14. Apparatus as set forth in claim 13 including additional means for automatically supplying make-up liquid directly to said separator if the liquid level therein falls below a predetermined value.

15. Apparatus as set forth in claim 13 including additional means for automatically discharging liquid through an additional liquid discharge conduit from said separator if the liquid level therein rises above a predetermined value.

16. Apparatus as set forth in claim 13 including a float in said separator, a liquid supply control valve actuated in joint response to the movement of said float and to a liquid supply regulator, an excess liquid discharge conduit connecting said separator to the liquid supply control means, a control valve in said excess conduit connected to be actuated by said float so as to be opened if the liquid level rises above a predetermined value, an auxiliary liquid supply conduit leading to said separator from said liquid supply means, and a valve in said auxiliary conduit connected to be actuated by said float so as to be opened in accordance with the fall of the liquid level in said separator.

17. A vapor generator of the forced passage type having a once-through fluid passage receiving liquid at one end and delivering vapor at the other end, said passage including a vapor generating section and a superheating section, said latter section consisting of two successive parts, a first liquid separator arranged between and connecting said vapor generating section and said superheating section, a second liquid separator arranged between and connecting the

two parts of the superheating section, a liquid discharge conduit leading from a point in said first separator below the liquid level therein to said second separator, liquid discharge controlling means for controlling the liquid flow in said discharge conduit, and means responsive to the temperature of the superheated vapor at the end of the superheater section for actuating said liquid discharge controlling means.

18. A vapor generator as set forth in claim 17 including in addition a main supply conduit for supplying liquid to said vapor generating section, an excess liquid discharge conduit connecting said first separator to said supply conduit, float means in said first separator, valve means for controlling the flow of liquid in said discharge conduit and connected to be actuated by said float means so as to be opened if the liquid level in said separotor rises above a predetermined value, an auxiliary liquid supply conduit leading to said first separator from said main conduit and a valve for controlling the flow of liquid in said auxiliary conduit operatively connected to be controlled by said float means so as to be opened in accordance with the fall of liquid level in said separator.

GUIDO WÜNSCH.