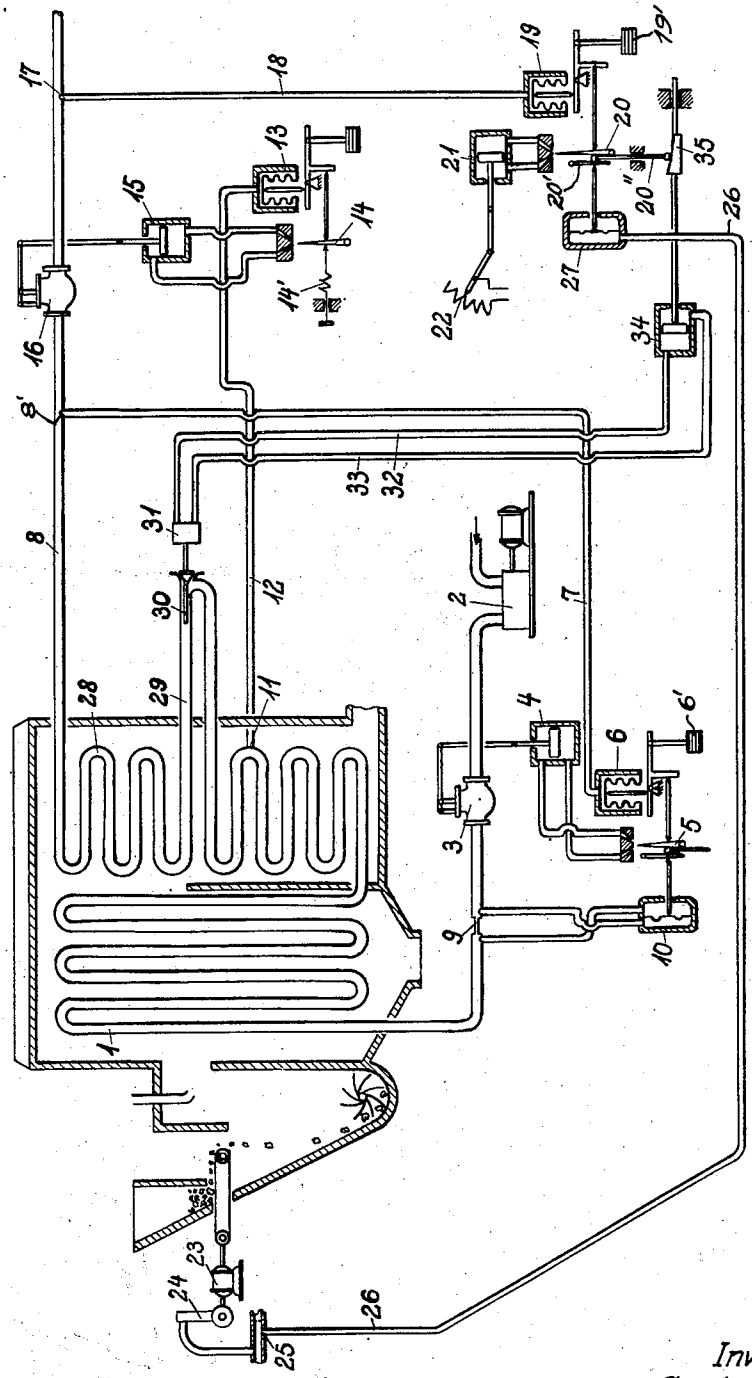
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MEANS FOR CONTROLLING THE OPERATION OF VAPOR GENERATORS

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Inventor:
Gustav Decker

By A. D. Adams

Attorney

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MEANS FOR CONTROLLING THE OPERATION OF VAPOR GENERATORS

Gustav Decker, Berlin, Germany; vested in the Alien Property Custodian

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This invention relates to means for controlling the operation of vapor generators having a once-through fluid passage receiving liquid at one end and delivering superheated vapor at the other end.

The main object of my invention is to provide particular means for maintaining a constant position of the zone of evaporation within said passage in order to keep constant the length of the superheater and quite constant the temperature of vapor at the end of the superheater.

It is well known in the art to provide a temperature responsive device at a point of the passage where the conversion ought to take place, said device controlling the fuel supply or the liquid supply to said passage in such a manner that the temperature at said point remains constant.

But I found out that by applying a temperature responsive device only, the zone of evaporation or conversion cannot be fixed to this very point since this temperature responsive device will not be able to distinguish whether the passage contains heated liquid, saturated vapor or superheated vapor at this point as all these fluids may have the same temperature.

My invention is based on the fact that every saturated vapor temperature conditions a corresponding pressure. According to the invention I propose, in order to fix the zone of evaporation or conversion to a certain point, to simultaneously control the temperature and the pressure in such a way that these two values have a certain reference to each other which is derived from the well known pressure-temperature diagram of saturated vapor.

These and other objects, aims and advantages will now be more fully explained with reference to the accompanying drawing schematically showing, by way of example only, one embodiment of a generator regulation according to the invention.

Referring to the drawing, the generator comprises a once-through passage 1 communicating with a water supply conduit from a supply pump 2. In the supply conduit there is arranged a supply control valve 3 for varying the water supply in response to the vapor outflow through the superheater section 28 of the generator. In the embodiment shown in the drawing the supply control valve 3 is operatively connected to a servo-motor 4 which is controlled by a well known jet pipe relay 5. This relay is acted upon in opposite direction by a vapor outflow impulse and a water inflow impulse. For deriving the last mentioned impulse a restriction 9 is provided in the supply conduit, the pressure drop across 9 acting upon a differential pressure system 10. The vapor outflow impulse is produced by a bellows 6 acted upon by the pressure in the main steam conduit 8, a pressure conduit 7 leading from the main conduit 8 to the bellows 6 as shown in the drawing. As will be readily understood, the pressure in the conduit 7 or at 8' in the conduit 8 must be less than the pressure at the zone 11 in the passage provided as zone of evaporation. The greater the vapor outflow through the superheater section and the conduit 8, the greater is the pressure drop between 11 and 8'. Accordingly this pressure drop is responsive to the vapor outflow. Now if the pressure at 11 is maintained constant so that a constant weight 6' may be provided for counteracting the bellows 6, the pressure fluctuations at 8' may be used as vapor outflow impulse.

The regulator for maintaining constant the pressure at 11 comprises a valve 16 arranged in the main conduit 8 and operatively connected to a servo-motor 15 which is controlled by means of a jet pipe relay 14 and a bellows 13 communicating by a pressure conduit 12 with the zone of evaporation 11. A counter spring 14' acts in opposition to the bellows 13 on the jet pipe 14. The tension of the spring may be adjusted in accordance with the pressure value to be maintained constant at 11.

If the pressure at 11 decreases (for instance due to an increased vapor outflow), the jet pipe 14 will be deflected counterclockwise so that the piston of the servo-motor 15 moves downwardly and decreases the cross section of the valve 16 as long as as a result of this cross section decrease the pressure at 11 is restored to its previous value.

From the foregoing explanation it will be apparent that the jet pipe 5 is controlled in response to the vapor outflow by means of the bellows 6. If it is assumed that the vapor outflow increases so that the pressure at 8' and in the conduit 7 decreases, the jet pipe 5 will be deflected counterclockwise so that the piston of the servo-motor 4 is moved upwardly thereby further opening the valve 3 as is necessary for keeping constant the ratio between the water inflow and the vapor outflow.

A short distance from the evaporation zone 11 towards the superheater section 28 a temperature responsive device 30 is inserted in a section 29 of the passage arranged outside of the generator housing. As will be more fully explained

later on, the temperature responsive device 30 is to be adjusted at a temperature somewhat higher than the temperature at 11 having, according to the saturated vapor diagram a predetermined relation to the pressure at 11, i. e. the pressure corresponding to the adjusted tension of the spring 14'. The greater the distance between 11 and 30, the greater is the temperature difference between 11 and 30. In other words, the temperature to be maintained constant at 30 is dependent on the distance between 11 and 30.

The temperature responsive device is shown to be a thermostat which controls the pressure fluid relay 31 from which two pressure conduits 32 and 33 lead to a servo-motor 34 connected to displace a cam 35 for correcting the operation of a fuel feeding regulator now to be more fully described. An electric motor 23 is provided for driving the conveyor of a well known pulverizer firing system, the circuit of this motor comprising a rheostat 22 which is variable by means of a servo-motor 21 cooperating with a jet pipe relay 20. This relay is designed for varying the rheostat 22 in response to the generator load in such manner that upon an increase in load the fuel feed will be increased likewise. Accordingly means are provided for exerting a load impulse on the relay 20, said means comprising—in conformity with the water supply regulator 5, 6, 6'—a bellows 19 and a counter weight 19', a pressure conduit 18 leading from the bellows to the main conduit 8 at a point 17 beyond the above mentioned valve 16. The counter weight 19' corresponds—as does the weight 6'—to the pressure to be maintained constant in the evaporation zone 11. Now, as pointed out above, the pressure drop between 11 and 8', i. e. the pressure at 8', is responsive to the vapor outflow. In a similar manner the pressure drop between 11 and 17 and the pressure itself at 17, is responsive to the generator load, i. e. to the vapor quantity required for any utilizing apparatus. The pressure drop between 11 and 17 will be influenced by the variations of the flow resistance caused by any control of the cross section of the valve 16. However, this influence on the pressure fluctuation at 17 is an advantage insofar as upon a load variation the pressure variation at 17 precedes that at 8' and furthermore the amplitudes of the pressure variation are greater at 17 due to the valve 16. As regards the fuel feed control, this involves that upon a load variation in the first instance the heat supply will be varied correspondingly, whilst the water supply will be controlled in accordance with the vapor outflow, i. e. the vapor quantity flowing from 11 to 8'. In the event therefore of the generator load, i. e. the vapor quantity required by the utilizing apparatus, being greater than the vapor outflow, the heat supply will be increased to a greater extent than the water supply, which is predetermined by the vapor outflow and not by the load. In this way the heat supply will more rapidly follow the generator load variations than would be the case if the fuel feed were controlled by the pressure variations at 8', or, in other words, if the bellows 19 were likewise communicating with the pressure conduit 7 leading to the bellows 6.

As is apparent from the drawing, any load increase causing a presssure decrease at 17 and at the bellows 19 results in a counterclockwise deflection of the jet pipe 20 and in an increase in speed of the motor 23. As in the water supply control system the vapor outflow impulse 6 is balanced by the water inflow impulse 9, 10, the fuel feed control system comprises in addition to the generator load impulse bellows 19 a counteracting impulse system 27, shown as being a diaphragm, for exerting a counter impulse in response to the fuel feed. A pressure conduit 26 leads from the diaphragm casing to a conduit 25 communicating with a measuring fan 24 driven by the motor 23 so that the measuring pressure in 25, 26 and 27 varies in response to the speed of the motor 23 and accordingly to the fuel feed.

The cam 35 referred to above is provided for varying the ratio between the impulse 19 and the counter impulse 27. To this end the jet pipe relay 20 is provided in a well known manner with an intermediate lever 20' and a so-called ratio slider 20'' which may be displaced between the jet pipe and the intermediate lever 20' for varying the transmission ratio. The ratio slider 20'' is kept in cooperative relation with the curvature of the cam 35 and therefore displaced in accordance with the displacement of said cam caused by the servo-motor 34 in accordance with the controlling impulse produced by the thermostat 30.

If it as assumed that the temperature at 30 exceeds the predetermined value to be maintained constant, the cam 35 displaces the ratio slider 20' and causes a variation of the ratio between the impulse 19 and the counter impulse 27 in such manner that the fuel feed or the heat supply is corrected so as to restore the temperature at 30 to its predetermined value. In this respect it is to be noted that the invention is not restricted to this particular embodiment because the temperature at 30 may also be maintained constant by controlling the water supply in response to the temperature at 30. However, I desire to point out that in a once-through vapor generator the water supply must be controlled not only in the sense of maintaining constant the temperature at 30, but also in response to the vapor outflow. Therefore it is a disadvantage to control the water supply in accordance with the temperature at 30, since such control would be inadequate insofar as in order to maintain constant the temperature at 30 it would be necessary to vary the vapor generation in a manner which is not in accordance with the generator load. Generally speaking I prefer therefore to use the temperature impulse derived at 30 for varying the ratio between the fuel feed and the water supply correspondingly.

With regard to the fixing of the evaporation zone according to the invention, the embodiment shown and described above operates as follows:

In the embodiment shown it may be assumed that the zone of evaporation extends from a point in front of the point 11 to a point in front of 30 so that the thermostat 30 is located in the superheater section. In the event of the evaporation zone being displaced in the direction towards the superheater section (for instance due to a decrease in the generator load), the temperature at the thermostat 30 decreases in accordance with the decrease in the distance between the end of the evaporation zone and the point 30. As soon as the evaporation zone reaches the thermostat 30, the temperature thereof is equal to the temperature in the evaporation zone corresponding to the evaporation pressure at 11. In both cases the temperature at 30 decreases so that the ratio slider 20' influences the ratio between the generator load impulse 19 and the fuel impulse 27 in such a manner that the fuel amount increases in relation to the load impulse.

Accordingly, the heat supply increases so that the evaporation zone is displaced in the opposite direction to such an extent that the temperature at 30 resumes the predetermined value. In other words, the end of the evaporation zone is again situated the predetermined distance from the thermostat 30 determined by said predetermined temperature value. In the same manner any displacement of the evaporation zone in the direction of the water supply end results in a change in the temperature at 30. In this event the distance between the end of the evaporation zone and the thermostat 30 increases thereby increasing the temperature at 30. In consequence thereof the ratio between the impulse 19 and the impulse 27 will be varied in such a manner that the fuel amount will be decreased while a corresponding decrease of the heat supply displaces the evaporation zone to the predetermined range.

In this connection it is to be noted that the temperature at the thermostat 30 represents a positive value of the superheating only in the case of a predetermined evaporation pressure. It may be possible that due to a change of the evaporation pressure the evaporation zone will be displaced without influencing the temperature at 30 in the described manner. For this reason it is essential to maintain constant the evaporation pressure at 11 by means of the valve 16 above referred to.

Having thus described my invention and one embodiment thereof, I desire it to be distinctly understood that I am not to be limited thereby particularly as far as the above described methods for regulating the pressure and the temperature are concerned.

What I claim is:

1. In a vapor generator of the forced passage type having a once-through fluid passage receiving liquid at one end and delivering superheated vapor at the other end, pressure controlling means for maintaining a constant pressure in said passage at a point provided as zone of evaporation, temperature responsive means arranged in said passage at a point predetermined in relation to said constant pressure point, temperature controlling means connected to be actuated by said temperature responsive means for maintaining a constant temperature at said temperature point, said temperature controlling means being adjusted at a temperature corresponding to the temperature potential between said temperature responsive means and said constant pressure point, liquid supply and fuel feed control means and means for varying the ratio of liquid supply and fuel feed, said last named means being connected to be actuated by said temperature responsive means so as to maintain constant the temperature in said passage at said temperature responsive means.

2. In a vapor generator of the forced passage type having a once-through fluid passage receiving liquid at one end and delivering superheated vapor at the other end, pressure controlling means for maintaining a constant pressure in said passage at a point provided as zone of evaporation, temperature responsive means arranged in said passage at a point predetermined in relation to said constant pressure point, temperature controlling means connected to be actuated by said temperature responsive means for maintaining a constant temperature at said temperature point, said temperature controlling means being adjusted at a temperature corresponding to the temperature potential between said temperature responsive means and said constant pressure point, means for controlling the liquid supply to said passage in response to the vapor outflow, means for controlling the fuel feed, means responsive to the generator load connected to actuate said fuel feed control means, means for varying the influence of said generator load responsive means on said fuel feed control means, said varying means being connected to be acted upon by said temperature responsive means for varying the ratio between the liquid supply and the fuel feed so as to maintain constant the temperature in said passage at said temperature responsive means.

3. In a vapor generator of the forced passage type having a once-through fluid passage receiving liquid at one end and delivering superheated vapor at the other end, first means responsive to the pressure in said passage at a point provided as zone of evaporation, valve means in the vapor part of said passage connected to be controlled by said first means for maintaining a constant pressure at said point in the passage, second means responsive to the pressure in the vapor part of said passage in front of said valve means, liquid supply control means connected to be actuated by said second means for controlling the liquid supply to said passage in response to the vapor outflow, third means responsive to the pressure in the vapor part behind said valve means, fuel feed control means connected to be actuated by said third means, means responsive to the temperature in said passage at a point predetermined in relation to said constant pressure point, additional means for varying the influence of said third means on said fuel feed control means, said additional means being connected to be actuated by said temperature responsive means for maintaining in said passage at said temperature responsive means a constant temperature corresponding to the temperature potential between the temperature at said temperature responsive means and at said first means.

GUSTAV DECKER.