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CONTROL SYSTEM FOR FORCED FLOW VAPOR GENERATORS

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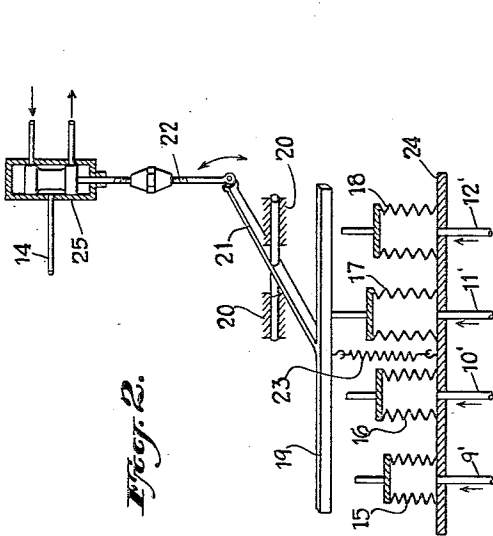


Fig. 2.

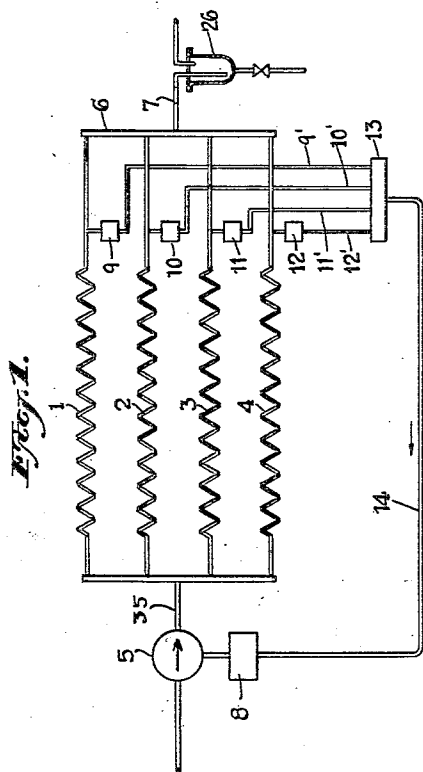


Fig. 1.

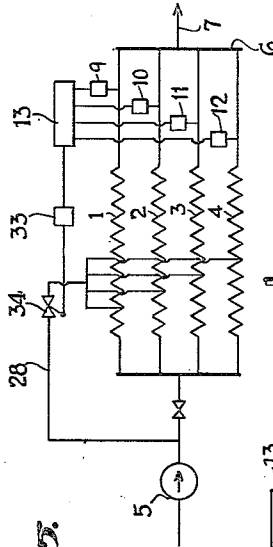


Fig. 3.

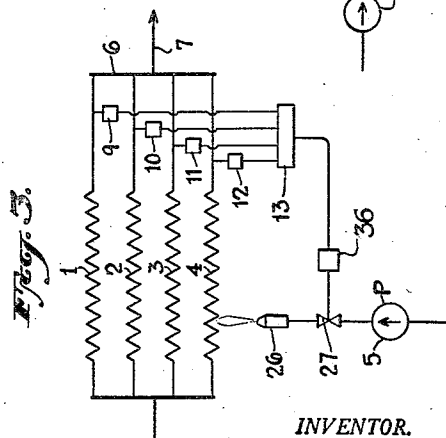


Fig. 4.

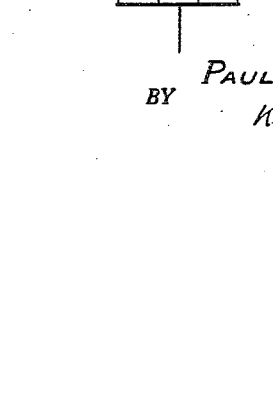


Fig. 5.

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CONTROL SYSTEM FOR FORCED FLOW VAPOR GENERATORS

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3 Claims. (Cl. 122-448)

The present invention relates to forced flow vapor generators of the kind in which the heating surface is formed by a plurality of tubes connected in parallel, at least in the zones of vaporization and of the beginning of superheating, and which generators comprise a device for regulating all or a part of the liquid supply or for regulating the fuel supply, the regulating device being responsive to the temperature of the working medium passing from the vaporization zone into the superheating zone.

It has been suggested to adjust the supply of heat or the supply of working medium to one of the parallel-connected tubes of forced flow steam generators differently from the supply to the other tubes, so that either the still liquid working medium is heated longer or superheating of the steam begins sooner than in the other tubes. The regulating device is actuated by the temperature of the differently adjusted tube. Due to numerous small changes of operating conditions, which cannot be controlled, individual tubes receive more or less heat than the other tubes, sometimes temporarily, sometimes for longer periods, or permanently, or receive more or less working medium so that at times one or another tube is favored with heat. Such disturbances may be caused by faulty operation of individual burners, slagging of individual tubes, disturbances in the supply of secondary combustion air, or by other effects which occur in every steam generator. Taking the temperature of a single tube for controlling fuel and/or operating medium supply may cause serious changes of the temperature of the total steam, if there is an irregularity in the heating of this single tube. Such temperature changes may cause damage, if they are not immediately discovered. Such damages occur particularly, if the measuring tube receives relatively little heat, because, in that case, all other tubes are supplied with too much heat.

It is an object of the present invention to provide a control system for forced flow steam generators which avoids the aforescribed disadvantages. In the system according to the invention a temperature sensitive device is connected with each tube or a plurality of the tubes of a set of tubes which are arranged parallel with respect to fluid flow and all temperature sensitive devices are connected with a selector which passes on impulses only which come from the device connected with the tube of highest temperature and interrupts all other impulses.

Further and other objects of the present invention will be hereinafter set forth in the accompanying specification and claims, and shown in the drawing which, by way of illustration, shows what I now consider to be preferred embodiments of my invention.

In the drawing:

Fig. 1 is a diagram illustrating the tube system of a forced flow steam generator at the evaporation zone and at the beginning of the superheating zone;

Fig. 2 is a diagrammatic illustration of a selector and pilot valve actuator forming part of the control system according to the invention;

Fig. 3 is a diagrammatic illustration of a modified system according to the invention;

Fig. 4 is a diagrammatic illustration of a further modification of the system according to the invention;

Fig. 5 is a diagrammatic illustration of a modification of the system according to Fig. 4;

Fig. 6 is a diagrammatic sectional view of a servomotor as may be used in the system according to the invention.

Like parts are designated by like numerals in all figures of the drawing.

The steam generator shown in Fig. 1 comprises four parallel-connected tubes 1 to 4 in the zones of vaporization and of the beginning of superheating. Feed water is supplied as uniformly as possible to these tubes by means of a feed pump 5 through a conduit 35. Heating of the tubes is effected as uniformly as possible by suitable arrangement of the tubes in the generator. In the area of the transition from the vaporization zone to the superheating zone the tubes 1 to 4 are connected to a collector 6, from which a pipe 7 leads to a superheater, not shown. The regulation of the amount of feed water supplied to tubes 1 to 4 is effected by adjusting the speed of the pump 5 by means of a regulator or servomotor 8 which may be of the type shown in Fig. 6. A thermostat, 9 to 12, is connected with each of the tubes 1 to 4, respectively, which tubes are connected in parallel relation with respect to medium flow. The thermostats are preferably connected with the tubes in the proximity of the header 6 and are individually connected by conventional temperature impulse transmitting means, 9' to 11', respectively, with a selector 13 from which control impulses are transmitted by conventional means 14 to the regulator or servomotor 8.

As seen in Fig. 2, the selector 13 which is interposed between the thermostats 9 to 12 and the servomotor 8 comprises four bellows 15 to 18 which are individually connected by the impulse transmitting means 9' to 11', respectively, with the thermostats 9 to 12. Rising temperature of the thermostats causes expansion of the bellows. One of the ends of each bellows is fixed to a base plate 24 common to all bellows. The other ends of the bellows are individually provided with pins adapted to abut against a cross bar 19 upon a predetermined expansion of the respective bellows. Bar 19 is fixed to one end of a two-arm lever 21 which is fulcrumed at 20. To the other end of lever 21, a rod 22 is pivoted which rod actuates the piston of a conventional hydraulic control valve 25 which controls the pressure in the impulse transmitting conduit 14, thereby controlling the regulator 8. A spring 23, whose one end is connected to the base plate 24 and whose other end is connected with the cross bar 19, pulls the latter against the pins extending from the movable ends of the bellows so that the pin of the bellows connected with the thermostat having the highest temperature is abutted by the bar 19. In the position shown in Fig. 2, thermostat 11 has the highest temperature and the pin of bellows 17 abuts against the cross bar 19. The pins of the other bellows cannot reach the cross bar because they are actuated by thermostats having relatively low temperatures. By proper adjustment of the length of rod 22, the system can be so set that only that one of the tubes 1 to 4 which has the highest temperature will discharge slightly superheated steam into the header 6, the other tubes discharging dry saturated or slightly wet steam into the header. During normal operation, actuation of regulator 8 will be affected by the temperature of different tubes 1 to 4 at different times depending on the heat transfer condition at the outside and inside surfaces of the tubes and other changing operating conditions. The system according to the invention prevents exces-

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sive heating of an individual tube, for example, caused by excessive scale deposit.

Without departing from the scope of the invention, each of the tubes designated by the numerals 1 to 4 may represent a group of tubes which are so arranged that they are subjected to substantially the same operating conditions, each group being provided with a thermostat.

A steam separator 26 may be provided between the points where the thermostats are connected to the tubes 1 to 4 and the superheater, not shown, which is connected with the header 6 by means of a conduit 7. The steam separator is preferably connected with the conduit 7.

Instead of controlling the supply of liquid to the vapor generator in dependence on the temperature of the hottest of a plurality of tubes which are arranged parallel with respect to medium flow, the fuel supply may be controlled. This is shown in Fig. 3 in which the selector 13 actuates a conventional servomotor 36 which may be of the type shown in Fig. 6 and which controls a valve 27 in the fuel conduit between a fuel pump 5 and a burner 26.

Instead of controlling the total feed water stream as in Fig. 1, a portion of the feed water supplied by pump 5 may be diverted into a conduit 28 (Fig. 4) and the diverted stream may be divided into a plurality of conduits 29, 30, 31, 32 corresponding in number and being individually connected to the conduits 1 to 4 of the steam generator. A valve 29', 30', 31', 32' is provided in each conduit, 29, 30, 31, 32, respectively. All valves 29' to 32' are connected to a servomotor 33 which is actuated by the selector 13.

The system illustrated in Fig. 4 may be modified by omitting the valves 29' to 32' in the conduits 29 to 32 and arranging a valve 34 in conduit 28 as shown in Fig. 5. Valve 34 is connected to and operated by a regulator 33 actuated by the selector 13 as in the other illustrated embodiments.

While I believe the above described embodiments of my invention to be preferred embodiments, I wish it to be understood that I do not desire to be limited to the exact details of design, and construction shown and described, for obvious modifications will occur to a person skilled in the art.

What is claimed is:

1. The method of controlling the liquid supply to a forced flow vapor generator in which the liquid is forced through a plurality of heated tubes which are arranged in parallel with respect to the flow of the liquid and of

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the vapor generated in the tubes, said method including the steps of measuring the temperature of each tube, and controlling the liquid supply to all tubes in accordance with the temperature of that tube which has the relatively highest measured temperature.

2. A system for regulating the liquid supply to a forced flow vapor generator in which the liquid is pumped through a plurality of heated tubes which are arranged in parallel with respect to the flow of the liquid and of the vapor generated in the tubes, said system comprising a temperature measuring means connected with each tube; a selector including a plurality of temperature indicating means which are individually connected with and actuated by said temperature measuring means for indicating the temperature measured by said temperature measuring means, and an element adapted to be actuated by that one of said temperature indicating means which indicates the relatively highest temperature; means for controlling the supply of liquid to the tubes of the vapor generator, said last mentioned means being connected with said element for operation thereby and controlling the supply of liquid to the vapor generator tubes in accordance with the temperature of the tube which has the relatively highest temperature.

3. A system for regulating the liquid supply to a forced flow vapor generator in which the liquid is pumped through a plurality of heated tubes which are arranged in parallel with respect to the flow of the liquid and of the vapor generated in the tubes, said system comprising a temperature measuring means connected with each tube, control means for controlling the supply of liquid, to the tubes of the vapor generator, temperature impulse transmitting means interconnecting said temperature measuring means and said control means, and impulse interrupting means interposed in said transmitting means for interrupting all temperature impulses emanating from said temperature measuring means except the impulse which emanates from that of said measuring means which measures the highest temperature.

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