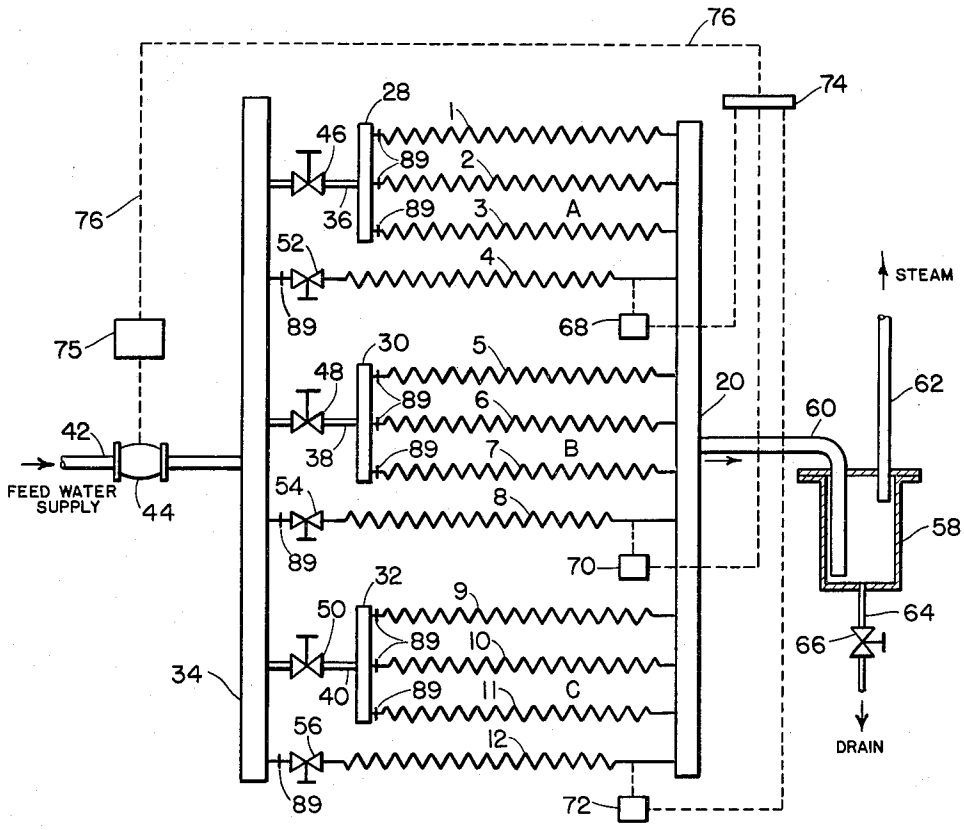
Oct. 17, 1961 J. I. ARGERSINGER ET AL 3,004,529

METHOD AND APPARATUS FOR CONTROLLING FUEL AND/OR FEEDWATER FLOW IN A ONCE-THROUGH STEAM GENERATOR

Filed March 6, 1956 2 Sheets-Sheet 1

FIG. 1



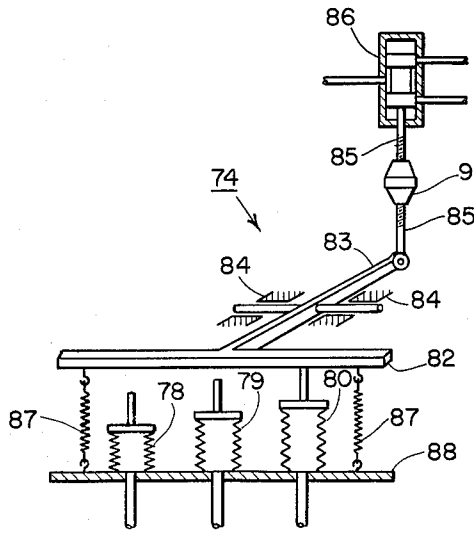


FIG. 2

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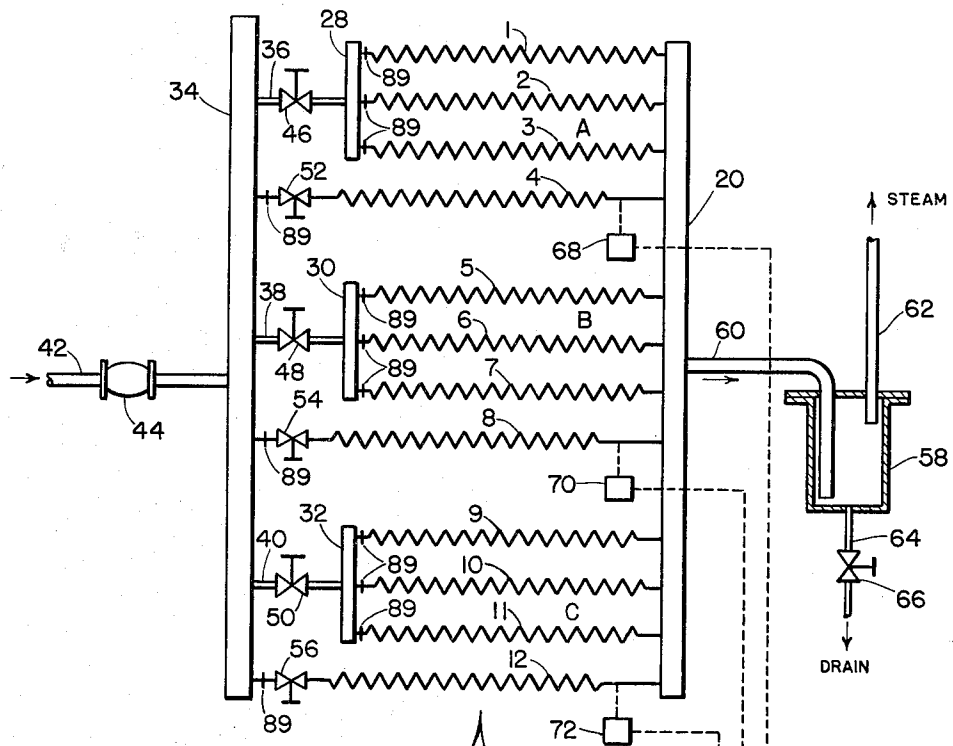
FIG. 3



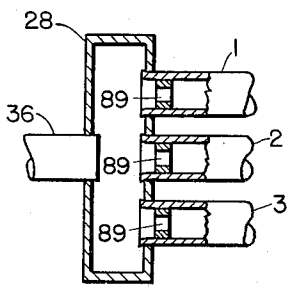


FIG. 4

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United States Patent Office 3,004,529 Patented Oct. 17, 1961

3,004,529

METHOD AND APPARATUS FOR CONTROLLING FUEL AND/OR FEEDWATER FLOW IN A ONCE-THROUGH STEAM GENERATOR

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Filed Mar. 6, 1956, Ser. No. 569,920
22 Claims. (Cl. 122—448)

The present invention relates to forced flow tubular vapor generators in which the heating surface is formed of a plurality of tubes through which the working medium flows, these tubes being arranged for parallel flow. Specifically the invention relates to a steam generator in which this parallel relationship exists at least in the zones of vaporization and the beginning of superheating of the steam. More specifically the invention relates to a generator of the above character which comprises a device which regulates all or a part of the liquid working medium supply, or 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 proposed in steam generators of the forced flow type to adjust the supply of heat or the supply of working medium to one of the parallel connected tubes differently from the supply to the other tubes. This causes the heating of the liquid working medium to the evaporation point to take longer, or the superheating of the steam to begin sooner, in the said one tube than in the other tubes. During normal operation the regulating device is actuated by the temperature of the differently adjusted tube through a temperature sensitive device. However this regulating device can also be actuated by the temperature of any of the other tubes if, due to abnormal operating conditions, the temperature of one of the other tubes should exceed that of the differently adjusted tube.

Such a control system of course calls for as many temperature sensitive devices as there are tubes. When applied to large steam generators however this system becomes too cumbersome, uneconomical and impractical because of the large number of tubes to be controlled and the large number of temperature sensitive devices to be employed.

It is an object of the present invention to provide a control system for large forced flow steam generators which avoids the aforedescribed disadvantages, particularly when dealing with unit sizes having as much as 100 or more individual tubes. In the system according to the invention a temperature sensitive device is associated with only one of a plurality or group of tubes, several such groups comprising the heating surface of the generator, all tubes or group of tubes being arranged parallel with respect to fluid flow therethrough. Each temperature sensitive device is operatively connected with a selector which transmits only those impulses to the device for regulating the working medium supply or fuel supply which come from the temperature sensitive device associated with the tube of highest temperature. In accordance with the invention flow controlling devices are provided for each tube to assure that the temperature and/or quality of each tube in a group as nearly as possible conforms to the temperature and/or quality of the other tubes and of the one tube in each group that is associated with the controlling temperature sensitive device.

Other objects and advantages of the present invention will become apparent from the following description of an illustrative embodiment of the invention when read in conjunction with the accompanying drawings wherein:

FIGURE 1 is a diagrammatic representation of a portion of the tubular heating surface of a forced flow steam generator at the end of the water heating zone, at the evaporation zone and the beginning of the superheating zone, and showing control of the feed water supply in accordance with the invention.

FIGURE 2 is a diagrammatic representation of one of the elements of the inventive control system.

FIGURE 3 is a diagrammatic illustration of a modified system according to the invention when applied to the control of the fuel supply.

FIGURE 4 is a cross section through the tube ends and showing individual flow controlling devices associated therewith.

In the apparatus illustrated in FIG. 1 a steam generator is shown diagrammatically representing three parallel connected groups of tubes A, B and C in the end zone of water heating, the zone of vaporization and the beginning of superheating. Each group A, B and C comprises four parallel connected tubes **1**, **2**, **3** and **4**; **5**, **6**, **7** and **8**; **9**, **10**, **11** and **12**, respectively. The outlet end of each tube of groups A, B and C is connected into outlet header **20**. The inlet ends of tubes **1**, **2** and **3** originate in sub-inlet header **28**; those of tubes **5**, **6** and **7** in sub-inlet header **30**; and those of tubes **9**, **10** and **11** in sub-inlet header **32**. The fourth tube of each group A, B and C, namely **4**, **8** and **12** respectively, by-passes the sub-inlet header associated with the group and is connected directly to main inlet header **34**. Sub-inlet headers **28**, **30** and **32** are also connected to main inlet header **34** by means of conduits **36**, **38** and **40** respectively.

The working medium, such as water, flows from a feed water source (not shown) through feed pipe **42** into header **34**. A flow control device such as valve **44** is installed in pipe **42** to regulate the amount of feed water fed to header **34**. Pipes **36**, **38** and **40** distribute the water to sub-headers **28**, **30** and **32** respectively. On the other hand tubes **4**, **8** and **12** receive water directly from header **38**. Flow control means such as valves **46**, **48** and **50** are provided in pipes **36**, **38** and **40**; and valves **52**, **54** and **56** in tubes **4**, **8** and **12** respectively.

Under normal operating conditions the water entering tube groups A, B and C is evaporated to such a degree that only a slight residue of water remains in the steam entering header **20**. The saturated steam and the small amount of water which carries a major portion of the impurities pass from outlet header **20** into a steam and water separator **58** by way of pipe **60**. Separator **58**, which may be of the centrifugal type, separates most of the water plus impurities from the steam, the steam leaving via pipe **62** to enter superheating surface (not shown). The water together with the impurities contained therein are drained off through pipe **64** and valve **66** to a sump not shown.

Each of the tubes **4**, **8** and **12** of the groups A, B and C respectively has associated therewith a temperature sensitive impulse transmitter **68**, **70** and **72**. Each transmitter is connected through an impulse conduit with a mechanism **74**, which on its part influences the regulator **75** through conduit **76**.

The mechanism is shown in diagrammatic form in FIG. 2. It has three bellows **78**, **79** and **80**, or other equivalent devices. Each of these is operatively connected with one of the impulse transmitters **68**, **70** and **72** (FIG. 1). These bellows expand and contract respectively with rising or falling temperatures and are arranged so that the moveable end of only the bellows connected to the impulse transmitter which is at the time at the highest temperature comes into contact with the cross bar **82** of a lever **83** mounted in bearing **84**. An adjustable rod **85** connects the other end of the lever **83** with a conventional hydraulic control valve **86**, which controls the pressure in the impulse transmitting conduit **76** thereby controlling valve **44** through the pressure

regulator 75. The lever 83 is biased toward the bellows by springs 87. Accordingly the cross bar 82 always bears on the bellows which is most fully extended. The cross bar 82 is thus always influenced only by the bellows, in this instance 80, the impulse transmitter of which is under the influence of the highest temperature. The impulse transmitter for the other bellows (78, 79) are influenced by lower temperatures. These other bellows therefore cannot come into contact with cross bar 82 and the impulse transmitters associated therewith can have no effect on regulation of valve 44 as long as this lower temperature is maintained.

Tubes 1, 2, 3 of group A; tubes 5, 6, 7 of group B; and tubes 9, 10 and 11 of group C are equipped with orifices 89 which may be permanently installed or be exchangeable. FIG. 4 shows three such tubes (1, 2, 3) the ends of which are provided with orifices 89. These orifices make it possible to proportion the water flow through these tubes in each group during the design stage so that the flow to each of the tubes will be equal or will be proportional to the heat absorbed by each tube. The fourth tube (4, 8, 12) of each group which is equipped with a temperature sensitive device (68, 70, 72) will also be designed, with or without an orifice 89, so that it will receive a water flow proportional to its heat absorption, and will produce steam at the outlet having the same temperature and/or quality as the steam produced by the remaining tubes of the respective group.

FIG. 3 shows the same arrangement of tube groups A, B and C as FIG. 1. However in the embodiment of FIG. 3 the mechanism 74 has a valve 86 which controls the fuel supply instead of the feed water supply as shown in FIG. 1.

In the illustrative embodiment of FIG. 3 this is accomplished by adjusting the pressure in the impulse transmitting conduit 90 thereby controlling the regulator 91 which in turn opens or closes fuel valve 92. This valve is installed in the fuel line 93 supplying fuel to a burner 94 from a source not shown. The required air for combustion is supplied through conduit 95 also from a source not shown.

By proper adjustment of the length of rod 85 by means of nut 96 (see FIG. 2), the control temperature is set at the desired value. Also one of the valves 52, 54 and 56 can be adjusted so that only one of the control tubes 4, 8 or 12, that which has the highest temperature, will discharge slightly superheated steam into the respective header 14, 16 or 18, the other tubes discharging slightly wet steam into these headers.

In operation, the feed water supply through pipe 42 or the fuel supply through pipe 93 is so proportioned that at first superheated steam is generated in tube groups A, B and C. Valves 46, 48 and 50, and 52, 54 and 56 are then so adjusted that the degree of superheat in the steam in each tube (1 through 12) entering header 20 is approximately the same. This is indicated by temperature readings obtained through a thermocouple installed in each tube end. Assuming now that the degree of superheat, to which all the tubes have been adjusted in this manner is 10° F. (above saturated steam temperature). Then the degree of superheat can be raised in one control tube, such as tube 12 for example, to 100° F. above saturated steam temperature by restricting the flow through valve 56. Now by adjustably opening feed valve 44 or adjustably closing fuel valve 92 the temperature of the steam leaving the control tube 12 can be lowered to a value of 25° F. above saturated steam temperature or other desired temperature level. At the same time the temperature in all the remaining tubes is also automatically reduced until that temperature reaches the saturated steam temperature. Since these latter tubes were initially discharging steam having a degree of superheat of only 10° F. above saturation point, the steam which leaves these tubes now will be wet steam. Accordingly the bellows associated with tubes 4 and 8 will be shorter than the bellows associated with tube 12.

The unit is now placed on automatic control. This means that the temperature of the steam leaving control tube 12 (25° F. above saturation point) is maintained within narrow limits by automatic control of either the feed water supply through valve 44, or the fuel supply through valve 92. The quality of the steam leaving the remaining tubes is thereby maintained at the desired value.

During the course of operation, an undue quantity of slag may accumulate on the heating surface of control tube 12. This will lower the amount of heat absorbed by tube 12 and cause the temperature of the steam to drop. The temperature sensitive device 72 then will influence mechanism 74 to act on regulator 75 to 91 to lower the feed water supply or increase the fuel supply respectively.

Such an action will raise the temperature of the steam in all the remaining circuits until one of the tubes 4 or 8 discharges steam having a degree of superheat in excess of that shown by the steam in the control tube 12. This results in automatically switching the control from tube 12 to either tube 4 or 8.

It is therefore practically impossible to burn out any tube in the groups A, B and C, since the tubes in each group are adjusted to the behavior of the respective control tube (4, 8, 12) by orifices 89 and each control tube in turn is operatively connected to mechanism 74 by one of the bellows 78, 79 and 80. The control tube recording the highest temperature therefore will by virtue of its longer bellows actuate lever 82 and hydraulic control valve 86 and finally exert an influence on feed valve 44 or fuel valve 92.

Under certain operating conditions, while one of the control tubes such as 12 discharges and maintains superheated steam having a temperature of 25° F. above saturated temperature, one or all of the other control tubes such as 4 and 8 may be so adjusted by means of valves 54 and 52 respectively that they discharge steam at a lower temperature such as 15° F. above saturated temperature. Accordingly in case tube 12 overheats, one of the other tubes will take over control of the unit sooner. Obviously more than two temperature levels could be established to suit special operating conditions. Thus, in the illustrative embodiment, tube 12 could be set to discharge steam at 25° F., tube 8 at 15° F. and tube 4 at 5° F. above saturated steam temperature.

The preferred embodiments of our invention have here been shown and described in connection with tubes and tube groups arranged in parallel relationship in the vaporization zone and in at least one other zone of variable temperature of the working medium namely the beginning of the superheating zone. However, as previously mentioned, there is one other zone of variable temperature of the working medium. And that is the heating zone immediately preceding the evaporation zone and commonly referred to as the water heating zone. In this zone, as in the superheating zone, the temperature of a given quantity of the heated medium reflects the amount of heat absorbed. Our invention could therefore equally well be applied to a system of control wherein the temperature variations in this other variable temperature zone are utilized to regulate the supply of the working medium or the supply of fuel in a manner similar to that earlier described herein in connection with temperature variation in the superheated vapor zone.

While the preferred embodiments of our invention have been here shown and described as employing hydraulic operating means, other equivalent means, well known in the prior art, including pneumatic, electric or electronic means could be utilized in practicing our invention. It will be understood that changes in construction, combination and arrangement of parts may be made without

departing from the spirit and scope of the invention as claimed.

We claim:

1. In a forced flow vapor generator in which heat is exchanged between a lquid working medium and a gaseous working medium and having the heating surface thereof divided into tubes carrying said liquid medium and being exposed to said gaseous medium, said tubes being connected in parallel at least in the zones of vaporization and the beginning of superheating, said tubes being divided into groups; the combination of means for regulating the rate of flow of at least one of said mediums in a manner to change the outlet temperature of said liquid medium, a plurality of temperature sensitive impulse transmitters each associated with one tube of each group to the exclusion of the other tubes in each group, in the region of the transition from the vaporizing zone into the superheating zone; means connecting said transmitters to a mechanism which permits only the impulse transmitter which at the moment is subjected to the highest temperature to influence said regulating means; a variable flow restricting device associated with, and individual to the said one tube of each group and having a flow restricting value to cause superheated vapor to issue from said one tube; a second variable flow restricting device common to and associated with said other tubes of each group and having a flow restricting value to cause saturated vapor to issue from said other tubes; and a plurality of other fixed value flow restricting devices each individual to said other tubes of each group for fixing the quality of the saturated steam issuing from said other tubes.

2. An apparatus according to claim 1 in which said plurality of other fixed value flow restricting devices includes also fixed value flow restricting devices individual to said one tube of each group.

3. In a forced flow steam generator having the heating surface thereof divided into tubes connected in parallel at least in the zone of vaporization and having a device for regulating the feed water supply, said tubes being divided into groups; the combination of a variable flow restricting device associated with, and individual to one tube of each group to the exclusion of the other tubes in the same group to cause superheating in at least a portion of said one tube by restricting the flow therethrough, a temperature sensitive impulse transmitter associated with said one tube of each group to the exclusion of the other tubes in each group, in the said superheated region thereof; means connecting said transmitters to a mechanism which permits only the impulse transmitter which at the moment is subjected to the highest temperature to influence the said regulating device; a second variable flow restricting device common to and associated with said other tubes of each group and having a restricting value to permit only saturated steam to issue from said other tubes; and a plurality of other fixed value flow restricting devices each individual to said other tubes of each group for fixing the quality of the saturated steam issuing from said other tubes.

4. An apparatus according to claim 3 in which said plurality of other fixed value flow restricting devices includes also fixed value flow restricting devices individual to said one tube of each group.

5. In a forced flow steam generator having the heating surface thereof divided into tubes connected in parallel at least in the zones of vaporization and the beginning of superheating and having a device for regulating the feed water supply, said tubes being divided into groups, the combination of a plurality of temperature sensitive impulse transmitters each associated with one tube of each group to the exclusion of the other tubes in each group in the region of the transition from the vaporizing zone into the superheating zone, means connecting said transmitters to a mechanism which permits only the impulse transmitter which at the moment is subjected to the highest temperature to influence the said regulating device, a variable flow restricting device associated with, and individual to the said one tube of each group and having a restricting value to cause only superheated steam to issue from said one tube, a second variable flow restricting device common to and associated with said other tubes of each group and having a restricting value to cause only saturated steam to issue from said other tubes, and a plurality of other fixed value flow restricting devices each individual to said other tubes of each group for fixing the quality of saturated steam issuing from said other tubes.

6. An apparatus according to claim 5 in which said plurality of other fixed value flow restricting devices includes also fixed value flow restricting devices individual to said one tube of each group.

7. In a forced flow steam generator having the heating surface thereof divided into tubes connected in parallel in the zone of vaporization and in at least one zone of variable temperature, and having a device for regulating the feed water supply, said tubes being divided into groups, the combination of a plurality of temperature sensitive impulse transmitters each associated with one tube of each group to the exclusion of the other tubes in each group, in the region of said variable temperature zone, means connecting said transmitters to a mechanism which permits only the impulse transmitter which at the moment is subjected to the highest temperature to influence the said regulating device, a variable flow controlling device associated with and individual to the said one tube of each group to the exclusion of the other tubes of the same group and having a restricting value to permit only superheated steam to issue from said one tube, a second variable flow controlling device common to and associated with said other tubes of each group and having a restricting value to permit only saturated steam to issue from said other tubes; and a plurality of other fixed value flow controlling devices each individual to said other tubes of each group for fixing the quality of the saturated steam issuing from said tubes.

8. An apparatus according to claim 7 in which said plurality of other fixed value flow controlling devices includes also fixed value flow controlling devices individual to said one tube of each group.

9. In a forced flow steam generator having the heating surface thereof divided into tubes connected in parallel in the zone of vaporization and in at least one zone of variable temperature; and having a device for regulating the feed water supply, said tubes being divided into groups; the combination of a variable flow controlling device associated with, and individual to one tube of each group to the exclusion of the other tubes in the same group to cause at least a portion thereof to fall within said variable temperature zone by controlling the flow through said tube; a temperature sensitive impulse transmitter associated with said one tube of each group to the exclusion of the other tubes in each group, in the said variable temperature region thereof; means connecting said transmitters to a mechanism which permits only the impulse transmitter which at the moment is subjected to the highest temperature to influence the said regulating device; a second variable flow controlling device common to and associated with said other tubes of each group and having a restricting value to permit said other tubes only to operate in the zone of vaporization; and a plurality of other fixed value flow controlling devices each individual to said other tubes of each group for fixing the quality of the vapor issuing from said other tubes.

10. An apparatus according to claim 9 in which said plurality of other fixed value flow controlling devices includes also fixed value flow controlling devices individual to said one tube of each group.

11. In a heat exchanger for generating and superheating vapor from a fluid said heat exchanger having the

heating surface thereof divided into tubes connected in parallel at least in the zones of vaporization and in at least one other zone of variable temperature, and having a device for regulating the fluid supply, said tubes being divided into groups; the combination of a plurality of temperature sensitive impulse transmitters each associated with one tube of each group to the exclusion of the other tubes of each group in the region of said variable temperature zone; means connecting said transmitter to a mechanism which permits only the impulse transmitter which at the moment is subjected to the highest temperature to influence the said regulating device, means associated with, and individual to said one tube of each group to the exclusion of the other tubes in the same group to permit a flow therethrough different from the flow through each of said other tubes so as to cause operation of said one tube of each group to fall within said variable temperature zone; a variable flow restricting device common to and associated with said other tubes of each group and having a restricting value to permit said other tubes only to operate in said vaporization zone; and a plurality of other fixed value flow restricting devices each individual to said other tubes of each group for fixing the quality of the vapor issuing from said other tubes.

12. An apparatus according to claim 11 in which said plurality of other fixed value flow restricting devices includes also fixed value flow restricting devices individual to said one tube of each group.

13. In a vapor generator having the heating surface thereof divided into tubes connected in parallel in the zone of vaporization and in at least one zone of variable temperature, and having a device for regulating the fluid supply thereto, said tubes being divided into groups; the combination of means associated with, and individual to one tube of each group to the exclusion of the other tubes of the same group for altering the fluid flow therethrough so as to cause operation of said one tube to fall within said variable temperature zone; a temperature sensitive impulse transmitter associated with said one tube of each group to the exclusion of the other tubes of each group in the said variable temperature region thereof; means connecting said transmitters to a mechanism which permits only the impulse transmitter which at the moment is subjected to the highest temperature to influence the said fluid flow regulating device; a variable flow controlling device common to and associated with said other tubes of each group and having a restricting value to permit only saturated vapor to issue from said other tubes; and a plurality of other fixed value controlling devices each individual to said other tubes of each group for fixing the quality of vapor issuing from said other tubes.

14. An apparatus according to claim 13 in which said plurality of other fixed value flow controlling devices includes also fixed value flow controlling devices individual to said one tube of each group.

15. In a heat exchanger for generating and superheating vapor from a fluid heat exchange medium by absorbing heat from a second heat exchange medium, said heat exchanged having the heating surface thereof divided into tubes carrying said fluid and being connected in parallel with respect to flow at least in the zones of vaporization and in at least one zone of variable temperature, and having a device for regulating the supply of at least one of said heat exchange mediums in a manner to change the exit temperature of said fluid, said tubes being divided into groups; the combination of a plurality of temperature sensitive impulse transmitter each associated with one tube of each group to the exclusion of the other tubes of each group, in the region of said variable temperature zone; means connecting said transmitter to a mechanism which permits only the impulse transmitter which at the moment is subjected to the highest temperature to influence said regulating device, means associated with, and individual to the said one tube of each group to the exclusion of the other tubes in the same group to alter the flow therethrough with respect to the flow through each of said other tubes so as to cause operation of said one tube to fall within said variable temperature zone; a variable flow restricting device common to and associated with said other tubes of each group and having a restricting value to cause operation of said other tubes only within said vaporization zone; and a plurality of other fixed value flow restricting devices each individual to said other tubes of each group for fixing the quality of vapor issuing from said other tubes.

16. An apparatus according to claim 15 in which said plurality of other fixed value flow restricting devices includes also fixed value flow restricting devices individual to said one tube of each group.

17. In a forced flow steam generator having the heating surface thereof divided into tubes connected in parallel at least in the zones of vaporization and the beginning of superheating, said tubes being divided into groups; the combination of means for regulating the heat supply; a plurality of temperature sensitive impulse transmitters each associated with one tube of each group to the exclusion of the other tubes in each group in the region of the transition from the vaporizing zone into the superheating zone; means connecting said transmitters to a mechanism which permits only the impulse transmitter which at the moment is subjected to the highest temperature to influence the said regulating means; a variable flow restricting device associated with, and individual to the said one tube of each group to the exclusion of the other tubes in the same group and having a restricting value to cause operation of said one tube within said superheating zone; a second variable flow restricting device common to and associated with said other tubes of each group and having a restricting value to permit only saturated steam to issue from said other tubes; and a plurality of other fixed value flow restricting devices each individual to said other tubes of each group for fixing the quality of saturated steam issuing from said other tubes.

18. An apparatus according to claim 17 in which said plurality of other fixed value flow restricting devices includes also fixed value flow restricting devices individual to said one tube of each group.

19. The method of controlling the liquid supply to a forced vapor generator in which the liquid is forced through a plurality of heated tubes which are arranged in a plurality of groups of tubes in parallel with respect to the flow of the liquid and of the vapor generated in the tubes; said method comprising the steps of restricting to varying degrees the flow through some of said tubes for the purpose of ensuring that each tube will receive a predetermined quantity of liquid for causing said liquid to issue from said tubes as saturated vapor; additionally restricting the flow through a selected one of said tubes in each group to the exclusion of the remaining tubes in each group to cause the superheating of the saturated vapor generated therein; measuring the steam temperature of each of said selected tubes to the exclusion of the remaining tubes; and controlling the liquid supply to all tubes in accordance with the steam temperature of the one of said selected tubes that indicates the highest superheated steam temperature, by increasing or decreasing respectively the liquid supply as said highest steam temperature increases or decreases.

20. The method of controlling the liquid supply to a forced flow vapor generator in which the liquid is forced through a plurality of non-uniformly heated tubes which are arranged in separate groups of tubes in parallel with respect to the flow of the liquid and of the vapor generated in the tubes; said method comprising the steps of restricting to varying degrees the flow through some of said tubes to equalize the non-uniform heat absorption rate caused by said non-uniform heating and to cause said liquid to issue from said tubes as saturated vapor; additionally restricting the flow through a selected one

of said tubes in each group to the exclusion of the remaining tubes in each group to cause the superheating of the vapor generated in said selected tube; measuring the temperature of said selected tube to the exclusion of the remaining tubes; and controlling the liquid supply to all tubes in accordance with the temperature of said selected tube by increasing or decreasing respectively the liquid supply as said temperature increases or decreases.

21. 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 separate groups in parallel with respect to the flow of the liquid and of the vapor generated in the tubes with one of said tubes in each group acting as a control tube; said method comprising the steps of restricting to varying degrees the flow through some of the tubes in each group for the purpose of ensuring that each tube in each group will receive a predetermined proportion of liquid and of causing said liquid to issue from said tubes as saturated vapor; additionally restricting the flow through each of said control tubes to the exclusion of the other tubes in each group, to cause the vapor generated in said control tubes to become superheated; measuring the temperature of steam in each of said control tubes; and regulating the liquid supply to all tubes in accordance with the steam temperature of that control tube which has the relatively highest measured steam temperature by increasing or decreasing respectively the liquid supply as said steam temperature increases or decreases.

22. The method of controlling the liquid supply to a forced flow of vapor generator in which the liquid is forced through a plurality of non-uniformly heated tubes which are arranged in separate groups in parallel with respect to the flow of the liquid and of the vapor generated in the tubes with one of said tubes in each group acting as a control tube; said method comprising the steps of restricting to varying degrees the flow through some of the tubes in each group to equalize the non-uniform heat absorption rate caused by said non-uniform heating and to cause said liquid to issue from said tubes in the form of saturated vapor; additionally restricting the flow through each of said control tubes to the exclusion of the other tubes in each group to cause the vapor generated in said control tube to become superheated; measuring the temperature of each of said control tubes; and regulating the liquid supply to all tubes in accordance with the temperature of that control tube which has the relatively highest measured temperature by increasing or decreasing respectively the liquid supply as said temperature increases or decreases.

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