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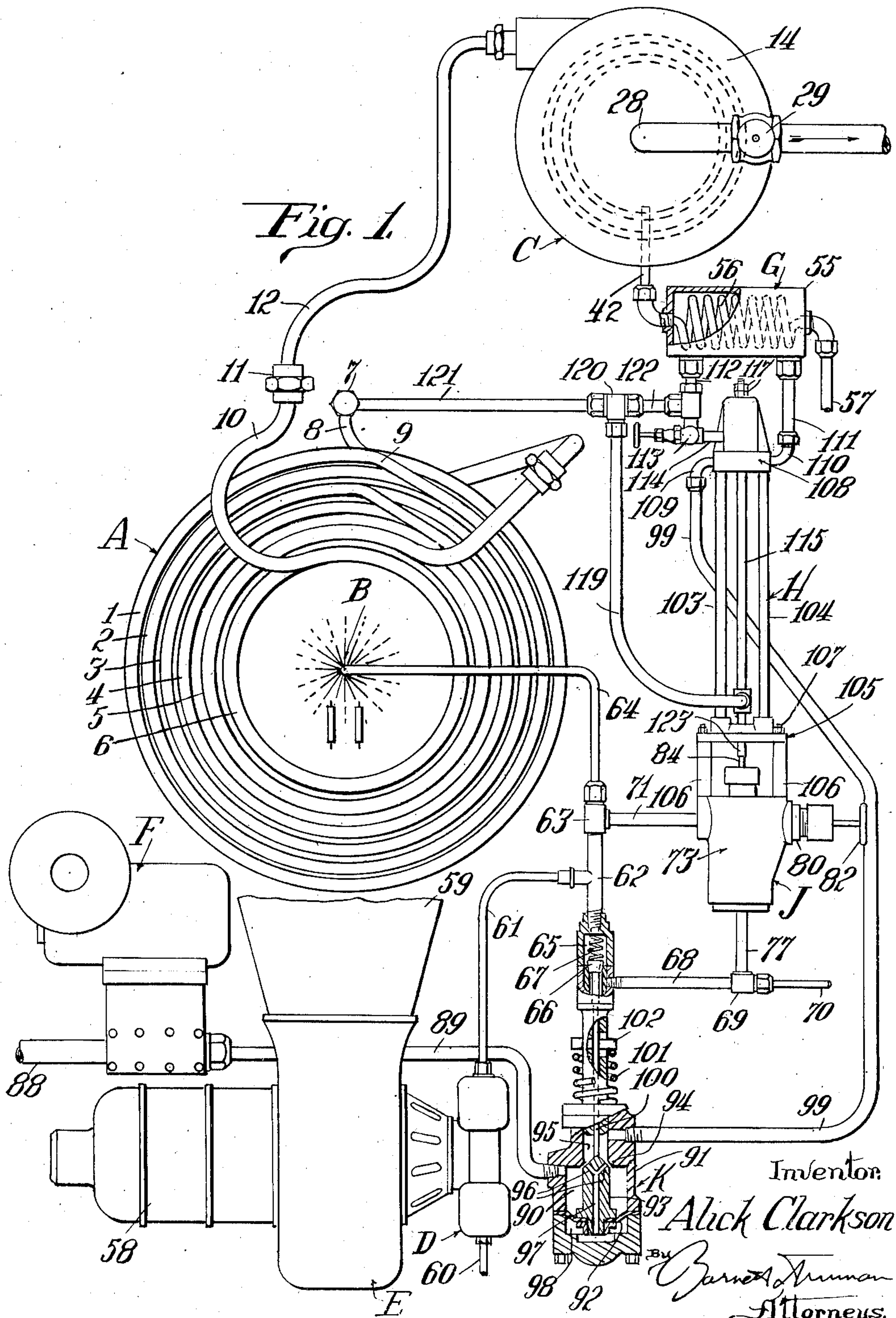
A. CLARKSON

2,123,166

STEAM GENERATING SYSTEM

Filed June 21, 1937

3 Sheets-Sheet 1



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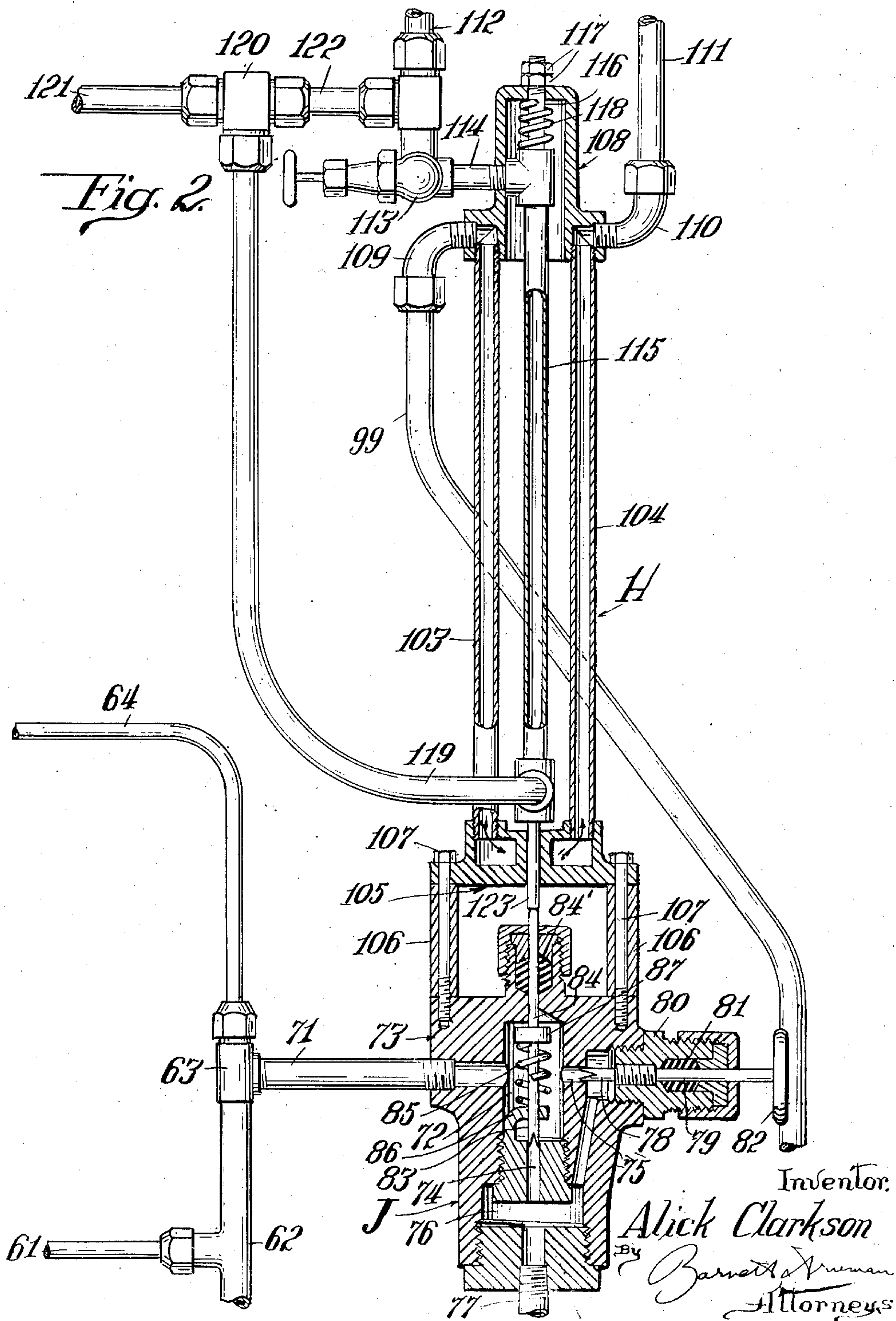
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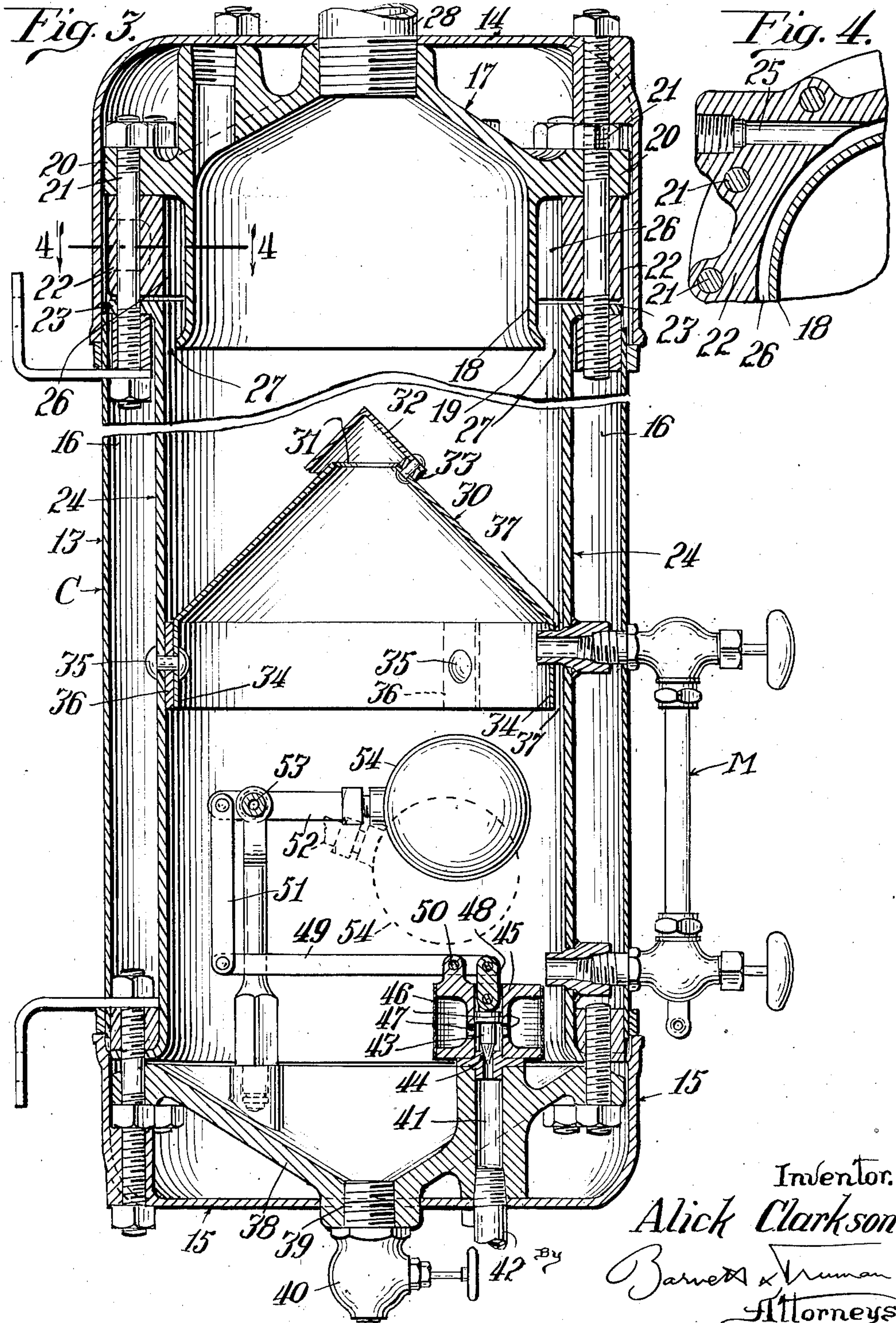
**A. CLARKSON**

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# STEAM GENERATING SYSTEM

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## UNITED STATES PATENT OFFICE

2,123,166

## STEAM GENERATING SYSTEM

Alick Clarkson, Elmhurst, Ill.

Application June 21, 1937, Serial No. 149,465

8 Claims. (Cl. 122-448)

This invention relates to certain new and useful improvements in a steam generating system, and more particularly to improved means for automatically controlling the relative proportions of fuel and feed water as supplied to such a steam generating system. This application is a continuation in part of the copending application of Alick Clarkson, Serial No. 99,736, filed September, 8, 1936.

10 The generator used in this system is of the forced circulation type in which a definite amount of excess water is circulated over and above that which is evaporated, the fluids from the generator being discharged into a separator operating preferably on the centrifugal principle, in which the excess water is separated from the steam. This excess water at high temperature and pressure is caused by means of a heat exchanger to give up its heat to the incoming feed water before such feed water is delivered to the generator. Thermostatic means influenced by the temperature of this feed water is utilized to control the supply of fuel to the generator-heater thereby controlling the proportion of excess water circulated through the system. Means are also provided whereby the failure of the feed-water supply will automatically cut off the supply of fuel to the heater.

30 The principal object of the invention is to provide an improved steam generating system of the type briefly described hereinabove and disclosed more in detail in the specification which follows.

Another object is to provide an improved means for automatically controlling a steam generating system of the forced circulation type whereby there will always be an excess of water circulated through the generator.

40 Another object is to provide improved means for controlling the supply of fuel to the heater of a steam generating system of the type hereinabove set forth.

Another object is to provide improved means of controlling the relative proportions of fuel and feed water delivered to the generator.

45 Another object is to provide an improved apparatus for separating the excess water from the steam.

Other objects and advantages of this invention will be more apparent from the following detailed description of one approved form of apparatus constructed and operating according to the principles of this invention.

In the accompanying drawings:

55 Fig. 1 is a diagrammatic plan view of the assembled apparatus.

Fig. 2 is a partial elevation and partial vertical section, on a larger scale, of a portion of the mechanism at the right hand side of Fig. 1.

Fig. 3 is a vertical central section through the improved separator.

Fig. 4 is a detail horizontal section taken substantially on the line 4-4 of Fig. 3.

Briefly described the system comprises the steam generator A provided with a burner B, the apparatus C for separating the steam and excess water, the fuel pump D, the air pump E, the feed water pump F, the heat exchanger G, the thermostatic mechanism H, which functions in response to temperature changes of the feed water as heated by exchanger G to actuate a portion of the valve mechanism J which controls the flow of fuel to burner B, and a shut-off mechanism K for stopping the flow of fuel to the burner in case the pressure in the feed water supply line is reduced below a predetermined minimum.

The generator A is preferably of the forced circulation type through which feed water is forced under pressure, a portion of the water being evaporated into steam and a fluid mixture consisting of steam and excess water being discharged into separator C. A preferred form of generator A is disclosed more in detail and claimed in the parent application Serial No. 99,736, hereinabove referred to. It is sufficient for present purposes to state that this generator consists of a plurality of vertically extending pipe coils or modified helices 1, 2, 3, 4, 5 and 6. The feed water is supplied through fitting 7 and inlet pipe 8 to the lower end of the outer coil 1, and from the upper end of coil 1 through pipe 9 to the upper end of the next inner coil 2, and so on throughout the series. The mixture of steam and water is discharged from inner coil 6 through outlet pipe 10, fitting 11 and pipe 12 to the separator C. The individual turns or loops of adjacent coils are preferably staggered with relation to one another so that the hot products of combustion from burner B which are introduced inside the stack or bank of coils and which flow outwardly between the several coils will engage a maximum surface area of the coils and thus transfer a maximum of heat to the fluids therein.

The separator C comprises an outer casing consisting of outer shell 13, top member 14, and bottom member 15, which encloses the inner fluid-holding assembly with interposed insulating spaces, such as indicated at 16. The inner assembly comprises an upper structure 17 formed with a depending circular flange 18 having, pref-



erably, an outturned lower lip 19. The outstanding flange 20 on structure 17 is connected by bolts 21 with a ring 22 and the outstanding flange 23 at the upper end of inner casing 24. The steam and water mixture from the generator enters from pipe 12 through a substantially tangential inlet port 25 in ring 22 into the annular space 26 formed between the baffle flange 18 and the ring 22 and inner casing 24. The water is discharged by centrifugal force against the inner face of ring 22 and passes as a film down the inner face of this ring and shell 24. The out-turned lip 19 tends to keep the water against the outer wall of this chamber. The steam issuing out through the constricted annular opening 27 between lip 19 and shell 24 passes upwardly through member 17 and out of the separator through pipe 28 which may be provided with a pressure reducing valve 29 (see Fig. 1).

Positioned below the baffle structure 18 is a hollow cone frustum 30 having an opening 31 in its upper end which is partially enclosed by a conical cap member 32 supported from cone 30 by the interposed spacers 33. The cone 30 is provided with an outer cylindrical flange 34, of smaller diameter than the inner diameter of shell 24, which flange is secured to the shell at 35 through interposed spacers 36. This leaves a passage 37 between flange 34 and casing 24 through which the water flows into the lower portion of the separator. Inner casing 24 is connected at its lower end with the lower conical hopper member 38 orificed at 39 for discharge through a blow-off valve 40. The hopper member is also provided with a second outlet passage 41 for discharge of water into the pipe 42 leading to the heat exchanger G (see Fig. 1). The valve 43 cooperating with valve seat 44 and guided in fitting 45 controls the discharge of water through outlet passage 41. When valve 43 is lifted from its seat, water collected in the lower portion of the separator flows out through strainer 46 and ports 47 formed in fitting 45 and thence into and through the discharge passage 41. Movable valve member 43 is connected by link 48 with one end of a lever 49 pivoted at 50, the opposite end of this lever being connected through link 51 with one end of a lever 52 pivoted at 53 and carrying float 54. When a sufficient head of water has collected in the separator chamber, float 54 will be elevated, thus lifting valve 43 from its seat and permitting the discharge of water from the separator. As the water level in the separator falls, the valve 43 will be lowered toward its seat thus diminishing the volume of the water stream discharged from the separator. In this manner the size of the stream of excess water discharged from the separator will be proportioned to the rate at which water accumulates in the separator, that is in proportion to the volume of excess water passing through the generator. The separator may be provided with a water-gauge indicated at M.

The heat exchanger G (Fig. 1) consists of a vessel 55 in which is positioned a coil 56 connected at one end to discharge pipe 42 leading from the separator and at the other end with a water discharge pipe 57 which may lead back to the water supply tank, or any other desired point of discharge.

The air pump E driven by motor 58 forces air through conduit 59 to the burner B and the combustion chamber within the generator. The fuel pump D, which may be driven by the same power means as pump E draws fuel (preferably oil) from the source of supply through pipe 60, and

forces this fuel through pipe 61, T-fitting 62, T-fitting 63, and pipe 64 to the burner B of the generator-heater. This burner B is of the type provided with a valve which opens only under a certain predetermined minimum fuel pressure. In other words, if the pressure under which the fuel is supplied falls below this minimum, the valve will close and cut off the supply of fuel to the heating apparatus.

The lower passage leading from fitting 62 discharges into a chamber 65 having an outlet normally closed by a valve 66 held against its seat by spring 67. When valve 66 is lifted from its seat (in the manner hereinafter described) the fuel can flow from chamber 65 through pipe 68 and fitting 69 and discharge pipe 70 back to the fuel tank or other source of supply. The pipe 71 leading from the other outlet of T-fitting 63 discharges into a chamber 72 formed in the casing 73 of valve assembly J. The two ports 74 and 75 lead from valve chamber 72 into valve chamber 76 from which fuel is discharged through pipe 77, fitting 69 and discharge pipe 70 back to the fuel tank. The discharge through port 75 is controlled by valve 78 carried by stem 79 threaded into thimble 80 of packing 81, the stem 79 being manually operable by means of handle 82. The flow of fuel through the other port 74 is controlled by a valve 83 mounted on stem 84 projecting upwardly through packing 84' in the upper end of casing 73. Spring 85 confined between a bracket 86 in valve casing 73 and a stop 87 on the stem 84 tends to lift valve 83 and increase the valve opening. Valve 83 is forced downwardly to close the valve opening against the resistance of spring 85, by the thermostatic assembly H, as hereinafter described.

It will be understood that in normal operation the pump D forces fuel through the piping system under sufficient pressure to open the valve at the burner B and supply fuel to the heating apparatus. It also pumps an excess volume of fuel so that a limited amount may be by-passed through either port 74 or port 75, chamber 76 and discharge pipes 77 and 70, back to the source of supply. In normal operation the valve 66 will be seated and valves 78 and 83 will be partially closed. At any time the amount of fuel bypassed may be adjusted by manually operated valve 78. Under certain conditions, when valve 83 is partially open, a sufficient pressure to supply fuel to the burner may be obtained by closing the valve 78. However, if both valves 78 and 83 are opened, the amount of by-passed fuel will be sufficient to lower the pressure and cut off the supply at burner B. Also, if valve 66 is lifted, the fuel will be by-passed through this valve opening and pipe 70 so as to shut off the flow of fuel to the burner B.

The feed water pump F receives water from a source of supply through pipe 88 and discharges this water through pipe 89 into chamber 90 of diaphragm casing 91 of the shut-off device K. The diaphragm 92 mounted in this casing carries the valve member 93 adapted to cooperate with valve seat 94 at the entrance to discharge passage 95. Valve member 93 is provided with the balancing ducts 96 and 97 communicating with chamber 98 below the diaphragm 92. When feed water under sufficient pressure is forced by pump F into the upper chamber 90, the diaphragm 88 will be deflected downwardly, as shown in the drawings, so as to open valve 93 and permit this water to flow out through passage 95 and outlet pipe 99. A valve stem 100 projects upwardly 75



from movable valve member 93, and a spring 101 is confined between the upper portion of the valve casing and an abutment 102 connected with valve stem 100. When the pump pressure normally exerted on diaphragm 100 fails, spring 101 will lift the valve 93 so as to cut off the water supply to pipe 99. It will be understood that when valve 93 is closed, the lower pressure existing in the piping system beyond device K will be communicated through balancing ducts 96 and 97 to the space 98 below the diaphragm so that the higher pump pressure will be effective to open the valve. When the pump is in operation, the valve 93 will not be moved very far from its seat and the rush of water through the annular passage around this valve will prevent the higher pressure from being communicated to the lower chamber 98 so that the valve will remain in this partially open position, as long as the pump pressure is maintained.

When the pump F is stopped or the pump pressure fails, the valve 93 will be closed by spring 101, and the upper end of valve stem 100 will engage and lift valve 66 from its seat, thus bypassing the fuel supply and shutting off the burner B. Thus the burner cannot operate unless feed water is being supplied under proper pressure.

The thermostatic regulator H comprises a pair of heat expansible tubes 103 and 104 mounted at their lower ends in a connecting manifold 105 which is supported on spacing posts 106 projecting upwardly from valve casing 73, the manifold being anchored to the casing by bolts 107. The upper ends of tubes 103 and 104 are connected into a fitting 108. Feed water supply pipe 99 communicates with the upper end of tube 103 through nipple 109 connected into fitting 108. The lower end of tube 103 connects through manifold 105 with the lower end of tube 104, the upper end of which connects through fitting 108, nipple 110, and pipe 111 with one end of the heat-exchanger tank 55. The other end of this tank connects through pipe 112 provided with restricting valve 113, and pipe 114 with the upper end of a third heat expansible tube 115. This tube 115 is supported at its upper end by stem 116 projecting through fitting 108 and held by nuts 117, a spring 118 being interposed between the head of tube 115 and fitting 108. This spring 118 may be compressed to permit unusual expansion of tube 115 but ordinarily the upper end of tube 115 may be considered as fixed to and moving with the fitting 108. The lower end of expansible tube 115 connects through pipe 119, fitting 120 and pipe 121 with the inlet fitting 7 of the generator coils. A restricted shunt pipe connection 122 leads from pipe 112 to fitting 120. With valve 113 wide open the greater portion of the flow of heated water from tank 55 will pass downwardly through tube 115, but as valve 113 is progressively closed a greater portion of the flow will be diverted through the restricted connection 122 to the generator.

A stem 123 projects downwardly from the lower free end of tube 115 to engage the upper end of valve stem 84.

It will now be evident that the expansion of tubes 103 and 104 will tend to lift stem 123 and permit valve 83 to open, whereas the expansion of tube 115 tends to close the valve 83.

As the feed water flows through casing 55 of the heat exchanger G on its way to the generator, this water will be heated by heat transferred thereto through coil 56 from the excess water

discharged from separator C. This will expand tube 115 and tend to close valve 83, thus increasing the supply of fuel to burner B. The amount of heat transferred to the feed water in heat exchanger G will depend upon the amount and temperature of the excess water passing through the generator and separator. If the supply of water is insufficient so that no excess is discharged from the separator, the feed water will not be heated and thermostatic device H will act to permit valve 83 to open and thus cut down or shut off the supply of fuel to burner B, thus decreasing the temperature of the generator. In this manner, overheating of the generator so as to cause damage to the tubing in the absence of sufficient water supply is prevented. The proportion of water converted into steam may be varied by proper adjustment of the thermostatic regulator. It will be noted that the heat transferred to the feed water in heat exchanger G is dependent not only on the temperature of the water discharged from the separator but on the amount of such water. If there is insufficient feed water supplied to the generator, or if an excessive quantity of the water is converted into steam, the discharged water will be reduced to such a small stream that the heat imparted to the feed water will be insufficient to close valve 83, even though this excess water is at a high temperature.

If the feed water initially supplied through pipe 99 is heated, this heat will expand the tubes 103 and 104 thus lifting the tube 115 and partially counteracting the effect of the expansion of tube 115. In this way compensation is made for preheated water so that the final control of the fuel supply will depend on the amount or temperature of the excess water from the separator.

I claim:

1. In steam generating apparatus, the combination of a generator through which water is circulated and partially converted into steam, means for delivering feed water to the generator, a heater for the generator, a separator for receiving the mixture of water and steam from the generator and separating the steam from the water, and means for increasing or decreasing the supply of fuel to the heater as the amount of water discharged from the separator increases or decreases.

2. In steam generating apparatus, the combination of a generator through which water is circulated and partially converted into steam, means for delivering feed water to the generator, a heater for the generator, a separator for receiving the mixture of water and steam from the generator and separating the steam from the water, means for discharging water from the separator, a heat exchanger through which this discharged water and the feed water going to the generator are separately passed in heat exchange relation, and means for increasing or decreasing the supply of fuel to the heater as the amount of heat delivered by the discharged water to the feed water in the heat exchanger increases or decreases.

3. In steam generating apparatus, the combination of a generator through which water is circulated and partially converted into steam, means for delivering feed water to the generator, a heater for the generator, a separator for receiving the mixture of water and steam from the generator and separating the steam from the water, means for discharging water from the separator, a heat exchanger through which this dis-



charged water and the feed water to the generator are separately passed for heat exchange, and means for increasing or decreasing the supply of fuel to the heater as the temperature of the feed water delivered to the generator increases or decreases.

4. In steam generating apparatus, the combination of a generator through which water is circulated and partially converted into steam, means for delivering feed water to the generator, a heater for the generator, a separator for receiving the mixture of water and steam from the generator and separating the steam from the water, means for discharging water from the separator, a heat exchanger through which this discharged water and the feed water to the generator are separately passed for heat exchange, and means for increasing or decreasing the supply of fuel to the heater as the temperature of the feed water delivered from the heat exchanger is increased or decreased.

5. In steam generating apparatus, the combination of a generator through which water is circulated and partially converted into steam, means for delivering feed water to the generator, a heater for the generator, a separator for receiving the mixture of water and steam from the generator and separating the steam from the water, means for discharging water from the separator, a heat exchanger through which this discharged water and the feed water to the generator are separately passed for heat exchange, and means for diminishing the supply of fuel to the heater as the temperature of the feed water delivered from the heat exchanger falls.

6. In steam generating apparatus, the combination of a generator through which water is circulated and partially converted into steam, means for delivering feed water to the generator, a heater for the generator, a separator for receiving the mixture of water and steam from the

generator and separating the steam from the water, means for discharging water from the separator, a heat exchanger through which this discharged water and the feed water to the generator are separately passed for heat exchange, and thermostatically controlled means responsive to temperature changes of the feed water delivered from the heat exchanger for shutting off the supply of fuel to the heater when the flow of water from the separator is stopped.

7. In steam generating apparatus, the combination of a generator through which water is circulated and partially converted into steam, means for delivering feed water to the generator, a heater for the generator, a separator for receiving the mixture of water and steam from the generator and separating the steam from the water, means for discharging water from the separator, and thermostatically controlled means responsive to an increase or decrease in the amount of heat delivered from the separator by the discharge water for increasing or decreasing the supply of fuel to the heater.

8. In steam generating apparatus, the combination of a generator through which water is circulated and partially converted into steam, means for delivering feed water to the generator, a heater for the generator, a separator for receiving the mixture of water and steam from the generator and separating the steam from the water, means for discharging water from the separator, a heat exchanger through which this discharged water and the feed water to the generator are separately passed for heat exchange, and thermostatically controlled means responsive to temperature changes of the feed water as delivered both to and from the heat exchanger on its way to the generator for controlling the supply of fuel to the heater.

ALICK CLARKSON. 40