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Arant

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[45] **Sept. 10, 1974**

[54] **STEAM SYSTEMS EQUIPPED WITH AN EXCHANGE RESERVOIR**

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[73] Assignee: **Clayton Manufacturing Company,** El Monte, Calif.

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[52] **U.S. Cl.** ..... **122/33,** 122/406 R, 126/362 R, 237/9 R, 237/66

[51] **Int. Cl.** **F22b 35/00**

[58] **Field of Search** ..... 122/32, 33, 35, 406; 126/362 R; 239/8 R, 9 R, 61, 66

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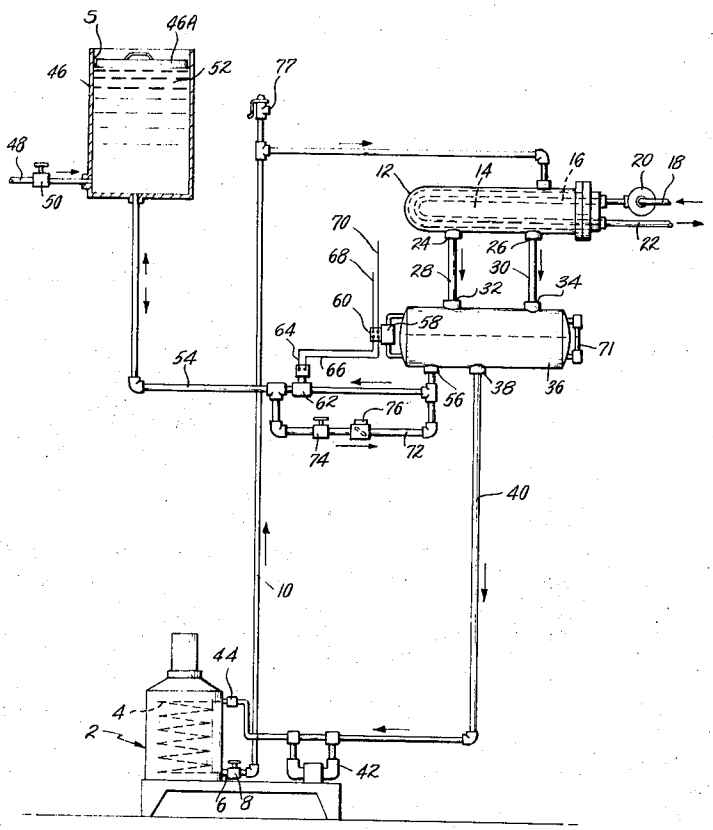
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Primary Examiner—Kenneth W. Sprague

[57] **ABSTRACT**

Closed, corrosion-free steam generating systems, including a heat exchanger and a condensate receiver, and having an exchange reservoir for pre-treated feed water; and control means arranged for the exchange of liquid between the reservoir and the condensate receiver to permit automatic "unloading" of excess liquid from the closed system while in operation and without discharge to waste, and for automatic or manual "loading" of the system upon cooling by return of liquid from the reservoir to the system, while preventing creation of a vacuum condition in the system that would draw contaminating air into the system.

15 Claims, 4 Drawing Figures



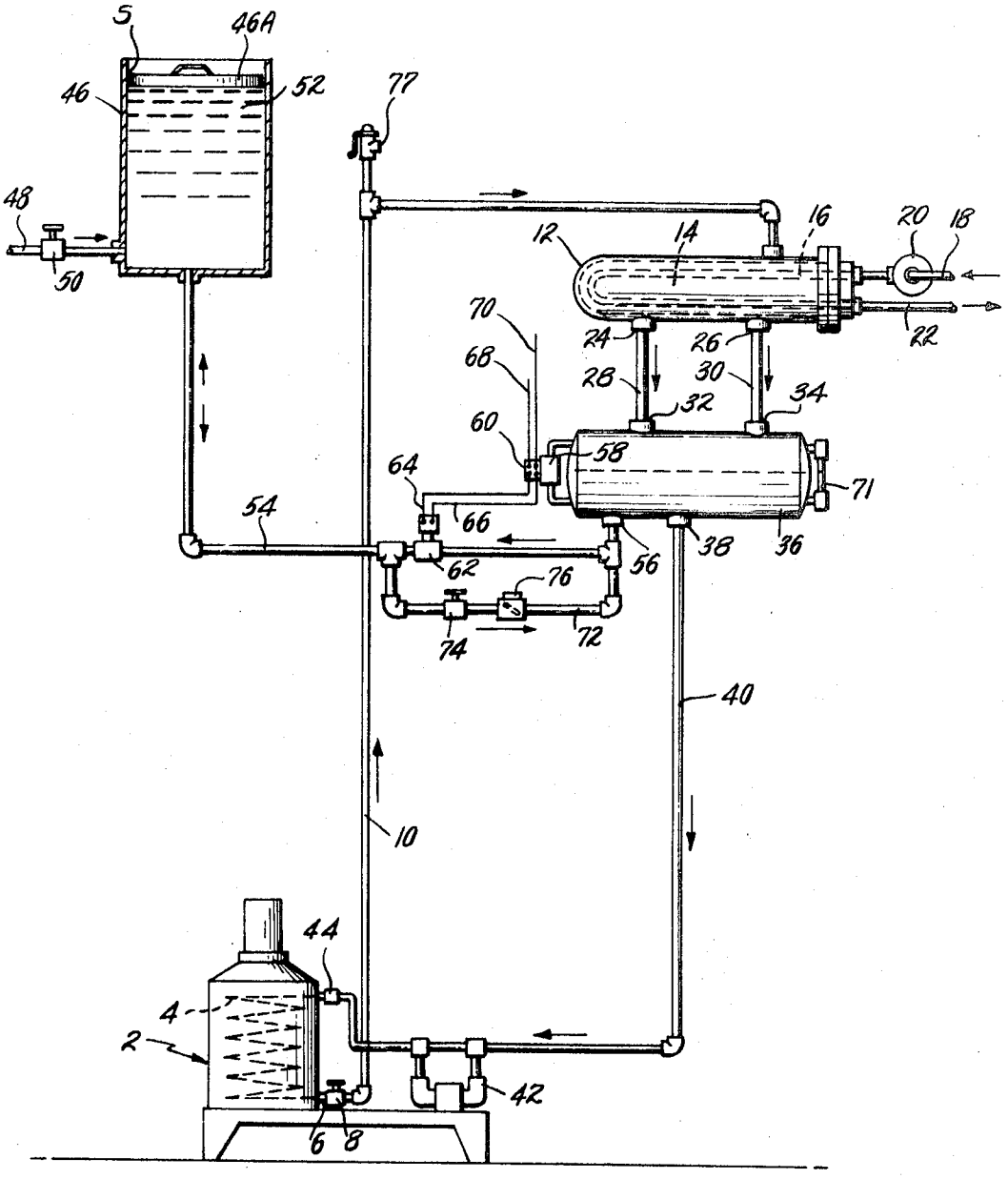

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46A
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Fig. 1.

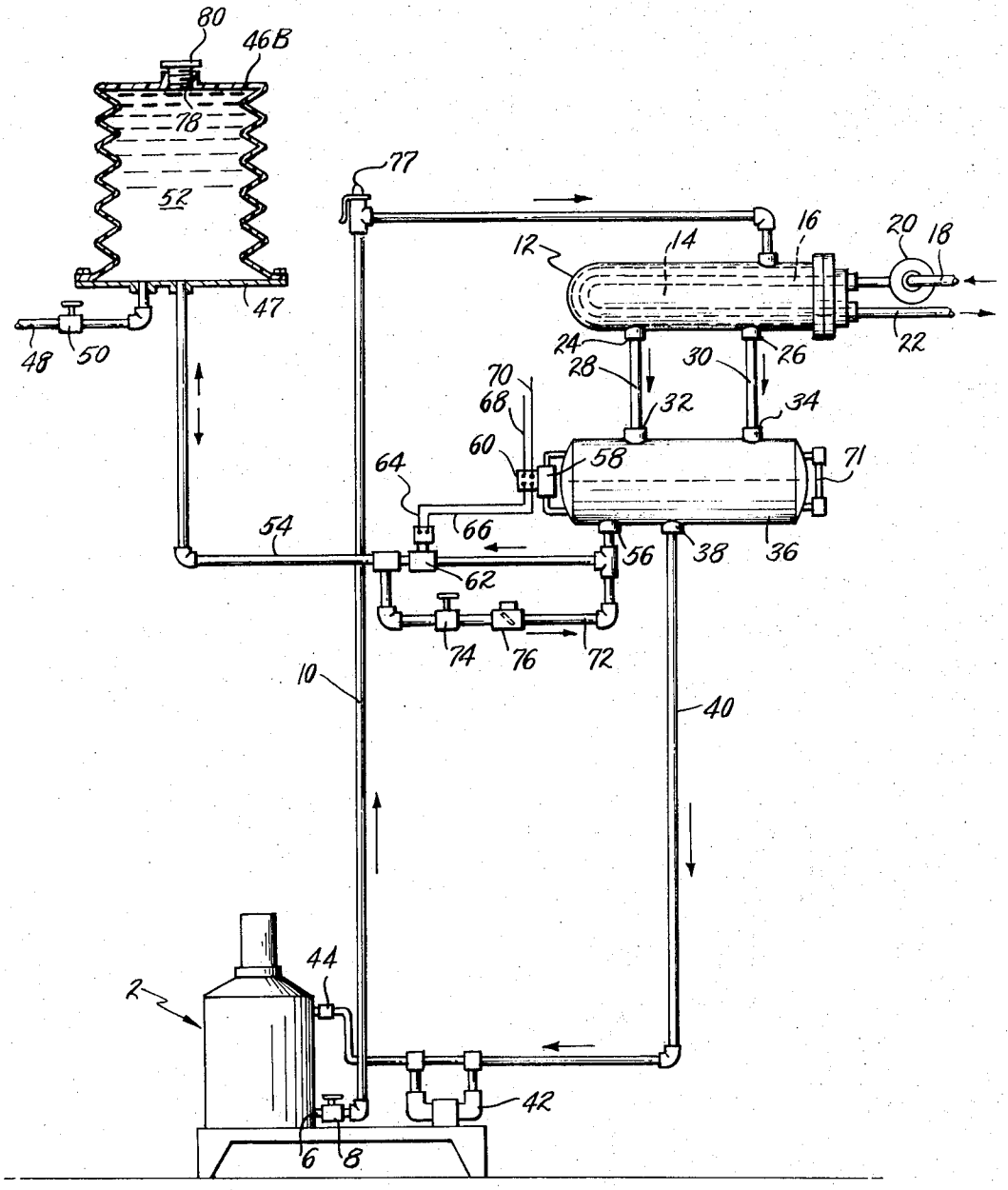

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46B
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Fig. 2.

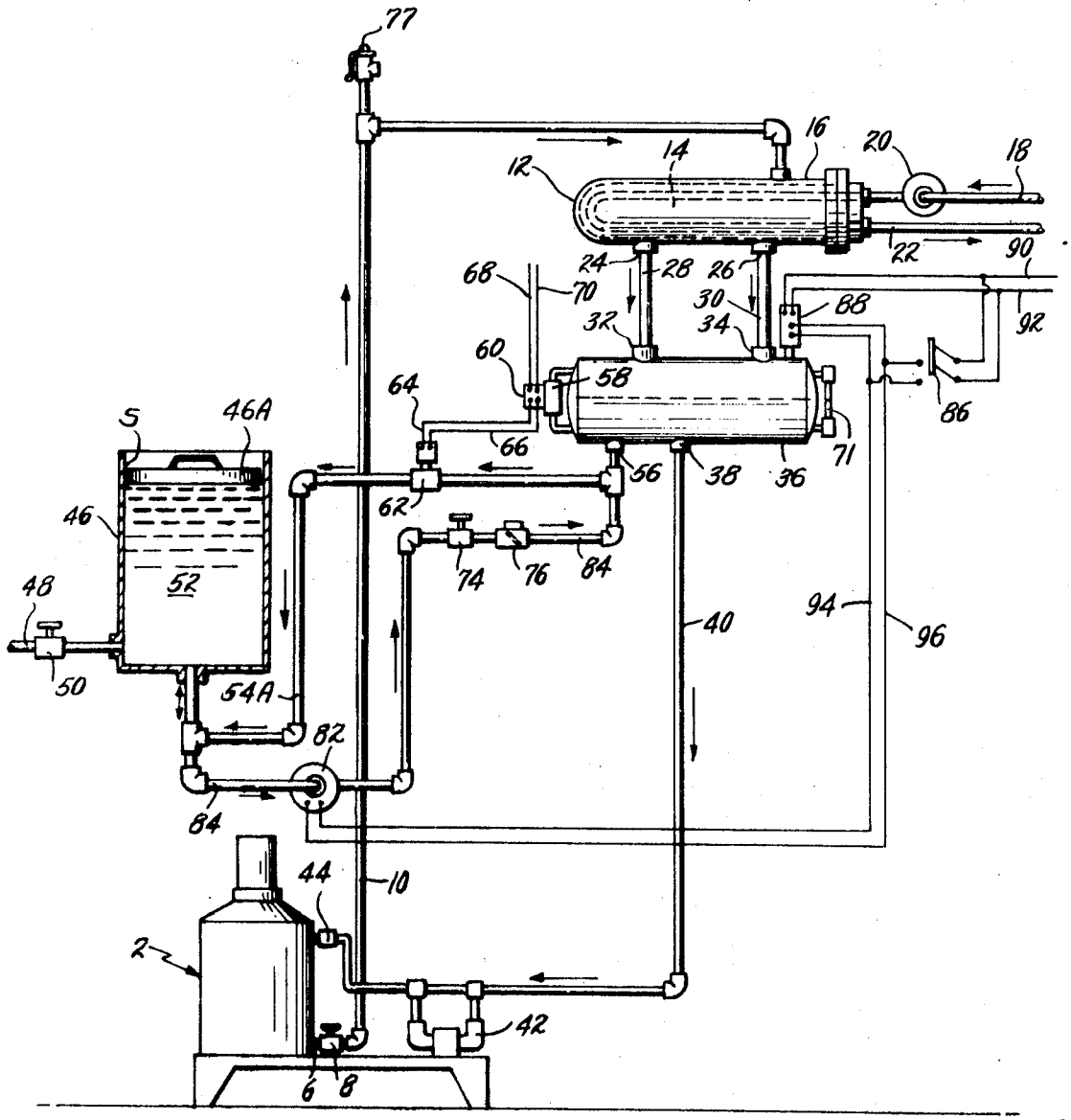

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86
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46A
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48
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76
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94
96
54A
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Fig. 3.

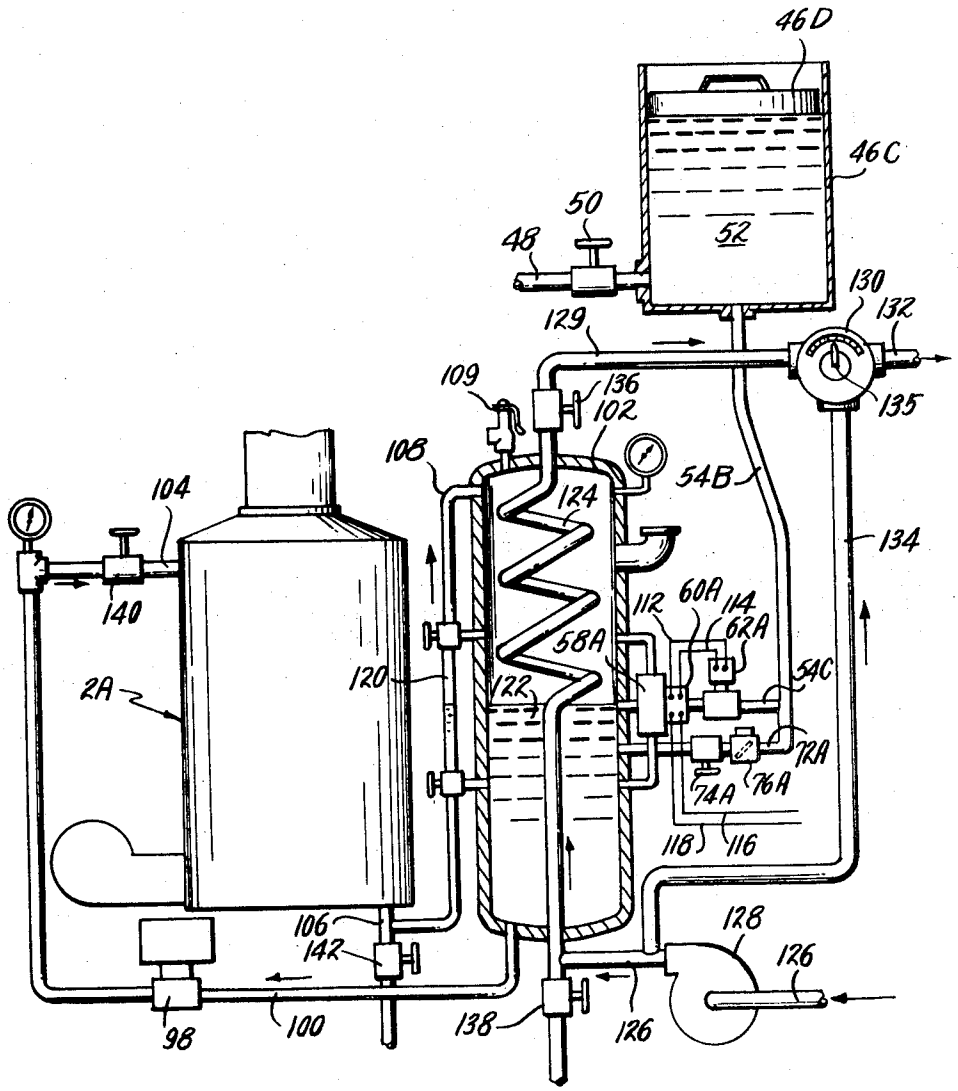

46D
46C
52
50
48
130
132
129
135
109
136
102
108
54B
104
124
134
140
112
60A
114
62A
58A
54C
120
122
2A
72A
74A
76A
118
116
106
142
128
126
98
100
138
126

Fig. 4.

STEAM SYSTEMS EQUIPPED WITH AN EXCHANGE RESERVOIR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to closed steam generating systems for supplying steam to a heat exchanger for heating a medium while flowing through the heat exchanger.

2. Description of the Prior Art

Closed steam generating systems per se are very old in the art. They all have a predetermined volumetric liquid capacity. Consequently, when the system is filled at a cold start, as required, the system contains more liquid than is necessary for its normal operation when heated. Accordingly, during the starting-up period, there is a substantial increase in the volume of liquid in the system due to the thermal expansion of the liquid and to the presence of vapor entrained in the liquid. This requires that the excess liquid be removed from the system. Heretofore, this has been done by providing a relief valve that opens and allows the excess liquid to discharge to waste.

One disadvantage of such prior systems, of course, is that the excess liquid which is discharged while the system is in operation must be replaced after the system is shut down and has cooled, and before it is re-started. Another disadvantage is that, as the system components cool, all vapor in the system condenses and a negative pressure or vacuum condition is created, resulting in air being drawn into the system through the valve stuffing boxes and other joints, which are normally tight under internal pressure but leak air into the system under vacuum conditions. In later starting up the system, the liquid is circulated before the burner is started and the air drawn into the system is mixed with the water already in the system. The system must be refilled by adding the necessary volume of make-up feed water. The air introduced into the system is mixed with the added feed water and contains oxygen, which is well known to have an extremely corrosive effect upon the components of the system. Such oxygen is not always absorbed by the chemicals already in the water. In order to overcome this problem, and avoid damage, more chemicals must be introduced into the system with the makeup water, prior to each cold start. Thus, prior closed steam generating systems have required daily replenishment of wasted water and water-treating chemicals. This not only results in additional work and a waste of a great deal of the operator's time, but also in considerable expense for the added water and water-treating chemicals.

SUMMARY OF THE INVENTION

The present invention overcomes the objections and disadvantages of prior closed steam generating systems in that it includes a feed water exchange reservoir or head tank, connected with a condensate receiver from which excess liquid, which would otherwise be discharged to waste, is "unloaded" during the operation of the system, and is automatically returned to the system to "load" it after it has been shut down and is cooling off. The water in the exchange reservoir is treated with boiler compounds including sodium sulphite for absorbing the oxygen in the water.

In the systems of the present invention, an automatic liquid level control valve is arranged between the exchange reservoir and the condensate receiver to permit excess water in the receiver to flow back into the reservoir as the system is being heated to steam-producing temperature. The steam generated by the system is discharged into a heat exchanger to effect heating of another medium flowing therethrough. The condensate is collected in the receiver. Once the system is in operation, a substantially fixed volume of operating liquid will remain in the system.

A liquid level responsive control device is conveniently mounted on the receiver and controls a solenoid-operated valve arranged between the receiver and the reservoir to allow condensate to be expelled from the system into the reservoir when the liquid level in the receiver exceeds a predetermined depth, as during the heating-up and operation of the system.

Upon shutting down of the system, the system components, as well as the liquid in the system, will cool and any vapor present will condense, thereby tending to create a negative pressure or vacuum condition in the system. Such condition is prevented by an automatic check valve connected in bypassing relation with the solenoid valve to allow liquid return-flow from the reservoir to the receiver to replenish or "load" the system. With such an arrangement, liquid, instead of air, enters the system to relieve the vacuum condition. Thus, all entry of air into the system is prevented. The effectiveness of the sodium sulphite in the feed water in the reservoir is prolonged by providing the reservoir with a floating lid that overlies nearly the entire surface of the liquid within the reservoir and maintains the liquid out of contact with air.

In a modified embodiment of the invention, the feed water exchange reservoir comprises an extensible bladder into which the excess liquid is forced from the steam generating system during operation. The bladder completely isolates the feed water from the atmosphere and thus prolongs the effective life of the water-treating chemicals.

Both types of exchange reservoirs are very effective for preventing air containing oxygen from getting into the system with the feed water and dissipating the treated water in the system. This is accomplished in both cases by maintaining the feed water in the reservoir out of contact with the atmosphere, and by pretreating the water in the reservoir with a suitable chemical compound to absorb the oxygen therein before introduction or return of the liquid to the system. The return is preferably automatically controlled but provision is made for manual control.

A further embodiment contemplates applying the principles of the present invention to a closed steam generating system including a combined receiver and heat exchanger through which a liquid medium to be heated is circulated and discharged through a blending valve, for example, to provide a supply of liquid at a desired temperature.

Accordingly, the principal object of the invention is to provide a closed, corrosion-free steam generating system designed so that it will prevent creating a vacuum condition during the cooling down period and thereby prevent air from being drawn into the system.

Another object is to provide a closed steam generating system wherein excess liquid is stored for reuse instead of being discharged to waste.

Another object is to provide means for automatically supplying pre-treated feed water to a closed steam generating system during shut-down periods to load the system and avoid creating a vacuum condition therein.

Still another object is to provide means that will prevent air from entering a closed steam generating system, and thereby prolong the effective life of the water-treating compounds in the system.

A further object is to eliminate the expense and labor of daily feed water replenishment, and daily water treatment in a closed steam generating system.

Still another object is to provide a feed water exchange reservoir and automatic control means for use with a closed steam generating system that will enable automatic unloading of the system during operation when the system is hot, and effect automatic, or manually controlled, re-loading of the system while it is shut down and cooling.

Other objects and advantages of the invention will be apparent from the following description considered with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic view of one embodiment of the present closed steam generating system, including an exchange reservoir, or head tank, for pre-treated feed water, and having a floating lid, the reservoir being shown connected with a condensate receiver, and means for automatically unloading, and automatically or manually loading, the closed system.

FIG. **2** is a diagrammatic view of a system similar to that shown in FIG. **1,** but wherein an extensible bladder closed to the atmosphere serves as the exchange reservoir for pre-treated feed water.

FIG. **3** is also a diagrammatic view of a system similar to that shown in FIG. **1,** but wherein the exchange reservoir is at a level lower than that of the condensate receiver and a pump is connected to pump the feed water from the exchange reservoir back into the system to load the system.

FIG. **4** is a diagrammatic view illustrating the application of the principles of the present invention to a closed steam generating system for providing liquid at any given desired temperature and provided with automatic means for unloading and loading the system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1,** a conventional steam generator **2** is shown having a heating coil **4** with an outlet connected to a pipe **6** and a shut-off valve **8** connected in the pipe. A conduit **10** extends from the valve **8** to a heat exchanger **12** containing a heat exchange space **14.** A tubular heat exchange element **16** is confined in the space **10** and may be connected with any apparatus wherein a heated medium is to be used. Thus, a supply pipe **18** having a pump **20** connected thereto, communicates with one end of the heat exchanger **16,** and a discharge pipe **22** is connected with the other end of the heat exchanger. Pipes **18** and **22** provide means whereby the medium to be heated can be withdrawn from a source of supply and circulated through the heat exchange element **16** and delivered to a point of use.

The heat exchanger **12** has a pair of condensate outlets **24** and **26** that are connected by conduits **28** and **30** with inlets **32** and **34** of a condensate receiver **36.** The receiver **36** has an outlet **38** that is connected by a conduit **40** to the inlet of a conventional circulating pump **42,** which delivers the condensate to an inlet **44** of the heating coil **4.** The pump **42** operates continuously when the steam generator **2** is in use, and circulates the liquid through the closed system comprising the components described above, in the direction indicated by the arrows.

A feed water exchange reservoir, or head tank **46,** is preferably disposed at a suitable height above the receiver **36,** so that water can be supplied to, or returned by gravity from, the reservoir **46** to the receiver **36** to load the system. A water supply pipe **48** having a shut-off valve **50** is connected with the exchange reservoir **46** for supplying make-up water to the exchange reservoir **46,** if and when necessary. The water **52** in the reservoir **46** is pre-treated with the usual boiler compounds, including sodium sulphite, which absorbs the oxygen from the water. Thus, corrosive oxygen is removed from the water before it enters the closed system.

The reservoir **46** has an open, upper portion that is substantially completely closed off from the atmosphere by a lid **46A** that floats on the feed water **52** in the reservoir. The lid **46A** can be made of any suitable buoyant material, for example, expanded polystyrene plastic. A clearance S is provided between the peripheral edge of the lid **46A** and the inner surface of the wall of the reservoir **46.** Such clearance may be ¼ to ½ inch, or less, and preferably just enough to provide for free up-and-down movement of the lid as the water level changes in the reservoir **46.** With such minimum clearance, substantially all air is kept out of contact with the upper surface of the treated feed water **52** and the loss of sodium sulphite to the oxygen in the atmosphere is practically nil.

By way of illustration and not limitation, a typical closed system may require **30** gallons of pre-treated water, which is more that adequate to completely fill the closed system. In such example, the exchange reservoir **46** would have a capacity of at least 21 gallons and the remaining 9 gallons would normally serve to fill the heating coil **4** and to bring the liquid level up to the desired height in the condensate receiver **36,** bearing in mind that in operation, the major volume of the heating coil **4** is occupied by vapor.

A discharge conduit **54** connects the lower end of the reservoir **46** with an opening **56** at the lower side of the receiver **36.** A conventional liquid level control device **58** is mounted upon one end of the receiver **36** and includes a switch **60.** A normally closed solenoid valve **62** is connected in the conduit **54** between the receiver **36** and the reservoir **46** and is arranged to open to allow flow of excess liquid in a direction from the receiver **36** to the reservoir **46.** Thus, the conduit **54** serves as an excess liquid conduit for returning liquid to the reservoir **46.** The switch **60** is connected to the solenoid valve **62** by leads **64** and **66.** Current is supplied to the switch **60** through electrical conductors **68** and **70.** The switch **60** is normally open but closes to energize and open the solenoid valve **62** when the water level in the receiver **36** exceeds a predetermined height. A water level sight glass **71** is mounted on one end of the receiver **36.**

A pipe **72** is connected in bypassing relation to the solenoid valve **62** and serves as a return pipe for return-

ing water by gravity from the reservoir **46** to replenish the closed system. A manually operable valve **74** and an automatic check valve **76** are both connected in the bypass pipe **72.** It will be understood that the manual valve **74** will be maintained open when it is desired to have liquid from the reservoir **46** return automatically to the receiver **36** through the check valve **76.** Under circumstances which would make it desirable to control the return manually, the valve **74** can be used to effect such control, or used as a shutoff valve. It will also be understood that the automatic opening of the solenoid valve **62** provides for "unloading" of the system by discharging liquid from the receiver **36** into the exchange reservoir **46;** and that the check valve **76** provides for immediate automatic "loading" of the system in response to a vacuum condition in the system by allowing return flow of liquid from the reservoir **46** to the system. Thus, entry of air into the system is positively prevented.

During normal operation, the steam generator **2** delivers fluid containing steam through the conduit **10** to the heat exchange space **14.** The heat in the steam is absorbed by the medium flowing through the heat exchange element **16,** so that the steam condenses and the condensate flows by gravity through the conduits **28** and **30** into the condensate receiver **36.** The reservoir **46,** as noted above, contains more than sufficient water to allow complete charging of the steam generator coil **4,** as well as the remainder of the system at a cold start. The circulating pump **42** operates continuously and draws water from the receiver **36** and delivers it through the pipe **6** to the inlet of the heating coil **4.**

During the initial heating of the system, the vapor pressure generated by the steam generator **2,** and the thermal expansion of the water in the closed system will force excess water from the receiver **36** back to the reservoir **46.** An abnormal liquid level in the receiver **36** will actuate the liquid level control **58** and energize the solenoid valve **62** to open, permitting such excess liquid to be discharged into the reservoir **46.** When the normal liquid level is restored in the receiver **36,** the liquid level control device **58** will allow the solenoid valve **62** to close, permitting operation of the system in a normal manner. Excess system pressure is relieved through a valve **77.**

Upon shutting down of the steam generator **2,** the circulating pump **42** is stopped, the components of the system will cool, and all vapor in the system will condense. Such condensation and thermal cooling of the liquid in the system will result in contraction of the volume of liquid in the system with the result that a vacuum condition will be created in the system. However, immediately upon the creation of any negative pressure in the system, the automatic check valve **76** will open and allow return flow of liquid from the reservoir **46** to the system through the by-pass pipe **72,** so long as the negative pressure exists in the system. In this manner, all air is prevented from entering the system and the system is thus automatically "loaded," ready for the next cold start.

Referring to FIG. **2,** a modified but identically operating system is illustrated wherein the exchange reservoir, or head tank, **46** is replaced by an extensible bladder **46B,** which completely isolates the feed water from the atmosphere. The bladder **46B** is flanged at its lower end and secured to a plate **47,** as shown. The bladder **46B** may be of the bellows type and made of any suitable material, such as reinforced synthetic rubber or plastic material. Access to the feed water in the bladder **46B** for the purpose of adding water-treating chemicals thereto is obtained through an opening **78,** which is normally closed air-tight by a plug **80.** The remaining elements of the system are the same as those described in FIG. **1** and corresponding parts have been identified by the same reference numerals.

Referring to FIG. **3,** the embodiment here illustrated is similar to that shown in FIG. **1,** except that the exchange reservoir **46** is disposed at a level lower than that of the receiver **36,** so that liquid cannot be returned to the closed system by gravity. The parts corresponding to those of FIG. **1** have been identified by the same numerals. As is shown, a pump **82** is connected with the reservoir **46** by a pipe **84,** which bypasses the discharge or excess liquid pipe **54A** containing the solenoid valve **62.** The manually operated valve **74** and the automatic check valve **76** are connected in the bypass pipe **84,** which extends from the pump **82** to the receiver **36.** The pump **82** is motordriven and may be controlled by a manually operated switch **86.** Alternatively, and preferably, the motor of the pump **82** is automatically controlled by a normally open low pressure switch **88** communicating with the interior of the receiver **36.** Electrical current is supplied to the low pressure switch **88** by a pair of conductors **90** and **92,** and leads **94** and **96** extend from the low pressure switch **88** to the pump **82.** The manually operated switch **86** is connected in the circuit in bypassing relation to the low pressure switch **88,** as shown. Whenever an abnormal low pressure condition occurs in the system, the low pressure switch **88** will be immediately closed and energize the motor driving the pump **82.** With the manual valve **74** open, the pump **82** will then draw water from the reservoir **46** and pump it through the bypass conduit **84** and automatic check valve **76** to "load" the system. The pump **82** will operate so long as the low pressure switch **88** remains closed by an abnormally low pressure in the system.

It will be understood that the closed system of FIG. **3** can be manually "loaded" after a shut down by closing the switch **86** to energize the pump **82,** and by manipulating the valve **74.**

FIG. **4** illustrates a closed steam generating system including an exchange reservoir and wherein a heat exchanger is combined with a condensate receiver. As is shown, a circulating pump **98** is connected in a pipe **100** extending from the bottom of a receiver **102** to the inlet **104** of the heating coil (not shown) of a conventional steam generator **2A.** The outlet **106** of the heating coil is connected by a pipe **108** to the upper portion of the receiver **102.** Any excess pressure in the receiver **102** is relieved through a safety valve **109.**

An exchange reservoir **46C** having a floating lid **46D,** similar to that illustrated and described in connection with FIG. **1,** is connected by conduits **54B** and **54C** to the receiver **102** for supplying feed water to the system and for receiving excess liquid discharged from the system during the heating-up and operating period.

A conventional liquid level control device **58A,** similar to that shown in FIG. **1,** is mounted on the receiver **102** and includes a normally open switch **60A** similar to the switch **60** shown in FIG. **1.** A normally closed solenoid valve **62A** is mounted in the pipe **54C** and is connected with the switch **60A** by leads **112** and **114.**

Electrical current to the liquid level control device **58A** is supplied through conductors **116** and **118.** The solenoid valve **62A** is energized to open when the liquid level in the receiver **102** exceeds a predetermined height. A sight glass **120** is mounted upon the receiver **102** to indicate the level of the condensate **122** therein. An automatic check valve **76A** and a manually operated valve **74A** are mounted in a by-pass pipe **72A** connecting the receiver **102** with the conduit **54B.**

A heat exchange element, or coil, **124** extends lengthwise through the receiver **102,** and its lower end is connected to a pipe **126** extending from a source (not shown) containing the medium to be heated. A pump **128** is connected in the pipe **126** for delivering the medium to and forcing it through the heat exchange element **124.** The upper end or outlet of the heat exchange element **124** is connected by a pipe **129** with an adjustable thermostat controlled mixing valve **130** having a discharge pipe **132** connected thereto. A blending conduit **134** connects the supply pipe **126** with the valve **130** in bypassing relation to the heat exchange element **124.** The valve **130** has a temperature control knob **135** for proportioning flow so that a portion of the unheated medium that would normally be delivered to the heat exchange element **124** can be diverted and mixed with a selected proportion of the heated medium being delivered to the valve **130,** whereby to deliver the blended medium at a desired temperature through the discharge pipe **132.**

A shut-off valve **136** is mounted at the upper end of the heat exchange element **124** and a drain valve **138** is mounted at its lower end. The heating coil has connected thereto the usual inlet valve **140** and a blowdown valve **142** at its outlet.

It will be understood that any excess liquid **122** in the receiver **102** can be forced back into the exchange reservoir **46C** by opening of the solenoid valve **62A** by operation of the liquid level control **58A** while the system is being heated up, or is in operation. After the system has been shut down, the circulating pump **98** is stopped, and as the components of the system cool, liquid from the reservoir **46C** can return to the receiver **102** through the check valve **76A** to automatically load the system prior to the next cold start. Thus, the closed steam generating system shown in FIG. **4** operates on the same principles and in the same manner as that described hereinabove in connection with FIG. **1.** Air is likewise prevented from being drawn into the system by automatically returning liquid thereto by gravity through the check valve **76A** as soon as a negative pressure or vacuum condition develops in the system. Of course, the manual valve **74A** is available to control loading manually, or to shut off flow through the bypass pipe **72A.**

All embodiments of the closed steam generating systems disclosed herein comprise an exchange reservoir for receiving excess liquid from the closed system, instead of discharging the same to waste. All systems also include an automatic liquid level control for "unloading" excess liquid, and automatic means for avoiding a vacuum condition and "loading" the system to prevent entry of air thereinto. Further, all systems eliminate corrosion, and the necessity for adding water-treating chemicals and make-up water prior to each cold start.

The exchange reservoir and unloading and loading means disclosed herein can be used with all systems wherein all of the condensate is returned to the boiler.

It will be understood that various changes may be made in the arrangement and details of construction of the several embodiments of closed steam generating systems described hereinabove without departing from the principles of the invention or the scope of the annexed claims.

I claim:

1. In a closed fluid heating system having a heater, a heat exchange element arranged to be heated by steam from said heater, a condensate receiver and a circulating pump connected between the condensate receiver and the heater, the improvement comprising: a reservoir for supplying feed liquid to the system; conduit means connecting the reservoir with the condensate receiver; and valve means connected in said conduit means arranged to allow excess liquid to flow from said condensate receiver to said reservoir when the system is heated, and to allow flow from said reservoir to said condensate receiver as the system cools to thereby prevent the creation of a vacuum condition in the system.

2. The improvement claimed in claim **1,** wherein the liquid reservoir is an open tank and contains a close-fitting, freely floating lid to substantially exclude air from contacting the upper surface of the liquid in the reservoir.

3. The improvement claimed in claim **1,** wherein the liquid reservoir is a closed, extensible bladder in communication with the conduit means connected with the condensate receiver, so that the liquid in the bladder is completely isolated from the atmosphere.

4. The improvement claimed in claim **1,** wherein the reservoir is located at a level above the level of the condensate receiver and the valve means includes an automatic check valve arranged in the conduit means so that liquid can be returned by gravity from the reservoir to the system to replenish the system.

5. The improvement claimed in claim **1,** including a liquid level responsive device mounted on the condensate receiver and actuated in accordance with changes in the liquid level therein; and wherein the valve means includes a solenoid-operated valve connected in the conduit means between the reservoir and the condensate receiver and controlled by the liquid level responsive device to effect opening of the solenoid valve to allow flow of excess liquid from the condensate receiver to the reservoir when the liquid level in the reservoir exceeds a predetermined level.

6. The improvement claimed in claim **5,** wherein the conduit means includes a pipe connected in bypassing relation to the solenoid valve, and wherein the valve means includes an automatic check valve connected in said bypass pipe for controlling the return of liquid from the reservoir to the system.

7. The improvement claimed in claim **5,** wherein the conduit means includes a pipe connected in bypassing relation to the solenoid valve, and wherein the valve means includes a manually operable valve connected in said bypass pipe for controlling the return of liquid from the reservoir to the system.

8. The improvement claimed in claim **1,** wherein a liquid level responsive control device is mounted on the receiver, and wherein the conduit means includes an excess liquid discharge pipe having a valve connected therein controlled by said liquid level responsive con-

trol device to open to allow liquid flow from the receiver to the reservoir, and wherein the conduit means also includes a pipe connected in bypassing relation to said liquid level controlled valve, and wherein an automatic check valve and a manually operable valve are connected in said bypass pipe.

9. The improvement claimed in claim **1** wherein a liquid supply conduit and a pump are connected with one end of the heat exchange element and a discharge pipe is connected with the other end of the heat exchange element.

10. The improvement claimed in claim **6,** wherein the reservoir is located at a level below the level of the condensate receiver; and wherein a motor-driven pump is connected in the bypass pipe between the reservoir and said check valve for pumping liquid from the reservoir through said check valve and back into the system.

11. The improvement claimed in claim **10,** wherein a low pressure responsive switch is mounted upon the receiver and is connected in an electrical circuit with the motor-driven pump for automatically energizing said pump in response to an abnormally low pressure condition in the receiver.

12. The improvement claimed in claim **11,** wherein a manually operable switch is connected in the circuit to the pump motor in bypassing relation to the low pressure switch.

13. The improvement claimed in claim **9,** wherein a thermostat valve is connected in the delivery pipe and a blending pipe has one end thereof connected with the thermostat valve and its other end connected with the supply pipe at a point between the pump and the one end of the heat exchange element.

14. The improvement claimed in claim **1,** wherein the heat exchanger and the condensate receiver are constructed as a single unit, comprising a casing, and wherein the heat exchange element extends through the casing.

15. In a closed fluid heating system having a heater, a heat exchange element arranged to be heated by steam from said heater, a condensate receiver for condensate from steam condensed by the heat exchange element, and a circulating pump connected between the condensate receiver and the heater, the improvement comprising: a reservoir for supplying to the system feed liquid isolated from the atmosphere; conduit means connecting the reservoir with the condensate receiver, said conduit means comprising a pipe connected with the receiver; a solenoid valve mounted in said pipe; a liquid level responsive device mounted upon the receiver having a switch connected with said solenoid valve to effect opening of said solenoid valve to allow flow of excess liquid from the condensate receiver to the reservoir when the liquid level in the receiver exceeds a predetermined level, said conduit means also including a pipe connected to the receiver in bypassing relation to the solenoid valve; an automatic check valve connected in said bypass pipe for controlling the return of liquid from the reservoir to the receiver in response to a negative pressure being created in said system; a supply pipe for a liquid medium to be heated connected with one end of the heat exchange element; a pump connected with said medium supply pipe for pumping the medium through the heat exchange element; and a discharge pipe for the heated medium connected with the other end of the heat exchange element.

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