

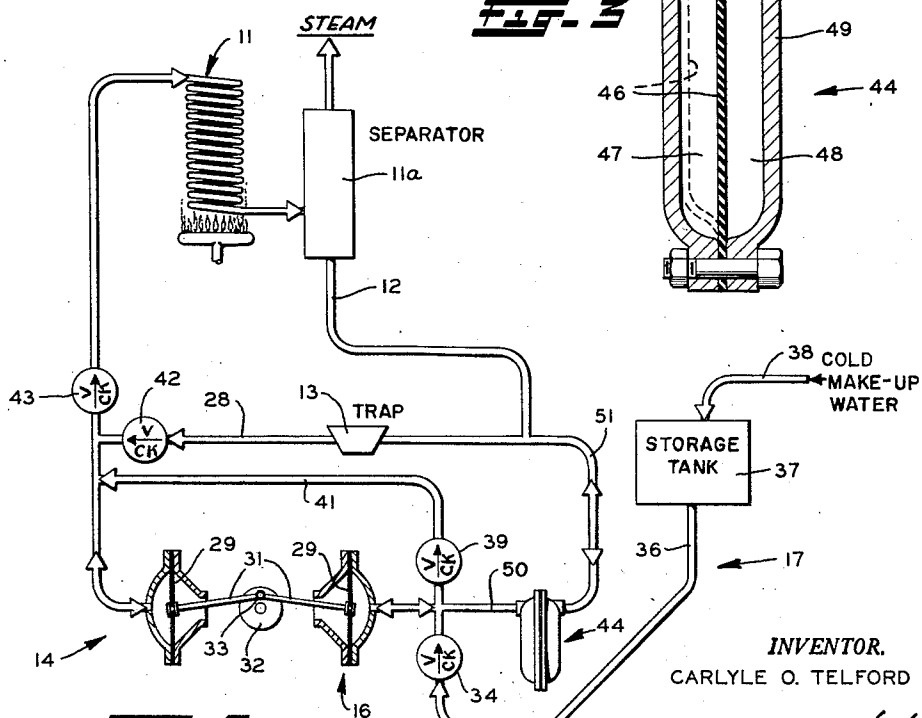
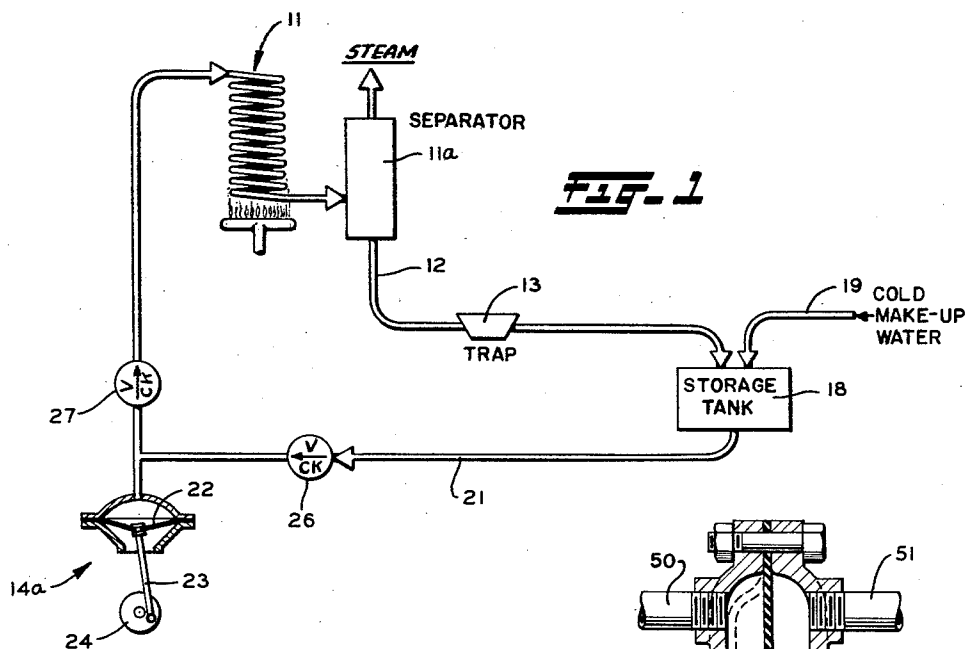
May 5, 1964

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3,131,676

FEED WATER SUPPLY SYSTEM

Filed April 17, 1961



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3,131,676

FEED WATER SUPPLY SYSTEM

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Filed Apr. 17, 1961, Ser. No. 103,542

10 Claims. (Cl. 122-451)

This invention relates to a feed water supply system and more particularly to return systems in which surplus water and/or condensate is recirculated to a steam generator or boiler with make-up water being added as required. Considerable amounts of heat energy are contained in the surplus water from steam generators and in the condensate from steam boilers. Significant savings in fuel can be obtained if the surplus water or condensate is returned as feed water to the generator or boiler. Conventionally, the return water is conveyed to a storage tank open to the atmosphere and make-up water is added to the tank as required.

Heat and evaporation losses from systems of this type are high. The return water is separated from the pressurized steam by a device known as a trap. When the return water goes through the trap the pressure is reduced down to atmospheric pressure. The return water must then cool down to the boiling point of approximately 212° F. at atmospheric pressure. It does this by flashing part of the water into steam containing considerable amounts of heat energy. It is difficult to salvage this steam and it is usually rejected.

If the return water is very hot and if only small amounts of cold make-up water are required, the water in the tank may attain a temperature high enough to interfere with pumping. This is because of the tendency of the hot water to flash into steam and create a vapor lock on the suction side of the pump.

Attempts have been made to eliminate the problems of pumping very hot return water by utilizing a closed return system in which pressure is maintained at a high enough level to prevent flashing of the water into steam. The simplest of the closed system designs consists of a manifold, into which return water flows by gravity, and a pump—usually of the turbine type—which feeds the return water directly to the boiler. Applications of this system are limited by problems of steam erosion of the pump and requirement of a high static inlet head at all times to prevent flashing. More complicated systems have been evolved which combine a centrifugal pump and a jet pump in series in a closed circuit, with the centrifugal pump energizing the jet pump, but such systems become quite expensive and encounter many design and operating difficulties.

The present invention contemplates a feed water supply system having a feed water pump which will supply the hot return water from the steam generator or boiler directly back to the generator or boiler whenever such return water is available. Make-up water is automatically supplied to the feed water pump whenever the supply of hot return water stops.

The described function is accomplished by continuously operating positive displacement reciprocating feed water and make-up water pumps 180° out of phase so that one pump will be accomplishing its suction stroke while the other pump is producing its discharge stroke. The feed

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water pump is connected into the condensate return line downstream of the trap, and the make-up water pump is connected between a source of make-up water and the chamber or head of the first pump.

My system incorporates a sensing device which renders the action of the second pump ineffectual whenever hot return water is being supplied to the first pump. Therefore make-up water is added only when the trap is not passing surplus water or condensate and improved thermal efficiency is achieved. Since the first pump draws on the return water line only when return water is present under a relatively high static head or pressure, pumping problems due to flashing are eliminated.

Accordingly it is a principal object of the present invention to provide a feed water supply system for a steam generator or boiler which will pump hot surplus water or condensate back to the generator or boiler whenever available and which will automatically supply make-up water when the supply of hot return water is interrupted.

Another object of the invention is to supply a constant amount of liquid from a source of the liquid under pressure and from a source of the liquid at a lower pressure, the system being adapted to utilize the liquid under higher pressure first and, when such liquid is exhausted, to utilize the liquid at lower pressure.

A further object of the invention is to provide a feed water system of the character described which incorporates positive displacement reciprocating pumps mounted in tandem, one of the pumps being adapted to supply feed water to the boiler and the other pump being adapted to supply make-up water to the first pump on demand.

A still further object of the invention is to provide a feed water supply system of the character described in which the action of the make-up water pump is automatically "killed" whenever condensate under pressure is being supplied to the feed water pump, this action being accomplished by accommodating water displaced by the make-up water pump whenever the latter is pumping against the back pressure imposed by the pressurized hot return water.

Yet another object of the invention is to provide a feed water supply system of the character described which is simple and sturdy and which is constructed of inexpensive components having a long and trouble-free operating life.

Further objects and advantages of my invention will be apparent as the specification progresses, and the new and useful features of my feed water supply system will be fully defined in the claims attached hereto.

The preferred form of my invention is illustrated in the accompanying drawing forming part of this application, in which:

FIGURE 1 is a flow diagram of a conventional open-well condensate return system;

FIGURE 2, a flow diagram similar to that of FIGURE 1 but illustrating the feed water supply system of the present invention; and

FIGURE 3, an enlarged cross-sectional detail view forming part of the feed water supply system of FIGURE 2.

While I have shown only the preferred form of my invention, it should be understood that various changes or modifications may be made within the scope of the claims attached hereto without departing from the spirit of the invention.

Referring to the drawings in detail, it will be seen that the feed water supply system of the present invention as illustrated in FIGURE 2 is designed for use with a steam generator 11 having a hot surplus water return line 12 incorporating a trap 13, the feed water system consisting basically of a feed pump 14 for returning surplus water from the trap to the steam generator, a make-up pump 16 adapted for supplying make-up water to the feed pump 14, and pressure-responsive control means 17 connected to the make-up pump 16 and to the condensate return line 12 upstream of the trap 13, the means 17 being formed to prevent pumping of make-up water by the make-up pump to the feed pump while hot surplus water is being supplied to the feed pump from the trap 13.

FIGURE 1 illustrates a conventional type of condensate return system in which a steam generator 11 supplies mixed steam and hot water to a separator 11a, the surplus water passing out of the separator through the return line 12 and trap 13 to a storage tank 18. Make-up water is added through conduit 19 to the tank 18 in the well known manner to maintain the desired water level in the tank. A feed water pump 14a is connected into a conduit 21 leading from tank 18 to the steam generator 11.

The pump 14a could be a rotary type or, as here shown, may comprise a conventional positive displacement reciprocating type having a flexible diaphragm 22 which is reciprocated by an arm 23 eccentrically connected to a rotary drive member 24. Movement of the diaphragm 22 downwardly, as viewed in FIGURE 1, provides the suction stroke of the pump and movement of the diaphragm upwardly provides the discharge stroke.

In accordance with usual practice, inlet and outlet check valves are provided on opposite sides of the pump. During the suction stroke of the pump a pressure drop is created across inlet check valve 26 and liquid in the line 21 passes into the pump. During the discharge stroke check valve 26 closes and the liquid contents of the pump are forced out through check valve 27 to the steam generator 11.

It will be apparent that, when the water in line 21 is hot enough to flash into steam at the reduced pressures created during the suction stroke of the pump, a vapor lock will be formed and the pump will be ineffective to supply feed water until the vapor pocket condenses. Moreover, very considerable amounts of heat will be lost from the hot return liquid in the form of steam formed when the pressure on the return liquid is reduced to atmospheric at the trap 13.

The system illustrated in FIGURE 2 of the drawing is constructed in accordance with the present invention and is designed to pump the hot return water to the steam generator 11 whenever the return water is issuing from the trap 13. The return water in line 28, between trap 13 and the feed pump 14, will be pressurized at approximately the output pressure of the steam generator. Even though some cooling will be unavoidable in the progress of the return water through line 12 and trap 13, the described pressure will be sufficient to prevent flashing and consequent vapor lock. Thus the hot return water will be supplied to the steam generator whenever available.

Preferably and as here shown, the pumps 14 and 16 are of positive displacement reciprocating diaphragm type and each pump includes a diaphragm 29 connected by a rod 31 to a rotary drive member 32. It will be noted from FIGURE 2 that both of the rods 31 are connected to the same eccentric pin 33 so that the pumps operate 180° out of phase—that is, one pump will always be effecting a suction stroke while the other pump is exerting its discharge stroke.

The intake check valve 34 of pump 16 is connected by line 36 to a reservoir 37 supplied with make-up water through line 38. The outlet check valve 39 of pump 16

is connected through line 41 to the feed pump 14 between its inlet check valve 42 and outlet check valve 43.

With this arrangement the make-up pump 16 would normally pump make-up water to the pump 14 which would then pump the water on to the steam generator 11. However, and as a principal feature of the present invention, pressure responsive control means 17 prevents delivery of make-up water when hot return water is available for this purpose. Control means 17 includes lines 50, 51 connecting a damper unit 44 to pump 16 and return line 12, respectively. Damper unit 44 is provided for "killing" (inhibiting the action of the pump 16 whenever return water is being supplied to pump 14 through line 28.

The damper unit 44 includes a movable element 46 dividing a chamber into two portions 47 and 48. Chamber 47 communicates with the make-up pump 16 between the inlet check valve 34 and the outlet check valve 39 through line 50. Chamber 48 communicates with the return line 12, upstream of the trap 13, through line 51. While any suitable movable element 46, such as a floating piston or the like, would function effectively in the control means 44, I prefer to provide the element 46 in the form of a flexible diaphragm mounted across an enlarged housing 49 providing the chamber portions 47 and 48.

The valving of the pumps 14 and 16 is constructed to equalize pressure on opposite sides of the diaphragm 46 when the trap 13 is supplying return water to the feed pump 14. With the pressure so equalized, the water displaced from the chamber of make-up pump 16, by the discharge stroke thereof, will be accommodated by substantially unresisted movement of the diaphragm 46 allowing an equal quantity of water to enter chamber 47. In other words, the pressure between check valves 34 and 39 will be equal to the pressure in line 41 during the discharge stroke of the pump and this, in turn, will be equal to the pressure in line 28 on the downstream side of trap 13. At the same time, the pressure in line 51, leading from return line 12 to housing 49, will be the same as the pressure between check valves 34 and 39. This is because the pressure on the upstream and downstream sides of trap 13 will be substantially equal when the trap is open and supplying return water to the feed pump 14. With the pressure equalized on both sides of diaphragm 46, water displaced by the pump 16 merely sloshes back and forth in the lines and thus damps out or inhibits any pumping action from the pump 16.

When trap 13 closes, cutting off the supply of return water to line 28, the pressure in lines 28 and 41 will drop, causing the pressure between check valves 34 and 39 to drop a corresponding amount. The pressure in chamber portion 48 will then be higher than the pressure in chamber portion 47 and this will urge the diaphragm 46 to the leftmost position illustrated by dotted lines in FIGURE 3.

With the diaphragm 46 held in this position, pressure surges caused by the discharge strokes of make-up pump 16 will not be absorbed and the pump 16 will then become effective to supply make-up water to the feed pump 14.

From the foregoing it will be apparent that I have provided a novel feed water supply system for a steam generator or the like which will automatically pump hot condensate to the steam generator when available and which will also automatically furnish make-up water to the feed water pump whenever the hot condensate is not available, the system being designed to utilize more or less standard components in a novel combination providing for much higher efficiency than has previously been obtainable.

I claim:

1. In a pumping system for supplying liquid at a constant rate to an apparatus from a first source of the liquid under pressure and from a second source of the liquid at

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a lower pressure, a first pump having an intake conduit adapted for connection to said first source and an output conduit adapted for connection to said apparatus, a second pump having an intake conduit adapted for connection to said second source and an output conduit connected to said first pump, a shut-off device mounted in said intake conduit of said first pump, and pressure-responsive control means connected to said second pump and to the intake conduit of said first pump upstream of said shut-off device so as to be responsive to the condition of the shut-off device and formed to prevent pumping of liquid from said second source by said second pump to said first pump while said shutoff device is open.

2. In a steam generating system having a hot water return line incorporating a trap, a feed water supply system comprising a first pump for returning hot water from the trap to the steam generating apparatus when the trap is open and supplying make-up water to the steam generating apparatus when the trap is closed, a second pump adapted for connection to a source of make-up water for supplying such water to said first pump when the trap is closed, and pressure-responsive control means responsive to the open and closed condition of the trap and connected to said second pump and to said return line upstream of said trap, said control means constructed to inhibit pumping of make-up water by said second pump to said first pump while return water is being supplied to the first pump from said trap.

3. In a steam generating system having a hot water return line incorporating a trap, a feed water supply system comprising a first pump for returning hot water from the trap to the steam generating apparatus when the trap is open and supplying make-up water to the steam generating apparatus when the trap is closed, a second pump adapted for connection to a source of make-up water for supplying such water to said first pump when the trap is closed, drive means connected to said pumps for continuous operation thereof, and control means responsive to the open and closed condition of the trap and connected to said second pump and to said return line upstream of said trap, said control means having a movable element formed to damp out the pumping action of said second pump by equalizing pressure on said element while return water is being supplied to the first pump from said trap.

4. In a steam generating system having a hot water return line incorporating a trap, a feed water supply system comprising a first positive displacement reciprocating pump for returning hot water from the trap to the steam generating apparatus when the trap is open and supplying make-up water to the steam generating apparatus when the trap is closed, a second positive displacement reciprocating pump adapted for connection to a source of make-up water for supplying such water to said first pump when the trap is closed, drive means connected to said pumps for continuous tandem operation thereof, and control means responsive to the open and closed condition of the trap and connected to said second pump and to said return line upstream of said trap, said control means having a movable element formed to damp out the pumping action of said second pump by equalizing pressure on said element while return water is being supplied to the first pump from said trap.

5. In a steam generating system having a hot water return line incorporating a trap, a feed water supply system comprising a first positive displacement reciprocating pump for returning hot water from the trap to the steam generating apparatus when the trap is open and supplying make-up water to the steam generating apparatus when the trap is closed, a second positive displacement reciprocating pump adapted for connection to a source of make-up water for supplying such water to said first pump when the trap is closed, drive means connected to said pumps for continuous tandem operation thereto, and control means having a movable element dividing a chamber into two portions communicat-

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ing with said return line at the upstream side of said trap and with said second pump, the valving of said pumps being formed to equalize pressure on opposite sides of said element when said trap is open and supplying return water to said first pump whereby water displaced from said second pump will be accommodated in said control means by substantially unresisted movement of said element, said valving being formed to reduce the pressure at one portion of said chamber below the pressure at the other portion when said trap is closed so as to immobilize said element and prevent accommodation of water displaced from said second pump whereby the latter will pump make-up water to said first pump whenever said trap is closed and not supplying return water.

6. A water supply system as described in claim 5 and wherein said movable element consists of a flexible diaphragm mounted across said chamber.

7. In a steam generating system having a hot water return line connected to a trap, a feed water supply system comprising a hot water supply line connected between said trap and the steam generating apparatus, a positive displacement reciprocating feed pump mounted in said supply line for feeding return water from said trap to the steam generating apparatus, a positive displacement reciprocating make-up water supply pump having an intake line adapted for connection to a source of make-up water and an output line communicating with said feed pump, drive means connected to said pumps for continuous tandem operation thereof 180° out of phase so that one of the pumps will always be effecting a suction stroke while the other of the pumps is accomplishing its discharge stroke whereby the suction pressure of said feed pump is always the same as the discharge pressure of said make-up water supply pump and the suction pressure on said feed pump is governed by the trap, and control means connected to said make-up water supply pump and to the return line upstream of said trap and having a movable element formed to accommodate water displaced from said make-up water supply pump when pressure is equalized on opposite sides of said element by opening of said trap whereby said make-up water supply pump will be effective to supply make-up water to said feed pump only when said trap is closed and no return water is being furnished to said feed pump.

8. In a steam generating system having a hot water return line connected to a trap, a feed water supply system comprising a hot water supply line connected between said trap and the steam generating apparatus, a positive displacement reciprocating feed pump having inlet and outlet check valves mounted in said supply line for feeding return water from said trap to said steam generating apparatus, a positive displacement reciprocating make-up water supply pump having an inlet check valve adapted for connection to a source of make-up water and an outlet check valve communicating with said feed pump between the inlet and outlet check valves thereof, drive means connected to said pumps for continuous tandem operation thereof 180° out of phase so that one of the pumps will always be effecting a suction stroke while the other of the pumps is accomplishing its discharge stroke whereby the pressure at the inlet check valve of said feed pump is governed by the trap, and control means having a movable element dividing a chamber into two portions communicating with said return line at the upstream side of said trap and with the inlet check valve of said feed pump, the inlet and outlet check valves of said pumps being formed to equalize pressure on opposite sides of said element when said trap is supplying return water to said feed pump whereby water displaced from said make-up water supply pump will be accommodated by substantially unresisted movement of said element, said check valves and trap being formed to reduce the pressure at the portion of said chamber communicating with the inlet check valve of said feed pump below the pressure at the portion of said chamber

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communicating with said return line when said trap is closed so as to immobilize said element and prevent accommodation of water displaced from said make-up water supply pump whereby the latter will pump make-up water to said feed pump whenever said trap is not supplying return water.

9. The steam generating system defined in claim 8, in which the movable element of said control means constitutes a flexible diaphragm mounted across said chamber.

10. The steam generating system defined in claim 9, in

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which the feed and make-up water supply pumps comprise opposed diaphragm pumps driven by a common member to insure that one pump will be undertaking a suction stroke while the other pump is accomplishing its discharge stroke.

References Cited in the file of this patent

UNITED STATES PATENTS

684,806	Enzinger	Oct. 22, 1901
2,322,102	Gschwind	June 15, 1943
2,840,052	Karassik	June 24, 1958