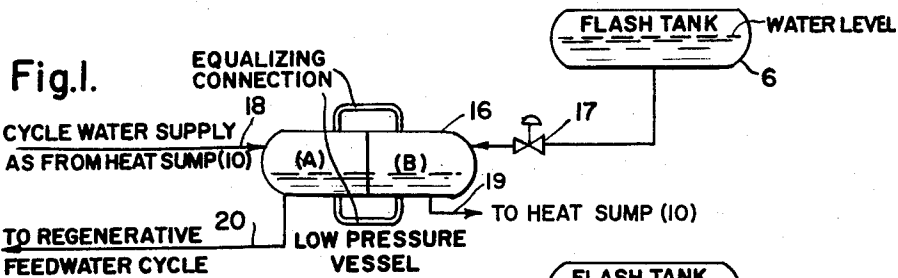
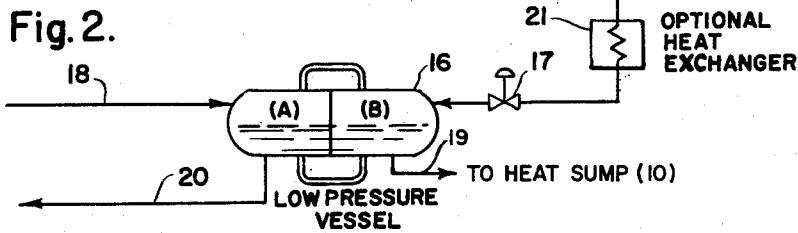
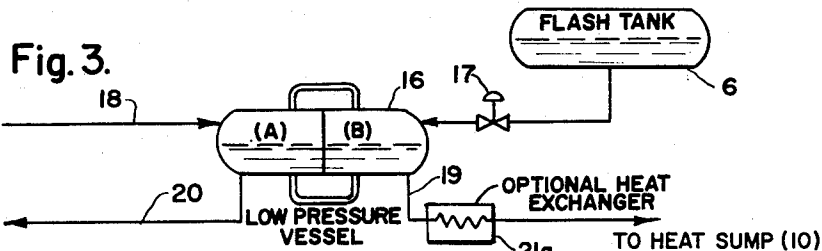
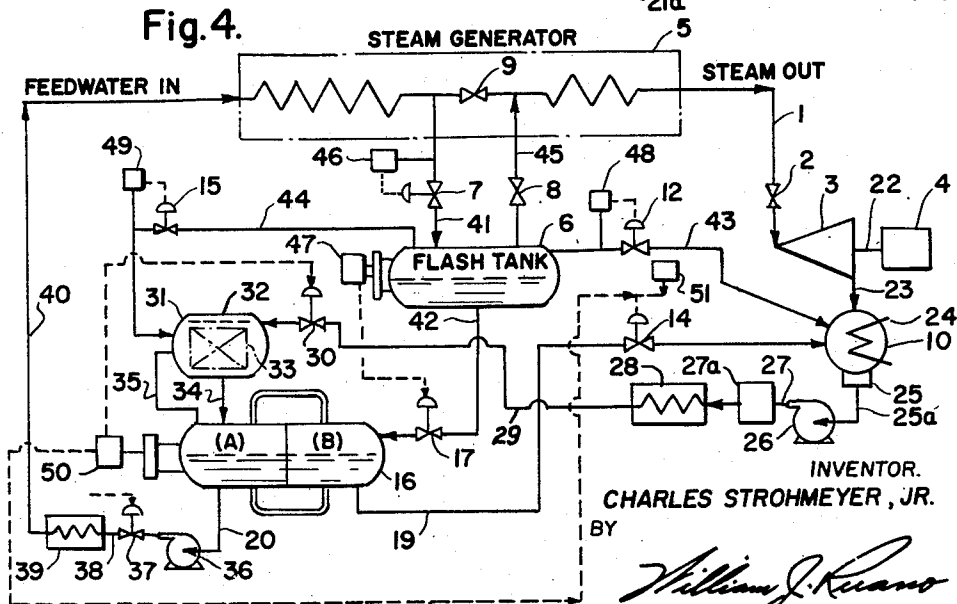


Dec. 1, 1964

C. STROHMEYER, JR.
STEAM GENERATOR BY-PASS SYSTEMS FOR
A STEAM-ELECTRIC GENERATING PLANT
Filed Feb. 26, 1963

3,159,145



INVENTOR.
CHARLES STROHMEYER, JR.

BY

William J. Ruano
his ATTORNEY

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3,159,145

STEAM GENERATOR BY-PASS SYSTEMS FOR A STEAM-ELECTRIC GENERATING PLANT

Charles Strohmeier, Jr., Wyomissing, Pa., assignor to Gilbert Associates, Inc., Reading, Pa.
Filed Feb. 26, 1963, Ser. No. 261,173
3 Claims. (Cl. 122—1)

This invention relates to devices and systems for improving the operating flexibility of steam-electric generating units including steam generator, turbine-generator and auxiliary equipment. This invention is a continuation-in-part of patent application Serial No. 154,087 filed September 5, 1961.

An object of the invention is to provide a novel apparatus and a system which will reduce unit start-up time and costs. Auxiliary bypass system costs are reduced, minimizing the total cost of the unit.

A more specific object of the invention is to provide a novel system for controlling drain flow from a flash tank or steam and water separator in a way which will return the flash tank drain flow to the regenerative feedwater cycle and/or to a heat sump; the heat in the drains flowing to the heat sump being at a lower heat level than that of the saturated liquid in the flash tank.

Other objects and advantages of the invention will become more apparent from a study of the following description taken with the accompanying drawings wherein:

FIG. 1 shows a system whereby the steam generator flash tank drains may be discharged to either the regenerative feedwater cycle or to a heat sump after passing through a vessel directly connected to the feedwater cycle at lower pressure than the flash tank.

FIG. 2 shows installation of an optional heat exchanger in the FIG. 1 system.

FIG. 3 shows installation of another optional heat exchanger in the FIG. 1 system.

FIG. 4 shows the FIG. 1 system integrated into the overall steam-electric generating plant.

General Description of Present Invention

FIG. 1 shows a system whereby the steam generator flash tank drains may be selectively discharged in whole or in part to either the regenerative feedwater cycle or to a heat sump after passing through a vessel directly connected in the regenerative feedwater cycle at lower pressure than the flash tank and a higher saturation temperature than the heat sump. The flash tank 6 liquid drains may be discharged to a lower pressure vessel 16 after discharge through throttling valve 17. This is one of many possible arrangements which illustrates the broad general principles. The lower pressure vessel 16 is so arranged that the heat sump 10 water supply to the cycle entering through connection 18 to compartment A is regulated to maintain a set or characterized level in 16. The flash tank 6 drains enter vessel 16 in a compartmented section B, the vapor and water sides of which are equalized with respect to vapor pressure and water level with the A section through open conduits, water level equalizing in the two compartments by means of gravity. The two compartments A and B may be in separate vessels which are similarly cross-connected in a way to equalize vapor pressure and the water level in the two vessels by means of gravity. The vessel 16 effluent to the regenerative feedwater cycle supplying water to the steam generator associated with the flash tank, is drawn off compartment A through conduit 20 and the drains to heat sump 10 are drawn off compartment B through conduit 19.

As the flash tank drains enter compartment B, level in vessel 16 rises if there is no flow through line 19 which reduces flow through line 18 to satisfy line 20 flow requirements. Flow control valves in conduits 18, 19 and

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20 are not shown in FIG. 1. Also, vessel 16 water level control mechanism associated with the flow control valve in conduit 18 is now shown. If there is flow through line 19, the flash tank drains will flow preferentially through line 19 to the heat sump (as a result of gravity equalizing water level between compartments A and B). Cooling in the heat sump permits the drains to be passed through low temperature purification equipment.

An optional heat exchanger 21 as shown in FIG. 2 may be placed in the line from the flash tank 6 to vessel 16 to extract heat from the flash tank drains before entering vessel 16 at lower saturation temperature. Heat can thus be conserved at a higher level than that of vessel 16.

The above arrangements permit segregation of the flash tank liquid drains at a heat level below the flash tank and above the heat sump so that less heat will be wasted when discharging the flash tank drains to heat sump 10. It alternately permits the flash tank drains to be returned to the feedwater cycle at a lower pressure level than the flash tank.

Optional heat exchanger 21a shown in FIG. 3 reduces heat in the flash tank liquid drain to heat sump 10.

FIG. 4 shows the FIG. 1 system integrated into the overall steam-electric generating plant. The outlet steam from steam-generator 5 flows through conduit 1, through steam admission control valve 2 to steam turbine 3 where the steam expands performing work, driving electric generator 4 through shaft 22.

The turbine 3 exhausts through conduit 23 to condenser 10. Cooling water passing through circuits 24 condenses exhaust steam which collects in hotwell 25. The hotwell discharges through conduit 25a to pump 26 wherein the liquid is raised to the 1st working pressure of the cycle. Pump 26 discharges through conduit 27, to low temperature condensate purification equipment 27a, through low pressure heat exchanger 28, through conduit 29 and flow control valve 30 to deaerator 31. Water enters deaerator 31 through spray pipe 32 and cascades over trays 33 by gravity. Gravity flow of liquid from deaerator 31 continues through conduit 34 to compartment A of low pressure vessel 16, which is the deaerator water storage tank in this case. Vapor pressure between compartment A and the deaerator 31 is equalized through conduit 35.

Flow from compartment A of low pressure vessel 16 passes through conduit 20 to feedwater pump 36 wherein the fluid is raised to the working pressure of steam generator 5. The discharge of pump 36 discharges through feedwater regulator valve 37, conduit 38, through high pressure heat exchanger 39, through conduit 40 to the feedwater inlet of steam generator 5. While not shown in FIG. 4, extraction steam from turbine 3 is fed to the shells of heat exchangers 28 and 39 through conduit and flow control means to heat the steam generator makeup water passing through the conduits inside the shells. Extraction steam from turbine 3 is also used to normally heat condensate flow from conduit 29 upon entering deaerator 31 when the unit is operating and the bypass system is inoperative. This supply of extraction steam is not shown in FIG. 4.

During startup and low load conditions, steam generator intermediate fluid flow is passed through conduit 41 and flow control valve 7 to flash tank 6. Pressure is reduced through valve 7 and the flash tank design pressure is considerably below that of the working pressure in the steam generator. Flash tank liquid drain flow passes through conduit 42 and flow control valve 17 to compartment B of vessel 16. Liquid from compartment B may be discharged to condenser 10 through conduit 19 and flow control valve 14.

Flash tank steam may be discharged to condenser 10 through conduit 43 and flow control valve 12. The flash tank 6, when in use, is normally operated at a pressure

whose saturation temperature is substantially higher than the designed operating limit of condenser 10. Flash tank steam may be supplied to deaerator 31 through conduit 44 and flow control valve 15.

Throttling valve 9 regulates the downstream pressure and fluid flow in the steam generator circuits. Flash tank steam may be passed to the steam generator circuits downstream of valve 9 through conduit 45. Valve 8 isolates the downstream circuits from the flash tank when the pressure downstream from valve 9 is higher than flash tank design pressure.

Valve 7 is provided with a pressure controller 46 which regulates fluid pressure in the steam generator circuits upstream of valve 9 to a preselected value. Valve 17 controls flash tank 6 water level to a preselected reference point as set in water level controller 47. The amount of flow through valve 17 is largely dependent upon the amount of flow through valve 7 and the heat content of such flow.

Valve 12, through pressure controller 48, prevents flash tank pressure from rising above a preselected value set in controller 48. When flash tank pressure rises above this value, valve 12 is opened to exhaust flash tank steam to condenser 10.

Valve 15, through pressure controller 49, maintains the vapor pressure in the downstream conduit at a value preselected in controller 49. This in turn maintains a minimum preset pressure in deaerator 31 and vessel 16 compartments A and B.

The discharge flow from pump 26 is regulated by control action of valve 30. Valve 30 is controlled by water level controller 50 to maintain a preset water level in compartments A and B of vessel 16.

Flow from vessel 16 is normally through conduit 20 to pump 36 and to the steam generator feedwater inlet. However, during startup of the unit, the flash tank drains in conduit 42 will contain impurities. The purpose of compartments A and B in vessel 16 is to segregate such impurities in compartment B so that they can be drawn off through conduit 19 and flow control valve 14 to condenser 10 without contaminating compartment A of vessel 16. At this time, flow quantity through valve 14 is regulated to exceed the flow quantity through valve 17. Flow meters and indicators (not shown) in conduits 42 and 19 will assist the operator to maintain the proper flows through the respective valves. Valve opening of valve 14 may be manually set by selector station 51. Valve 14 also may serve as a spillover for high level in vessel 16 so that valve 14 will open when level in vessel 16 exceeds a preset high limit set in level controller 50.

Flow through conduit 20 and pump 36 are regulated by means of valve 37 in conjunction with feedwater flow control equipment (not shown) to maintain flow necessary to sustain the preset load required of turbine generator 3-4 in conjunction with steam temperature control in conduit 1 as well as to maintain the required minimum flow in the steam generator circuits upstream of valve 9 at low turbine generator loads.

Thus, flash tank drains through conduit 42 and valve 17 may be selectively returned to the regenerative feedwater cycle through conduit 20 and pump 36 or alternately discharged to condenser 10 through conduit 19

and valve 14. Flow from condenser 10 may be passed through low temperature condensate purification equipment 27a before the fluid is returned to the steam generator for recycling.

Thus it will be seen that I have provided an efficient system for improving the operating flexibility of steam-electric generating units having a steam generator, turbine generator and auxiliary equipment; furthermore, I have provided a novel system for controlling drain flow from a flash tank in the steam generator bypass system in a way which selectively returns the flash tank drains to the regenerative feedwater cycle and/or to a heat sump at a lower pressure level than that of the flash tank and a higher saturation temperature level than that of the heat sump.

While I have illustrated and described several embodiments of my invention, it will be understood that these are by way of illustration only, and that various changes and modifications may be made within the scope of the following claims.

I claim:

1. A startup bypass fluid flow control system for a steam generator having fluid heat absorption conduits, a flash tank, a flow controlled fluid bypass conduit from an intermediate point between said heat absorption conduits and discharging to said flash tank, the invention comprising a two compartmented lower pressure vessel system, each compartment having a vapor and water side, conduit means for equalizing the vapor and water sides of both compartments by gravity for maintaining a common vapor pressure and water level, means therein connected to one of said compartments and adapted to conduct drains from said flash tank to said one compartment, a heat sump, means for flowing water from said one compartment to said heat sump, means for returning water from said heat sump to the other compartment to maintain a set level in said lower pressure vessel system, a steam generator regenerative feedwater cycle, and a flow conduit discharging water from the said other compartment to the regenerative feedwater cycle.

2. A startup bypass system for a steam generator as defined in claim 1 wherein said means to conduct drains from said flash tank to said one compartment has a heat exchanger positioned therein to lower the water temperature before the fluid enters said one compartment.

3. A startup bypass system for a steam generator as defined in claim 1 wherein said means for flowing water from the said one compartment to said heat sump includes a portion in which is located a heat exchanger to lower the water temperature before the fluid enters said heat sump.

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