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FEED WATER SUPPLY SYSTEM FOR STEAM GENERATORS

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Fig. 1.

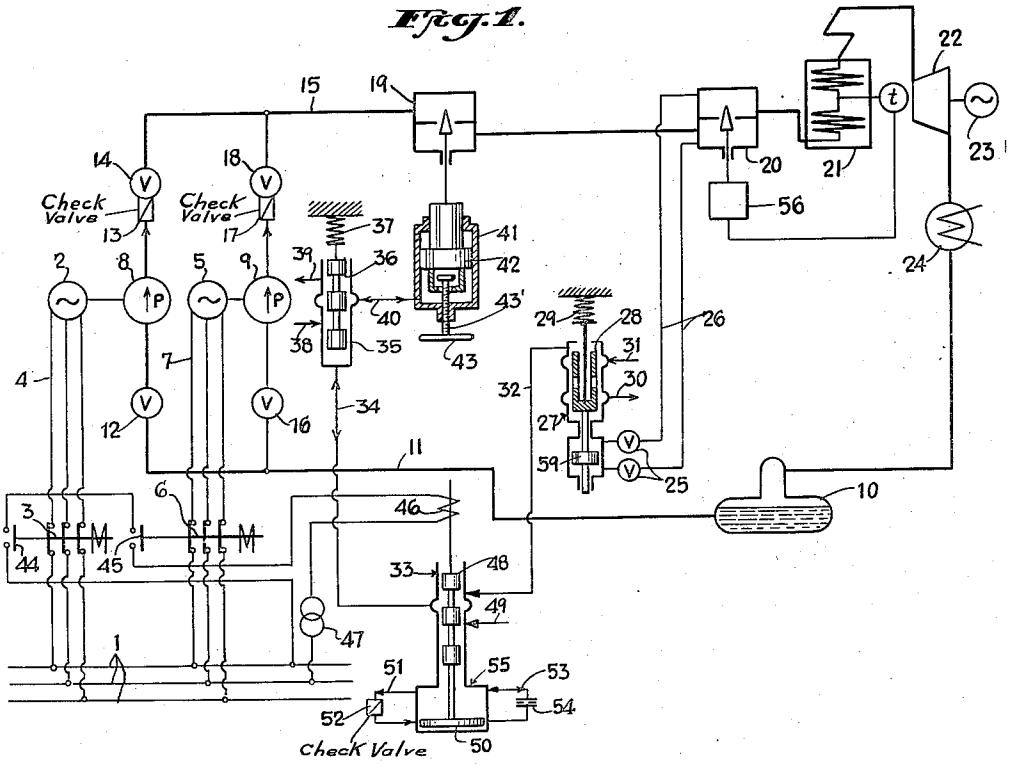
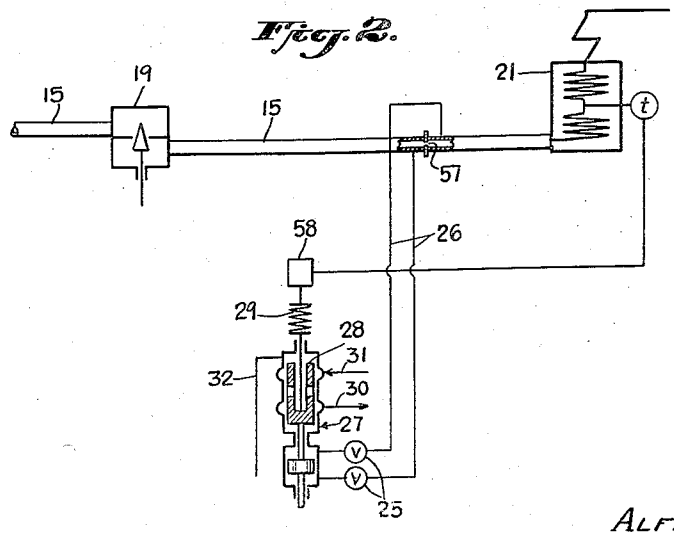


Fig. 2.



INVENTOR.
ALFRED BURI.
BY
K. B. Mayer
ATTORNEY.

United States Patent Office

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FEED WATER SUPPLY SYSTEM FOR STEAM GENERATORS

Alfred Buri, Winterthur, Switzerland, assignor to Sulzer Freres, Societe Anonyme, Winterthur, Switzerland, a corporation of Switzerland

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The present invention relates to a feed water supply system for steam generators having one or more centrifugal pumps.

Particularly large centrifugal pumps must not be made to pump immediately upon starting because otherwise the machine driving the pump or the pump itself would be overloaded. Usually, only one valve is provided downstream of the feed pump for controlling the flow of liquid to the steam generator. This valve is usually so controlled that it opens, if there is a deficiency of liquid in the steam generator. Therefore, the valve is fully opened when the pump is disconnected and supplies no liquid because of the absence of liquid downstream of the valve. At the moment the pump is started, it would have to furnish the full amount of liquid and would be damaged. It must also be considered that the pump must not run idle after it has been accelerated to normal speed because in this case the pump would be overheated.

For the above reasons, the valve which is downstream of the feed pump must be closed by hand prior to starting the pump and maintained closed. The valve is set by hand for normal control after the pump has reached normal speed, i.e. after a period of time which depends, for example, on the speed characteristic of the asynchronous motor driving the unloaded pump. These manual operations cannot be effected as correctly as it is necessary, particularly in large pumping plants. Hand adjustment of the feed valves is not possible in connection with automatically started and stopped pumps because manual operation takes too long and may easily be omitted by inadvertence.

It is an object of the present invention to provide a feed water supply system which avoids the aforementioned disadvantages by arranging a valve downstream of the pump or pumps and by provding a control mechanism for this valve which closes the valve upon stopping of all pumps and which opens the valve upon starting of one of the pumps, the opening being delayed or retarded relatively to the starting of the pump. In this way the pumps are protected, independently of the position of other valves provided in the pipe system supplied by the pumps, against overloading at the starting moment and against overheating after they have attained full speed. With the system according to the invention, the pumps can be quickly and fully automatically started or the pumping operation may be changed over from one pump to another pump.

Since, normally, a valve for controlling the amount of feed water supplied to the steam generator must be inserted in the pipe line between the pumps and the steam generator, it is of advantage to supplementally control the valve as set forth in the paragraph next above by means of a regulating mechanism which is responsive to the pressure difference at the inlet and outlet of a device for measuring the amount of liquid flowing through the feed water conduit downstream of the valve, when at least one of the feed pumps is in operation. In this manner, the pumps can be protected and the amount of feed water can be controlled without an additional control element. The device for measuring the amount of liquid flowing in the feed conduit may be in the form of an orifice plate. In many cases, however, it is of advantage to provide a quantity measuring device in the form of a second regulated valve, whereby the pressure drop in this second valve is maintained constant by the aforementioned regulating mechanism and by the first valve. This is the conventional arrangement of a differential pressure regulating valve and of a feed valve in series, the feed valve being usually controlled by the conditions of the steam generator at a point which is located downstream of a primary heating surface, the differential pressure control valve serving also for protecting the pumps. In an embodiment of the invention in which the first valve arranged downstream of the pumps is controlled by liquid pressure, the control device may be in the form of an electromagnetically actuated slide valve inserted in a regulating fluid circuit. If the centrifugal pumps are driven by electric motors, it is recommended to use an actuating device which operates the control device according to the position of the switches of the electric motors.

The novel features which are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself however and additional objects and advantages thereof will best be understood from the following description of embodiments thereof when read in conjunction with the accompanying drawing, in which

Fig. 1 is a diagram illustrating a system according to the invention;

Fig. 2 is a diagram of a modified part of the system shown in Fig. 1.

The same numerals designate the same parts in both figures.

Referring more particularly to Fig. 1 of the drawing, numeral 1 designates an electric distributing net which furnishes power to a motor 2 through a switch 3 and conductors 4. The net 1 also furnishes power to a motor 5 through a switch 6 and conductors 7. The motor 2 drives a centrifugal pump 8, and the motor 5 drives a centrifugal pump 9. The pump 8 draws water from a feed water reservoir 10 through a conduit 11 and a valve 12 and pumps the water through a check valve 13 and a valve 14 into a feed water conduit 15. The pump 9 draws liquid through a valve 16 from the conduit 11 and from the feed water reservoir 10 and pumps the liquid through a check valve 17 and a valve 18 also into the feed water conduit 15. If necessary, more than two centrifugal feed pumps may be arranged in parallel with respect to the flow of the liquid. A differential pressure controlled valve 19 and a feed valve 20 are inserted in the conduit 15. The valve 19 is actuated in accordance with the pressure drop in the valve 20, the valve 20 being actuated in dependence on an operating condition, for example, the temperature, of the operating medium after it has passed through a primary heating surface in the steam generator 21. The superheated steam produced in the steam generator is used for operating a turbine 22 which drives an electric generator 23, the exhaust steam of the turbine 22 being condensed in a condenser 24, the condensate returning to the reservoir 10. The pressure difference of the liquid at the inlet and outlet of the valve 20 is transmitted through conduits 26 individually provided with throttling devices 25, to a differential pressure responsive control signal producing device 27 including a piston 59 which is actuated by the differential pressure at the valve 20 and by a spring 29. The piston 59 actuates a piston valve 28 connecting either a supply conduit 31 or a discharge conduit 30 of

an actuating fluid supply system with a conduit 32. The latter is connected to a control signal conduit 34 through a solenoid actuated slide valve 48. The conduit 34 terminates in the cylinder 35 of a piston actuated valve 36. If the conduits 32 and 34 are under pressure, the valve 36 is moved upward against the action of a spring 37, whereby a pressure fluid supply conduit 38 is connected with a conduit 40, if the liquid pressure in conduit 34 is greater than the pressure of the spring 37, and whereby the pressure fluid discharge conduit 39 is connected with the conduit 40, if the pressure of the spring 37 exceeds the pressure of the liquid in conduit 34. Conduit 40 is connected with the hydraulic servomotor or motor operator 41, actuating the valve 19. When the piston 42 of the servomotor moves upward, the valve 19 is closed, and when the piston 42 of the servomotor moves downward, the valve 19 is opened. By manipulation of a handwheel 43 on a threaded spindle 43', the piston 42 can be moved upward and downward and the valve 19 closed and opened by hand.

If both pumps 8 and 9 are at a standstill, the switches 3 and 6 of the motors driving the pumps are open and auxiliary switches 44 and 45 connected to the switches 3 and 6, respectively, are closed. The switches 44 and 45 are arranged in series in an electric circuit including a solenoid coil 46 which circuit receives current from the net 1 through a transformer 47. If, upon closing of both switches 44 and 45, the coil 46 is energized, a valve 48 forming part of a controlling device 33 is moved upward, disconnecting the conduits 32 and 34 and stopping transmission of signals from the signal producing means 27 to the actuating means 35, 36, 37 for the motor operator 41, 42, and connecting an actuating pressure fluid supply conduit 49 with the conduit 34, so that the valve 36 is moved upward because the chamber below the piston 42 is supplied with pressure fluid, and the valve 19 is closed. Thus, the controlling device 33 produces a signal causing closing of the valve 19 when the pumps are stopped.

The control device 33 includes a delaying or retarding device 55 which affords immediate pulling-up of the piston 48 upon switching-off of the motors 2 and 5 and energization of the coil 46, so that the pressure fluid supply conduit 49 is connected with the conduit 34. The oil in the chamber above a retarding piston 50 can easily flow through a by-pass conduit 51 and a check valve 52 into the space below the piston 50. A small portion of the oil flows through a conduit 53 and a throttle orifice 54 from the space above the piston 50 to the space below the piston 50. Conversely, the piston 48 moves only slowly downward by gravity if, due to switching-on of one of the pumps, one of the switches 44 or 45 is opened and current supply to the coil 46 is interrupted. The downward movement is retarded because the piston 50 must press the oil from the space below the piston through the conduit 53 and the throttling orifice 54 into the space above the piston 50. The check valve 52 closes the by-pass conduit 51 against flow from below the piston to above the piston. The slowing-down effect of the retarding device 55 is such that the pump can be accelerated to its normal speed before normal regulating impulses effecting complete opening of the valve 19 can be transmitted from the conduit 32 to the conduit 34, there being no pressure drop in the valve 20 when the pump is started.

Upon stopping of the pumps 8 and 9, the switches 3 and 6 of the driving motors 2 and 5 are open and the auxiliary switches 44 and 45 are closed, so that the coil 46 is energized. This causes lifting of the piston 48, affording flow of pressure fluid from the conduit 49 to the cylinder 35 and actuation of the valve 36 to supply pressure fluid from conduit 38 to the servomotor 41, 42 for closing the valve 19. The piston 48 is lifted more or less quickly depending on the flow area of the conduit 51 and the viscosity of the oil. If one of the pumps, for example the pump 8, is switched on, the auxiliary switch 44 is opened and the coil 46 is de-energized, so that the piston 48 slowly drops into its normal position. Normal control impulses can therefore be passed from the conduit 32 to the servomotor 41, causing full opening of the valve 19. This is not possible until the valve 48 has reached a sufficiently low position. If thereupon the second pump (9) is started, no additional control of the feed water conduit is needed because the check valve 17 remains closed as long as the pressure produced by the pump 8 in the conduit 15 is greater than the pressure produced by the pump 9. The latter does not produce a pressure causing opening of the check valve 17 before the pump 9 operates at full speed, so that it cannot be overloaded.

The system according to the invention is of particular advantage in cases in which changing from one of the pumps to the other pump is desired. If, for example, the pump 8 is normally used for feeding the steam generator and the pump 9 is used for emergency cases, stoppage of the pump 8 causes closing of the auxiliary switch 44; because the motor 5 is not operating at this time the switch 6 is open and the switch 45 is closed. Since now both switches 44 and 45 are closed the coil 46 is energized and the control device 33 effects closing of the valve 19. Immediately thereafter, the pump 9 would be switched on and the current supply to the coil 46 would be interrupted causing the aforedescribed delayed opening of the valve 19. Normal operation can therefore be restored quickly without damaging the pumps or the driving motors.

The feed valve 20 is controlled by a conventional servomotor 56 which is responsive to the temperature of the operating medium in the steam generator 21. Since the amount of feed water flowing through the valve 20 depends not only on the flow area of the valve but also on the pressure in the feed water supply conduit 15, a definite coordination of the temperature and of the feed water supply is possible only, if the first valve 19 which is provided for protecting the pumps, is so controlled, upon operation of at least one pump, that the pressure drop in the valve 20 is maintained constant. Although a constant pressure drop is desirable, a slight variation of the pressure drop which is unavoidable because of constructional and control limitations can be tolerated.

If during normal operation, the amount of liquid flowing through the valve 20 at a certain opening thereof becomes, for example, smaller, the pressure difference acting on the piston 59 and actuating the valve 28 also becomes smaller and the spring 29 can expand. This causes lowering of the piston 28 connecting the pressure fluid discharge conduit 30 with the conduit 32, lowering the pressure also in the conduit 34 and in the cylinder 35. The piston valve 36 will therefore be pressed downward by the spring 37 and the discharge conduit 39 will be connected with the conduit 40, so that pressure fluid flows out of the servomotor 41. Piston 42 can therefore move downward due to its own weight, increasing the opening of the valve 19. This causes an increase of the amount of feed water flowing into the valve 20, so that the desired pressure drop in this valve is restored. The valve 19 would open completely if the pumps are stopped and there is no pressure drop in the valve 20, and if no provisions were made for closing the valve 19. If the pressure difference between the inlet and the outlet of the valve 20 increases, the valve 19 moves in the closing direction.

Instead of the valve 20 an orifice plate 57 may be provided in the conduit 15 downstream of the differential pressure valve 19, as shown in Fig. 2. In that case, a conventional servomotor 58 is provided for actuating the slide valve 28 in accordance with the temperature of the operating medium in the steam generator 21, supplementally to the actuation of the valve 28 in accordance

with the pressure drop between the upstream and the downstream side of the orifice plate 57.

The diagrams Figs. 1 and 2 merely illustrate examples of embodiments of the invention. Without departing from the scope of the present invention, all control devices may be operated, for example, by electricity and the control device 33 may be an electric relay. The auxiliary electric circuit including the switches 44, 45 and the solenoid coil 46 may be replaced by a hydraulic system for actuating the piston valve 48. It is immaterial for the invention whether the pumps are driven by electric motors or by turbines. The devices which are responsive to the operation of the pumps may be actuated, for example, by a transmission, particularly by a hydraulic transmission interposed between a turbine and the pump driven thereby, instead of the actuation in accordance with the position of the main switches of the electric motors shown in Fig. 1. The hydraulic retarding device 55 may be arranged in the auxiliary electric circuit and be, for example, in the form of a retarding relay.

What is claimed is:

1. A steam generating apparatus including a steam generator, a feedwater supply system comprising at least one centrifugal pump, starting and stopping means operatively connected to said pump for starting and operating said pump and for stopping said pump, the latter having an outlet, a feedwater conduit connecting said outlet and said steam generator, a valve in said feedwater conduit, a motor operator connected to said valve for opening and closing said valve, and control means connected to said motor operator for controlling operation of the latter, said control means including a control signal producing means connected to said feedwater conduit downstream of said valve for producing a control signal corresponding to the rate of flow of the feedwater to the steam generator, and control signal transmitting means operatively connected to said control signal producing means and to said motor operator and including controlling means operatively connected to said starting and stopping means for actuation thereby for transmitting said produced control signal to said motor operator when starting and during operation of the pump and for stopping transmission of said produced control signal to said motor operator upon stopping of said pump, said controlling means including means for producing a control signal and for transmitting said last mentioned control signal to said motor operator for closing said valve upon actuation of said controlling means by said starting and stopping means when the pump is stopped, said controlling means including means for retarding actuation of the controlling means upon starting of the pump, and means for rendering said retarding means ineffective upon stopping of the pump.

2. A steam generating apparatus as defined in claim 1 wherein said control signal producing means includes a feed valve, and means connected to said feed valve and responsive to the pressure difference between the pressure of the feedwater upstream and downstream of said feed valve for producing the control signal corresponding to the rate of flow of feedwater to the steam generator.

3. A steam generating apparatus as defined in claim 1 wherein said control signal producing means includes an orifice plate, and means connected to said feedwater conduit upstream and downstream of said orifice plate and responsive to the pressure difference between the pressure of the feedwater upstream and downstream of said orifice plate for producing the control signal corresponding to the rate of flow of feedwater to the steam generator.

4. A steam generating apparatus according to claim 3 including means responsive to the temperature of the operating medium in the steam generator and operatively connected to said control signal producing means for modifying the energy of the signal produced by said control signal producing means according to said temperature whereby the energy of the signal produced by said control signal producing means is increased for closing said valve upon a decrease of the temperature and vice versa.

5. A steam generating apparatus including a steam generator, a feedwater supply system comprising at least one centrifugal pump having an outlet, a feedwater conduit connecting said outlet and said steam generator, a valve in said feedwater conduit, a motor operator connected to said valve for opening and closing said valve, control signal responsive actuating means connected to said motor operator for actuating the latter, control signal producing means connected to said feedwater conduit downstream of said valve for producing a control signal corresponding to the rate of flow of the feedwater to said steam generator, controlling means, a first control signal conduit interconnecting said control signal producing means and said controlling means, a second control signal conduit interconnecting said controlling means and said actuating means, and starting and stopping means operatively connected to said pump for starting and stopping said pump, said controlling means being operatively connected to said starting and stopping means for actuation thereby and including means for connecting said signal conduits to pass the control signal from said signal producing means to said actuating means upon starting and during operation of said pump to move said valve in closing direction upon an increase of the rate of flow of the feedwater and vice versa, and for disconnecting said signal conduits to stop passage of the control signal from said signal producing means to said actuating means upon stopping of said pump, said controlling means including supplemental control signal producing means for producing, upon stopping of said pump, a control signal and passing the latter through said second signal conduit to said actuating means for closing said valve, said controlling means including retarding means for retarding actuation of said controlling means upon starting of the pump, and means rendering said retarding means ineffective upon stopping of the pump.

6. A steam generating plant as defined in claim 5 wherein said controlling means includes valve means, a solenoid having an armature connected to said last mentioned valve means for actuating the latter, said solenoid being operatively connected to said starting and stopping means for energization upon stopping of said pump and for deenergization upon starting of said pump, said valve means having a first portion for connecting said control signal conduits upon deenergization of said solenoid and for disconnecting said signal conduits upon energization of said solenoid, said supplemental control signal producing means including a signal fluid supply conduit, said valve means having a second portion for connecting said signal fluid supply conduit to said second control signal conduit upon energization of said solenoid.

7. A steam generating apparatus including a steam generator, a feedwater supply system comprising a feedwater conduit connected to said steam generator, two centrifugal pumps connected to said feedwater conduit for pumping feedwater thereinto, a valve in said feedwater conduit, a motor operator connected to said valve for opening and closing said valve, control signal responsive actuating means connected to said motor operator for actuating the latter, control signal producing means connected to said feedwater conduit downstream of said valve for producing a control signal corresponding to the rate of flow of the feedwater to said steam generator, controlling means, a first control signal conduit interconnecting said control signal producing means and said controlling means, a second control signal conduit interconnecting said controlling means and said actuating means, and starting and stopping means operatively connected to each of said pumps, said controlling means being operatively connected to said starting and stopping means for actuation thereby in one operating sense upon

starting of at least one of said pumps and in the opposite sense upon stopping of both pumps, said controlling means including means for connecting said signal conduits to pass the control signal from said signal producing means to said actuating means upon starting and during operation of at least one of said pumps to move said valve in closing direction upon an increase of the rate of flow of the feedwater and vice versa, and for disconnecting said signal conduits to stop passage of the control signal from said signal producing means to said actuating means upon stopping of both pumps, said controlling means including supplemental control signal producing means for producing upon stopping of both pumps, a control signal and passing the latter through said second signal conduit to said actuating means for closing said valve,

said controlling means including retarding means for retarding actuation of said controlling means upon starting of at least one of said pumps, and means rendering said retarding means ineffective upon stopping of both pumps.

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