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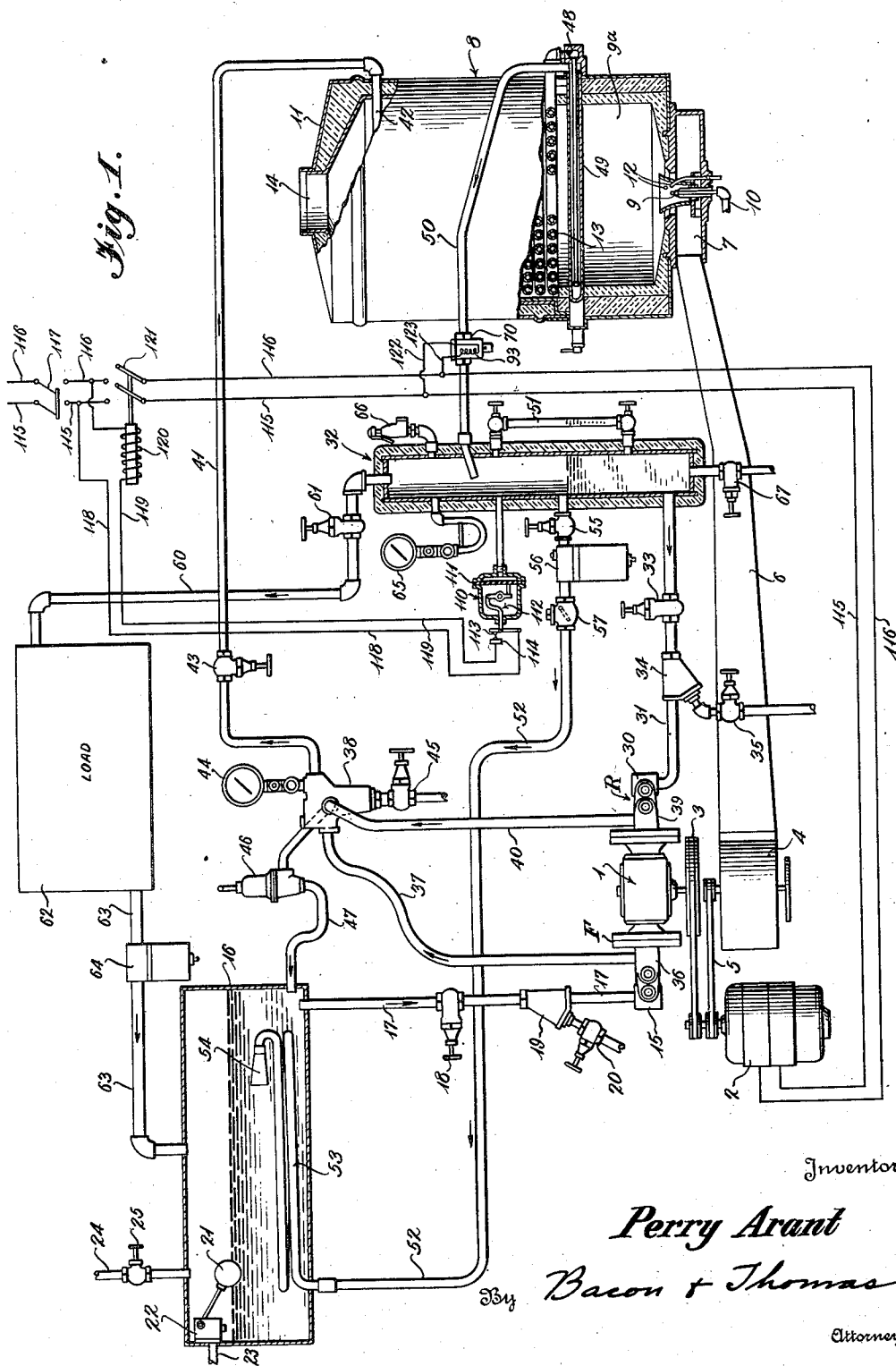
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ANTISURGE MEANS FOR STEAM GENERATING APPARATUS

Filed Dec. 6, 1943

2 Sheets-Sheet 1



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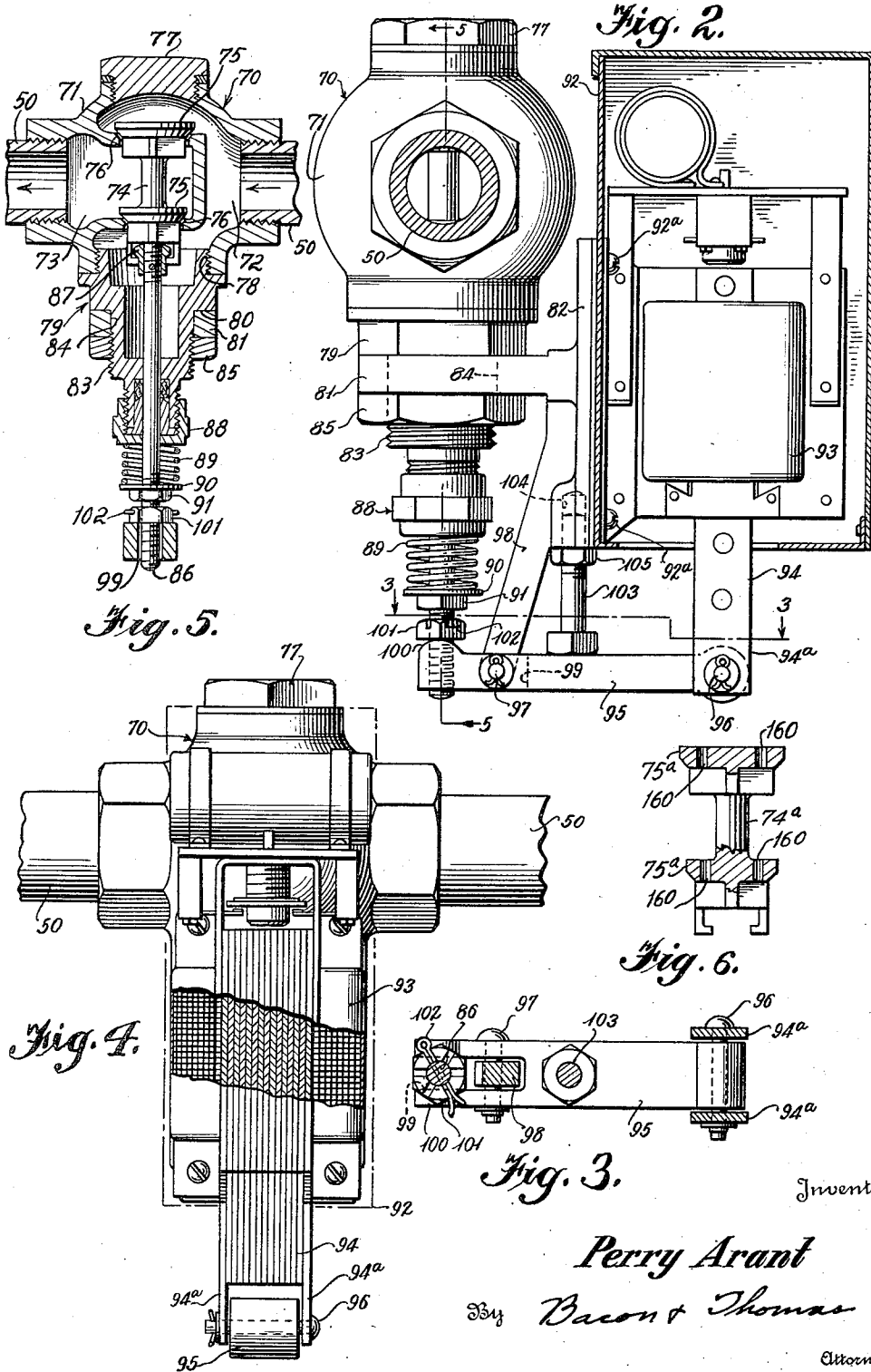
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2 Sheets-Sheet 2



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ANTISURGE MEANS FOR STEAM
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1

The present invention relates to intermittently operated steam generating apparatus of the type comprising a heating coil and a steam separator, and in particular to means for preventing surging between the heating coil and steam separator during the intervals when the steam generating apparatus is shut down or idling.

In steam generating apparatus of the general type referred to, often, after the burner has been cut off, sufficient radiant heat is given up by the walls of the firebox to cause a portion of the liquid in the lower end of the heating coil to evaporate. Such evaporation produces steam bubbles or slugs of steam which expand and cause liquid and/or vapor to be discharged from the lower end of the heating coil into the steam separator in a surging manner. In the majority of installations, such surges or pulsations are not objectionable, but in certain cases it is highly desirable to completely eliminate all surging.

One way of overcoming the aforementioned surging comprises the installation of an automatically operating bleeder valve in the line between the heating coil and the steam separator, the valve being arranged so that it does not fully close but remains open to a predetermined extent, or else closes fully but allows limited flow through suitable ports, when the pump means supplying liquid to the heating coil is shut down. In one form of the invention, the automatic valve is an electrically operated solenoid valve connected in circuit with the motor that drives the pump.

A further embodiment of the invention for overcoming the aforementioned surging comprises the use of two pumps, one of which continues to operate and circulate the liquid through the steam separator and heating coil so that no opportunity is afforded for the radiant heat to evaporate the liquid in the lower portion of the coil and cause it to surge over into the separator.

Accordingly, the principal object of the invention is to eliminate surging in steam generating apparatus between a heating coil (or equivalent means) and a steam separator connected with said heating coil (or equivalent means).

Another object of the invention is to provide automatic means for restricting communication between a steam generating unit and a steam separator to avoid surging during the inactive intervals of said steam generating unit.

A further object of the invention is to provide, in intermittently operated steam generating apparatus, anti-surge means which automatically

2

becomes effective when the operation of the feed pump is discontinued.

Other objects of the invention will be apparent from the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 diagrammatically illustrates one form of the invention including a solenoid valve for preventing surging between the heating coil and the steam separator;

Fig. 2 is an enlarged elevational view, partly in section, of the solenoid valve shown in Fig. 1;

Fig. 3 is a horizontal sectional view taken on the line 3-3 of Fig. 2;

Fig. 4 is a rear end view, partly in section, of the solenoid valve shown in Fig. 2;

Fig. 5 is a vertical sectional view through the valve taken on the line 5-5 of Fig. 2; and

Fig. 6 is a view of a bleeder valve element which will permit the valve of Fig. 5 to completely close and still avoid surging.

Referring now to Fig. 1 of the drawings, the numeral 1 generally indicates a combined pump means including a feed water supply pump F and a recirculating pump R. The pump means 1 is driven by a motor 2 through a belt 3. The motor 2 also drives a blower 4 through a belt 5. The blower 4 is connected by a suitable conduit 6 with an air inlet chamber 7 of a steam generating unit generally indicated by the numeral 8. The steam generating unit comprises a suitable burner nozzle 9 to which fuel is supplied through a conduit 10. Fuel from the nozzle 9 is sprayed into a firebox 9^a contained within a housing 11 and is ignited by suitable electrodes 12. The housing 11 contains a heating coil 13 of the pancake type through which the liquid to be heated is circulated. A flue 14 is provided at the upper end of the housing 11 for the escape of the products of combustion.

The feed pump F includes an intake feed manifold 15 the details of which need not be shown herein inasmuch as the pump means per se is not a part of the present invention. The inlet manifold 15 is connected to a feed water tank 16 by a pipe line 17. The pipe line 17 has a manually operable shut-off valve 18 connected therein and a strainer 19 associated with a strainer blow-down valve 20. A predetermined minimum water level is maintained in the feed water tank 16 by a float mechanism 21 operatively associated with a float-controlled valve 22 and a water supply pipe 23. The feed water tank 16 is vented to the atmosphere by a pipe 24 having a shut-off valve 25 connected therein. The recirculating pump R of the pump means

3

1 includes an intake recirculating manifold 30 similar to the manifold 15. The manifold 30 is connected by a pipe 31 with the lower end of a steam separator generally identified by the numeral 32. A manually controlled valve 33 in the line serves to cut off communication between the steam separator 32 and the recirculating pump R. A strainer 34 is connected in the pipe line 31 and serves to prevent the passage of any foreign matter from the steam separator 32 through the pipe 31 into the inlet manifold 30. A strainer cleanout valve 35 is connected with the strainer 34 as shown.

The feed pump F includes an outlet feed manifold 36 which is connected by a pipe 37 to a mixing device 38. The recirculating pump R includes an outlet recirculating manifold 39 which is connected by a pipe 40 with the mixing chamber 38. The mixing chamber 38 is, in turn, connected by a pipe 41 to the inlet end 42 of the heating coil 13. A manually controlled shut-off valve 43 connected in the pipeline 41 controls the flow of liquid to the heating coil 13. Hence, it will be clear that feed water supplied through the pipe 37 and recirculating water supplied through the pipe 40 are brought together in the mixing chamber 38 and then delivered to the heating coil 13 through the pipe 41. A pressure gauge 44 indicates the pressure in the mixing chamber 38 and, hence, in the line 41 going to the heating coil 13. A valve 45 is connected with the mixing chamber 38 for effecting blowing down of the heating coil 13. A pressure relief valve 46 is interposed in a pipe line 47 connecting the mixing chamber 38 with the feed water tank 16. The pressure relief valve 46 serves as a safety valve for the pump means 1 and is adapted to open to relieve any excess pressure in the chamber 38 by passing liquid directly to the feed water tank 16.

The outlet end 48 of the heating coil 13 is connected to a thermostat fuel control device 49, which per se forms no part of the present invention, and said device is connected by a pipe 50 with the steam separator 32, so that the heating coil discharges through said pipe into the upper portion of said steam separator. Any of the liquid not flashed into vapor in the steam separator 32 collects in the bottom thereof, and the level of said liquid is indicated by a gauge glass 51.

In order to prevent the liquid level in the steam separator 32 from rising above a predetermined height, one end of a pipe 52 is connected to said separator at a level corresponding to the maximum desired liquid level, and the other end of said pipe is connected with a heat transfer coil 53 in the feed water tank 16. The coil 53 terminates in an ejector 54 which serves to agitate the water in said tank while it is being heated. The pipe 52 has a manually operable shut-off valve 55 connected therein at a point adjacent the steam separator 32 and on the inlet side of a conventional steam trap 56. A one-way check valve 57 is connected in the pipe 52 between the steam trap 56 and the feed water tank 16. The check valve 57 is installed to allow flow in the pipe 52 only in a direction away from the steam trap 56.

Steam is taken from the upper end of the steam separator 32 through a pipe line 60 containing a manually operable shut-off valve 61. The pipe line 60 is connected with a load diagrammatically indicated at 62. A condensate pipe 63 conducts condensate from the load 62

4

to the feed water tank 16. A conventional steam trap 64 is connected in the line 63 to prevent the return of any substantial quantities of steam from the load 62 to the feed water tank 16. The steam separator 32 is also provided with a pressure gauge 65, a safety valve 66 and a blow-off or drain valve 67.

An electromagnetically operated valve 70 is connected in the line 50 between the outlet end 48 of the heating coil 13 and the steam separator 32. The valve 70 is shown in detail in Figs. 2 to 5, inclusive, to which reference will now be made.

As will be apparent from Fig. 5, the valve 70 comprises a body 71 having an inlet chamber 72 and an outlet chamber 73. The flow of fluid between the chambers 72 and 73 is controlled by a movable valve element 74, of the double poppet type. The element 74 includes spaced heads 75 adapted to cooperate with seating surfaces 76 to restrict the flow through the valve 70. One of the features of the valve 70, which is attained by structure which will be described more fully hereinafter, is that the element 74 is limited in its closing movement to prevent complete closure of the valve in order to provide communication at all times between the heating coil 13 and the steam separator 32. Hence, the head portions 75 are not intended to seat and form a seal with the heating surfaces 76 as they would normally do.

The valve body 70 is provided with a threaded opening in which a plug 77 is inserted after the valve element 74 has been passed there-through. A threaded opening 78 in the body 70 is aligned with the plug 77 and a cap member 79 is threaded into said opening. The cap member 79 is externally shouldered at 80 and said shoulder is adapted to seat upon a horizontal flange 81 (Fig. 2) projecting from a bracket 82. The cap 79 includes a threaded portion 83 which projects through an opening 84 in the flange 81 and a lock nut 85 threaded onto the portion 83 and jammed against the underside of the flange 81 serves to mount the valve 70 upon the bracket 82. A valve stem 86 projects through the cap 79 and has its upper end provided with a flanged sleeve 87 which provides a detachable connection between said stem and the valve element 74. A fluid-tight seal is maintained around the valve stem 86 by a stuffing box structure generally indicated by the numeral 88 associated with the cap 79. A spring 89 surrounds the stem 86 and one end thereof engages said stuffing box and its opposite end engages a washer 90. A nut 91 is threaded upon the stem 86 and engages the washer 90. The nut 91 is adjustable on the stem 86 to vary the tension of the spring 89 urging the valve element 74 toward closed position.

The bracket 82 previously referred to is secured to a casing 92 (Fig. 2) by screws 92^a. The casing 92 houses a conventional electromagnet 93 having a movable armature or core 94. The core 94 has depending arms 94^a to which a lever 95 is pivotally connected at one end by a pin 96. The lever 95 is fulcrumed intermediate its length upon a pin 97 carried by an arm 98 depending from the bracket 82. The free end of the lever 95 is provided with a slot 99 adapted to receive the lower end of the valve stem 86. The slotted end of the lever 95 is provided with curved bosses 100 engaged with the lower side of an adjusting nut 101 carried by the valve stem 86 and held against rotation by the cotter pin 102. A stop member

103 (Fig. 2) in the form of a bolt is threaded into an opening 104 in the bracket 82 and the head thereof is engaged by the lever 95 at a point intermediate the pins 96 and 97. A lock nut 105 maintains the stop 103 in any desired position of adjustment.

The electromagnet 93 is arranged so that when it is energized the core 94 is forced downwardly causing the lever 95 to fulcrum about the pin 97 and effect an upward movement of the valve stem 86 and the element 74 through the engagement of the curved bosses 100 with the nut 101. Upward movement of the element 74, of course, opens the valve 70 to its wide open position. On the other hand, when the electromagnet 93 is deenergized, the spring 89 will move the valve stem 86 downwardly and tend to close the valve, but by suitably adjusting the stop member 103 it is possible to limit the extent of closing of the valve to any degree desired. Normally the stop 103 is so adjusted that it will prevent the spring 89 from completely closing the valve 70. The object of this arrangement is to restrict communication between the heating coil 13 and the steam separator 32, to prevent surging as will be explained hereinafter.

The electromagnetically operated valve 70 is connected in a circuit in parallel with a conventional pressure-responsive switch, generally indicated by the numeral 110 (Fig. 1), for automatically controlling the motor 2 which drives the pump means 1 and the blower 4. The pressure-responsive switch 110 includes a diaphragm 111 and a linkage 112 for separating contacts 113 and 114 of said switch when a given steam pressure is attained in the steam separator 32. The details of the pressure-responsive switch are unimportant inasmuch as any suitable or conventional pressure-responsive switch can be used.

Current for operating the motor 2 is supplied through lines 115 and 116 connected with a manually operable switch 117. When the switch 117 is closed, a lead 118 connects the line 115 with the contact 113 and a lead 119, including a relay coil 120, connects the line 116 with the other contact 114 of the switch 110. The relay coil 120 controls a switch 121 arranged in the circuit between the electromagnetically operated valve 70 and the manually operated switch 117. The electromagnet 93 of the valve 70 is connected to the line 115 by a lead 122 and to the line 116 by a lead 123. It will, therefore, be apparent that the electromagnet 93 and the motor 2 are connected in the circuit in parallel.

Normally, the contacts 113 and 114 of the pressure switch 110 are closed and when the manually operated switch 117 is closed the relay 120 will be energized, closing the switch 121 so that the electromagnetically operated valve 70 and the motor 2 simultaneously receive operating current. As a result, the motor 2 starts to drive the pump means 1 and the blower 4, and the valve 70 opens wide. However, the pressure-responsive switch 110 is arranged so that when a predetermined steam pressure is developed in the steam separator 32 it can interrupt the flow of current to the motor 2 and effect incomplete closing of the valve 70 through the lines 115 and 116 by deenergizing the relay 120, thereby opening the switch 121, not withstanding the fact that the manually operated switch 117 is closed.

When the steam generating unit 8 is shut down manually by opening the switch 117, or as a result of the automatic operation of the pressure-responsive switch 110, the solenoid operated valve 70

will tend to close simultaneously with the stopping of the motor 2, inasmuch as they are connected in parallel, as previously pointed out. The stopping of the pump means 1, of course, interrupts forced circulation of liquid through the heating coil 11. The burner 9 is automatically shut off by the thermally responsive control means 49. Usually, sufficient radiant heat remains in the firebox 9^a after the burner 9 has been shut down to cause a portion of the liquid in the lower end of the heating coil 13 to be vaporized thereby. The vapor thus formed normally tends to leave the heating coil 13 causing intermittent surging of liquid over into the steam separator 32, which is highly undesirable in certain installations. Any tendency for such surging is overcome by the present system due to the fact that the valve 70 is permitted to remain slightly open after the steam generating unit 8 has been shut down. Such slight opening of the valve 70 provides a bleeding action which definitely restricts the flow of liquid and/or vapor into the steam separator 32 to such extent that all surging is eliminated. At the same time the bleeding action also prevents any possibility of a substantial amount of steam being generated and remaining in the heating coil 13, any such steam tending to pass over into the steam separator 32 because said separator is under a lower pressure than said heating coil.

The rate at which vapor and/or liquid is permitted to pass from the heating coil 13 to the steam separator 32 (when the unit 8 is shut down) is determined by the extent of opening of the valve 70, and this can be varied to suit the requirements of individual steam generating units by suitably adjusting the stop 103.

It will be understood that any excess liquid accumulating in the steam separator 32 will be removed through the steam trap 56 and returned to the feed water tank 16 through the pipe 52. It will also be understood that the circulating pump R withdraws water from the separator 32 and recirculates it through the heating coil 13.

The valve shown in Fig. 5 is, in effect, a bleeder valve because it does not completely close. It will be apparent that the results accomplished by this valve can also be achieved by a valve which does completely close, provided that the valve is constructed to permit the liquid to bleed therethrough to avoid surging when the valve is in its fully closed position. Thus, Figure 6 discloses a modified valve element 74^a, similar to the valve element 74 shown in Figure 5, except that the valve element 74^a has the head portions 75^a thereof pierced by a plurality of bleeder ports 160. It will be apparent that when a solenoid valve utilizing the element 74^a is used, in lieu of the valve 70, such valve can be completely closed and surging will be avoided by the restricted flow afforded by the ports 160. Any number of ports 160 may be employed and their size may be varied in accordance with the requirements of an individual steam generating unit. Manifestly, if the element 74^a is substituted in the valve 70 the means employed for limiting the closing movement of said valve may be dispensed with to permit engagement of the heads 75^a with the seats 76.

It will be understood that various changes may be made in the means and system disclosed herein to eliminate surging without departing from the spirit of the invention or the scope of the annexed claims.

I claim:

1. Steam generating apparatus comprising: a

7

steam generating unit including conduit means having an inlet for liquid to be heated and an outlet for said liquid; pump means for supplying liquid to said inlet; an electric motor driving said pump means; a steam separator; a pipe line connecting the outlet of said conduit means with said steam separator; an electrically operated valve connected in said pipe line, said valve being connected in a circuit in parallel with said pump-driving motor and arranged to close to a predetermined extent upon stopping of said motor to thereby restrict flow through said pipe line and thus prevent surging of liquid and/or vapor from said conduit means over into said steam separator.

2. Steam generating apparatus comprising: a steam generating unit including conduit means having an inlet for liquid to be heated and an outlet for said liquid; pump means for supplying liquid to said inlet; an electric motor driving said pump means; a steam separator; a pressure-responsive switch having its pressure-responsive portion connected with said steam separator and arranged to open upon attainment of a predetermined pressure in said steam separator; a pipe line connecting the outlet of said conduit means with said steam separator; an electrically operated valve connected in said pipe line, said valve being connected in a circuit in parallel with said pump-driving motor, said pressure-responsive switch being connected in said circuit to interrupt the flow of current to said motor and electrically-operated valve upon attainment of said predetermined pressure, and said electrically-operated valve being arranged to restrict flow through said pipe line upon said interruption of flow of current, to thus prevent surging of liquid and/or vapor from said conduit means over into said steam separator.

3. Steam generating apparatus comprising: a steam generating unit including conduit means having an inlet for liquid to be heated and an outlet for said liquid; pump means for supplying liquid

8

uid to said inlet; an electric motor driving said pump means; a steam separator; a pipe line connecting the outlet of said conduit means with said steam separator; an electrically operated valve connected in said pipe line, said valve being connected in a circuit in parallel with said pump-driving motor; a relay controlling the supply of current to said motor and electrically operated valves; a switch connected with said relay controlling the actuation thereof; and a pressure-responsive means connected to said steam separator and arranged to open said switch in response to a predetermined steam pressure in said steam separator, said relay and switch being so connected that opening of the switch causes the relay to interrupt flow of current to said valve and pump, said electrically operated valve being arranged to restrict flow through said pipe line upon interruption of the circuit to said relay and thus prevent surging of liquid and/or vapor from said conduit means over into said steam separator.

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