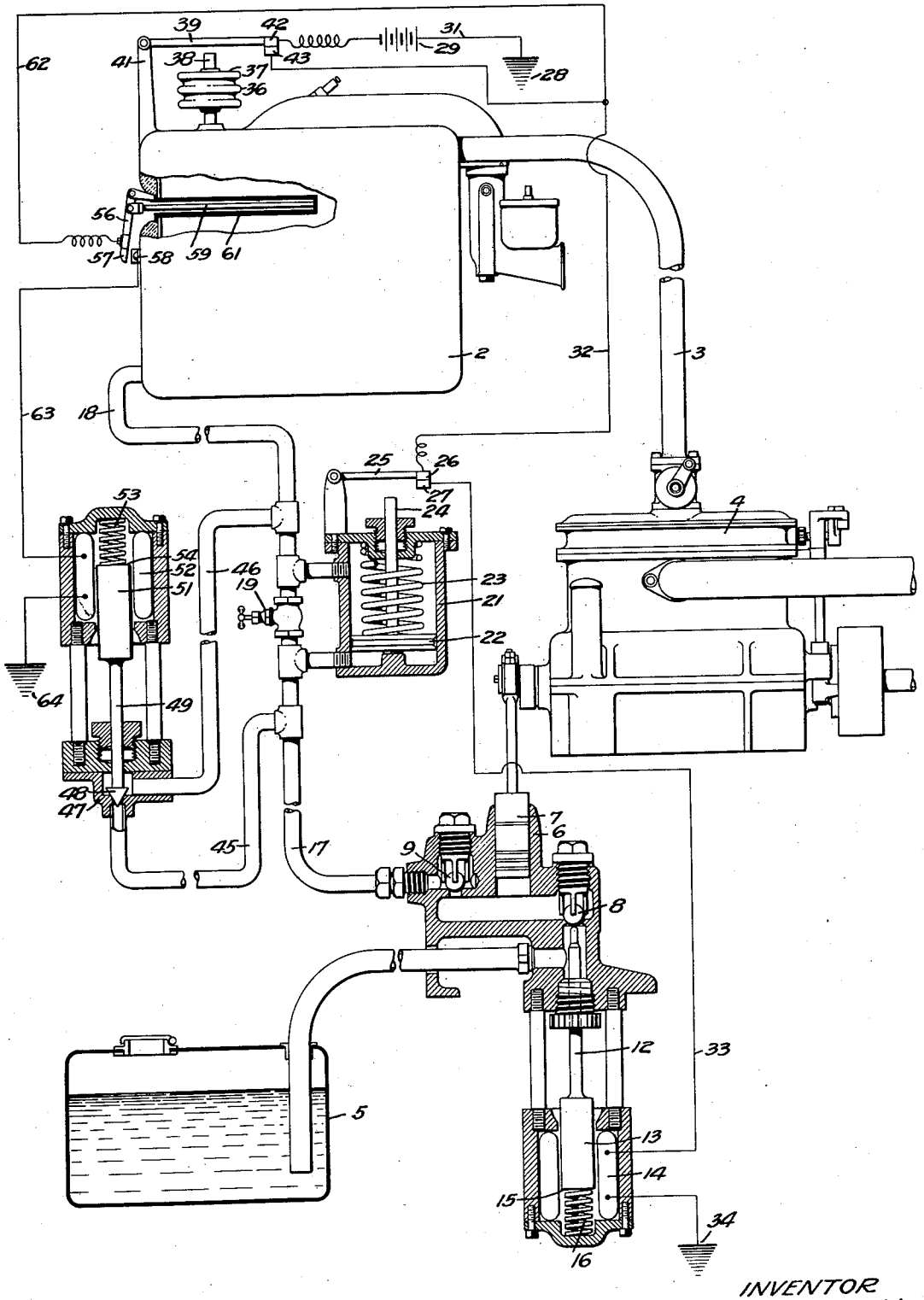
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FEED WATER REGULATING SYSTEM

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FEED-WATER-REGULATING SYSTEM.

Application filed September 29, 1924. Serial No. 740,641.

The invention relates to a system of controlling the rate at which feed water is introduced into a steam boiler by a feed water pump.

An object of the invention is to provide means for controlling the rate of flow of feed water to the boiler independent of the speed of the feed water pump.

Another object of the invention is to provide means for introducing feed water into the boiler at a substantially constant rate.

Another object of the invention is to provide means for varying the rate at which the feed water is pumped to the boiler in accordance with the temperature of the boiler.

Another object of the invention is to provide a system for controlling the amount of water introduced into the boiler in accordance with the pressure existing within the boiler.

The invention possesses other advantageous features, some of which with the foregoing, will be set forth in the following description, where I shall outline in full that form of my invention which I have selected for illustration in the drawing accompanying and forming part of the present specification. In the drawing I have shown one form of apparatus embodying my invention, but it is to be understood that I do not limit myself to such form, since the invention, as set forth in the claims, may be embodied in a plurality of forms.

The drawing is a somewhat diagrammatic representation of the system of my invention, some of the devices forming parts of the system being shown in section to more clearly illustrate their construction.

The system of my invention comprises means for controlling the introduction of feed water into a steam boiler, preferably in accordance with the conditions of temperature and pressure within the boiler. The feed water is introduced into the boiler by a pump which is preferably connected to the engine, which is driven by steam from the boiler, so that the plunger of the pump is working when the engine is in operation and means are provided for controlling the rate at which water is introduced into the boiler. These means include means controlled by the rate at which water is introduced into the boiler to maintain the rate substantially constant, means controlled by variations in temperature within the boiler for controlling the rate at which water is introduced into the boiler and means controlled by variations in pressure within the boiler for controlling the introduction of water into the boiler. To control the amount of water introduced into the boiler or the rate at which it is introduced, the pump is preferably disabled by controlling or preventing the operation of the pump inlet valve, so that reciprocation of the pump piston will not operate to pump water. The control of the rate of introduction by variations in temperature above and below a predetermined magnitude is effected by short circuiting or by-passing the rate controlling means. The system is particularly applicable to steam generating plants for use on steam automobiles, conveyances and other vehicles.

The system of my invention comprises a boiler or steam generator 2 which is supplied with heat by any suitable type of burner or heat generating apparatus, which is preferably provided with a control so that the amount of heat delivered to the boiler is controlled. Steam from the boiler is conducted through the conduit 3 to the steam engine 4, which is employed for propelling the vehicle. Water is supplied to the boiler from a supply tank 5 by the feed water pump 6, which is preferably directly connected to the steam engine, so that the pump piston 7 reciprocates continuously during the operation of the engine. The pump is provided with an inlet valve 8 and an outlet valve 9 and means are provided for disabling the pump to control the amount of water delivered thereby. The control of the quantity of water delivered by the pump to the boiler is preferably accomplished by controlling the inlet or the discharge valve of the pump and since the inlet valve operates under less pressure than the outlet valve, I prefer to control the operation of the inlet valve. This control is accomplished by providing means for unseating and holding unseated the inlet valve 8, when the discharge of water from the pump is to be interrupted. Associated with the inlet valve 8 is a rod 12 which when elevated holds the valve 8 from its seat. Secured to the rod 12 is a magnetic core 13 which is associated with a solenoid 14. The rod 12 extends through the core and solenoid and is provided on its lower end with a foot 15 which bears against

a spring 16 which normally holds the rod 12 elevated and the valve 8 unseated. When the solenoid 14 is energized, the core 13 is pulled downward, against the action of the spring 16, and is held downward as long as the solenoid is energized. When the rod 12 is moved downward, the upper end of the rod is withdrawn from contact with the inlet valve 8, so that such valve is then permitted to function normally. The circuit of the solenoid 14 is controlled by variations in pressure within the boiler and by the rate at which feed water is being introduced into the boiler, as will be set forth hereinafter.

From the feed water pump 6, the water passes to the boiler 2 through the pipes 17 and 18, between which is interposed a device such as the valve 19 having a constricted aperture or orifice. The valve, which is preferably adjustable, so that the size of the orifice may be varied, serves to control the rate at which water is introduced into the boiler. This control is accomplished by providing means for maintaining a substantially constant differential between the pressures on opposite sides of the orifice, so that the amount of water passing through the orifice is substantially constant. The rate at which water passes the orifice is determined by the differential pressure at the orifice and, by controlling this differential pressure, the rate at which water is introduced into the boiler may be controlled. When the differential pressure at the orifice increases beyond a predetermined value, means are actuated which operate to disable the pump. The pumping capacity of the pump is greater than the water demand of the boiler and the control means serves to alternately disable and enable the pump, so that the rate at which water is introduced into the boiler is controlled. During the operation of the pump, the pressure of the water pulsates, due to the reciprocation of the pump plunger. Connected to the pipes 17 and 18 at opposite sides of the valve 19 is a chamber or cylinder 21 having a movable member or piston 22 therein, which is subjected on one side to pump pressure and on the other side to the lower pressure existing on the other side of the valve 19 and the piston is urged in a direction opposite to the force applied by the pump pressure, by a spring 23. The pressure of the spring is the equivalent of the differential pressure which may be produced at opposite sides of the orifice in the valve 19 during the normal operation of the pump. The chamber 21 has sufficient volume to act as a pressure storage chamber, into and out of which water flows, as the differential pressure at the orifice varies. The spring 23 acts to maintain the differential pressure substantially constant. As the differential pressure on the movable wall increases, due to the operation of the pump, and the presence of the restricted aperture through which water must pass, a portion of the water pumped passes into the pressure chamber 21, causing a movement of the wall 22 in opposition to the pressure of the spring. Secured to the piston 22 and extending from the chamber 21, is a rod or stem 24, the upper end of which is arranged in operative relation with the arm 25 of a switch arranged in the circuit of the solenoid 14. The arm 25 carries at its end a contact 26 which cooperates with the fixed contact 27 to open and close the solenoid circuit. This circuit includes the ground 28, a source of electrical energy such as a storage battery 29, the conductors 31, 32 and 33, and the ground 34. When the differential pressure at opposite sides of the orifice in the valve 19 increases to a predetermined maximum, said maximum being the force required to compress the spring 23, the piston 22 is raised to open the switch between the contacts 26 and 27, thus opening the circuit of the solenoid 14, permitting the spring 16 to unseat and hold unseated the inlet valve 8. The water stored under pressure in the chamber 21 below the piston therein is then discharged from the chambers into the pipe 17 and passes through the orifice. Thus when the rate of introduction of feed water exceeds the predetermined maximum, the pump is rendered inoperative and as soon as the differential pressure drops below the predetermined maximum, the solenoid circuit is again closed, and the pump rendered operative. In practice, the solenoid circuit is intermittently opened and closed to control the rate at which feed water is introduced into the boiler and such control and the presence of the storage chamber 21 serves to maintain the rate at which water passes the valve substantially constant.

Means are provided for controlling the introduction of feed water into the boiler in accordance with the pressure obtaining within the boiler, so that the boiler may not be flooded with water and so that the pressure within the boiler may not become excessive. Connected to the steam space within the boiler is a pressure responsive device or pressure cell 36, which expands and contracts as the pressure of the steam within the boiler increases and decreases. The movable wall 37 of the pressure responsive device is provided with a stem or projection 38 which is associated with the switch arm 39, forming part of a switch interposed in the circuit of the solenoid 14. The switch arm 39 is pivoted on a suitable fulcrum 41 and is provided at its end with a contact 42 which is normally in contact with the fixed contact 43. When the pressure in the boiler exceeds a certain predetermined maximum, the stem 38 contacts with the arm 39 and moves said

arm to separate the contacts 42 and 43, thus opening the circuit of the solenoid 14 and disabling the inlet valve 8 of the feed water pump.

The system also contemplates the provision of means for controlling the amount of water introduced into the boiler in accordance with temperature conditions within the boiler. Connected to the pipes 17 and 18, at opposite sides of the valve 19, by the pipes 45 and 46, is a by-pass valve body 47, the flow of water through which is controlled by the valve 48. The position of the valve 48 is controlled by variations of the temperature of the steam in the boiler, to control the amount of water by-passed around the orifice in the valve 19. The valve 48 is provided with a stem 49 to which is secured a magnetic core 51, which is associated with the solenoid 52. The valve 48 is normally held to its seat by a spring 53 engaging the head 54 on the end of the stem 49, so that no water is by-passed around the valve 19. When the solenoid 52 is energized, the core 51 is lifted, unseating the valve 48 and permitting water to pass through the by-pass conduits 45 and 46. The circuit of the solenoid 52 is controlled by variations in temperature of the steam within the boiler. Arranged in the circuit of the solenoid 52 is a switch arm 56 provided at its end with a contact 57 which cooperates with a fixed contact 58 in the solenoid circuit. The switch arm 56 is connected with a suitable thermal responsive device such as a quartz rod 59 disposed within a metallic tube 61 fixed to the shell of the boiler and extending into the steam space in the boiler. As the temperature of the steam in the boiler increases, the tube 61 is elongated and the quartz rod 59 recedes and effects the closing of the switch contacts 57 and 58. The solenoid 52 is then energized and the valve 48 unseated to permit water from the pump to flow around the valve 19 to the boiler. The circuit of the solenoid 52 comprises the ground 28, source of electrical energy 29, conductor 31, switch contacts 42 and 43, conductor 62, switch contacts 57 and 58, conductor 63 and ground 64. The pressure actuated switch contacts 42 and 43 are in series with the contacts 26 and 27 of the differential pressure controlled switch and are in series with the switch contacts 57 and 58 of the temperature controlled switch, so that an increase in boiler pressure above a predetermined magnitude disables the pump and prevents the effective operation of the other devices of the system as long as the excess pressure exists.

I claim:

1. The combination with a steam boiler and a continuously driven feed water pump, of a conduit having a restricted passage therein connecting the pump to the boiler, the flow of water through the conduit producing different pressures on opposite sides of the passage and means actuated by the differential pressure for controlling the amount of water pumped independent of the speed of the pump.

2. The combination with a steam boiler and a steam engine connected thereto and to the load, of a feed water pump connected to the engine, a conduit having a restricted passage therein connecting the pump to the boiler, the flow of water through the conduit producing different pressures on opposite sides of the passage, and means actuated by the differential pressure for enabling and disabling the pump.

3. The combination with a steam engine arranged to propel a vehicle, of a steam boiler for supplying steam to said engine, a feed water pump permanently connected to said engine and driven thereby at varying speeds and means independent of the speed of the engine for controlling the rate at which water is introduced into the boiler.

4. The combination with a steam engine arranged to propel a vehicle, of a steam boiler for supplying steam to said engine, a feed water pump driven by said engine, a conduit having a restricted passage therein connecting the pump to the boiler, the flow of water through the conduit producing different pressures on opposite sides of the passage, and means actuated by the said differential pressure for controlling the rate at which water is introduced into the boiler independently of the speed of the pump.

5. The combination with a steam boiler, of a conduit having a restricted passage therein, connected to the boiler, a pump adapted to force water through the conduit, a pressure responsive device subjected to the differential pressure produced on opposite sides of the passage due to the flow of water through the conduit, a solenoid for controlling the operation of the pump, a circuit for said solenoid and a switch in said circuit arranged to be operated by said pressure responsive device.

6. The combination with a steam boiler, of a conduit having a restricted passage therein, connected to the boiler, a pump adapted to force water through the conduit, a pressure responsive device subjected to the differential pressure produced on opposite sides of the passage due to the flow of water through the conduit, means actuated by the movement of the pressure responsive device to control the operation of the pump, a second conduit connecting the pump to the boiler and means controlled by variations in temperature within the boiler for controlling the flow of water through the second conduit.

7. The combination with a steam boiler, of a conduit having a restricted passage

therein, connected to the boiler, a pump adapted to force water through the conduit, a pressure responsive device subjected to the differential pressure produced on opposite sides of the passage due to the flow of water through the conduit, means actuated by the movement of the pressure responsive device to control the operation of the pump, a second conduit connecting the pump to the boiler, and means controlled by variations in pressure and temperature within the boiler for controlling the flow of water through the second conduit.

8. The combination with a steam boiler, of a conduit, having a restricted passage therein, connected to the boiler, a pump adapted to force water through the conduit, a pressure responsive device subjected to the differential pressure produced on opposite sides of the passage due to the flow of water through the conduit, means actuated by the movement of the pressure responsive device to control the pump and means actuated by variations in pressure within the boiler to control the pump.

9. The combination with a steam boiler and a feed water pump, of a conduit having a restricted passage therein connecting the pump to the boiler, the flow of water through the conduit producing different pressures on opposite sides of the passage, means actuated by said differential pressure for controlling the rate at which water is introduced into the boiler and means controlled by variations in temperature within the boiler for by-passing water around said passage.

10. The combination with a steam boiler and a feed water pump, of a conduit having a restricted passage therein connecting the pump to the boiler, the flow of water through the conduit producing different pressures on opposite sides of the passage, means actuated by said differential pressure for controlling the rate at which water is introduced into the boiler and means controlled by variations in temperature in the boiler for temporarily varying the rate at which water is introduced into the boiler.

11. The combination with a steam boiler and a feed water pump, of a conduit having a restricted passage therein connecting the pump to the boiler, the flow of water through the conduit producing different pressures on opposite sides of the passage, means actuated by said differential pressure for controlling the rate at which water is introduced into the boiler and means controlled by an increase in boiler temperature beyond a predetermined maximum for increasing the rate at which water is introduced into the boiler.

12. The combination with a steam boiler and a feed water pump, of a conduit having a restricted passage therein connecting the pump to the boiler, the flow of water through the conduit producing different pressures on opposite sides of the passage, means actuated by said differential pressure for controlling the rate at which water is introduced into the boiler, a by-pass conduit around said passage and means controlled by variations in temperature in the boiler for controlling the flow of water through the by-pass conduit.

13. The combination with a steam boiler and a power driven feed water pump of a conduit having a restricted aperture therein connecting the pump to the boiler, means for rendering the pump inoperative to pump water and means actuated by an increase in the differential pressure on opposite sides of the apertures to a predetermined magnitude, to actuate said first named means.

14. The combination with a steam boiler and an engine connected thereto, of a feed water pump driven by the engine and means for causing water to be introduced into the boiler at a substantially constant rate independent of the speed of the pump.

15. The combination with a steam boiler and a power driven feed water pump, of means for causing the water to be introduced into the boiler at a substantially constant rate independent of the speed of the pump

16. The combination with a steam boiler and a power driven feed water pump, of means for causing the water to be introduced into the boiler at a substantially constant rate independent of boiler pressure and independent of the speed of the pump.

17. The combination with a steam boiler and an engine connected thereto, of a feed water pump permanently connected to the engine and means independent of the speed of the engine for causing the water to be introduced into the boiler at a substantially constant rate.

18. The combination with a steam boiler and a feed water pump, of a conduit having a restricted passage therein connecting the pump to the boiler, a spring loaded movable member subjected on one side to pump pressure and on the spring loaded side to the pressure on the discharge side of the passage and means actuated by the movement of said member for controlling the pump.

19. The combination with a steam boiler and a continuously driven feed water pump of a conduit having a restricted aperture therein, a spring loaded movable element subjected on one side to pump pressure and on the spring loaded side to the pressure on the discharge side of the aperture and means actuated by the movement of said member for enabling and disabling the pump.

20. The combination with a steam boiler and a feed water pump, of a connecting conduit, a pressure responsive device sensitive to the drop in pressure in the conduit caused

by the flow of water therethrough, connected to the conduit, means actuated by the pressure responsive device for controlling the operation of the pump and means actuated by variations in pressure in the boiler above and below a predetermined pressure, for controlling the operation of the pump.

21. The combination with a steam boiler and a feed water pump connected thereto, of a casing through which water is pumped to the boiler, said casing being provided with a restricted passage whereby different pressures are produced at opposite sides of the passage, a spring loaded movable element subjected on opposite sides to said respective pressures and means actuated by the movement of said element for controlling the pump.

22. The combination with a steam boiler and a feed water pump connected thereto, of a casing through which the water is pumped to the boiler, said casing being provided with a restricted passage whereby different pressures are produced at opposite sides of the passage, a spring loaded movable element subjected on opposite sides to said respective pressures, means for disabling the pump and means operative by the movement of said element due to an increase in the differential pressure on said element for actuating said disabling means.

23. The combination with a steam boiler and a feed water pump connected thereto, of a casing through which the water is pumped to the boiler, said casing being provided with a restricted aperture, a by-pass conduit around said aperture and means controlled by variations in the temperature of the steam in the boiler for controlling the passage of water through said by-pass conduit.

24. The combination with a steam boiler and a feed water pump connected thereto, of a casing through which the water is pumped to the boiler, said casing being provided with a restricted aperture, a by-pass conduit around said aperture and means operative by an increase in boiler steam temperature to a predetermined magnitude to open said by-pass conduit.

25. The combination with a steam boiler and a feed water pump, of a conduit through which the water is pumped to the boiler, said conduit being provided with a restricted aperture to control the flow of water through the conduit, a by-pass conduit around said aperture and means actuated by variations in boiler steam temperature for controlling the passage of water through said by-pass conduit.

26. The combination with a steam boiler and a feed water pump, of a conduit through which the water is pumped to the boiler, said conduit being provided with a restricted aperture to control the flow of water through the conduit, a normally closed by-pass conduit around said aperture and means actuated by an increase of boiler steam temperature to a predetermined magnitude to open said by-pass conduit.

27. The combination of a steam boiler and a feed water pump, of a conduit through which the water is pumped to the boiler, said conduit being provided with a restricted aperture to control the flow of water through the conduit, a by-pass conduit around said aperture, a valve controlling the flow of water through the by-pass conduit and means actuated by variations in the temperature of the boiler steam for actuating said valve.

28. The combination with a steam boiler and a feed water pump, of a conduit through which the water is pumped to the boiler, said conduit being provided with a restricted aperture to control the flow of water through the conduit, a by-pass conduit around said aperture, a normally closed valve in said conduit and means actuated by a rise of boiler steam temperature to a predetermined magnitude to open said valve.

29. The combination with a steam boiler and a feed water pump, of a conduit through which the water is pumped to the boiler, said conduit being provided with a restricted aperture to control the flow of water through the conduit, a by-pass conduit around said aperture, a normally closed valve in said conduit and means actuated by a rise of boiler steam temperature to a predetermined magnitude to open said valve and by a decrease in boiler steam temperature below said magnitude to close said valve.

30. The combination with a steam boiler and a feed water pump, of a conduit through which the water is pumped to the boiler, said conduit being provided with a restricted aperture to control the flow of water through the conduit, a by-pass conduit around said aperture, a valve for controlling the flow of water through said conduit, a solenoid arranged to operate said valve, a circuit for the solenoid and means actuated by variations in boiler steam temperature above and below a predetermined magnitude for controlling said circuit.

31. The combination with a steam boiler, a steam engine connected thereto and a feed water pump driven by the steam engine, of a conduit connecting the pump and the boiler, said conduit being provided with a restricted aperture through which the water passes means for adjusting the area of said aperture and means operated by the difference in pressure on opposite sides of the aperture for controlling said pump.

32. The combination with a steam boiler, a steam engine connected thereto and a feed water pump driven by the steam engine, of a conduit connecting the pump and the boiler, said conduit being provided with a

restricted aperture through which the water passes, means for adjusting the area of said aperture, a movable element subjected on opposite sides to the pressures produced on opposite sides of the aperture and means actuated by the movement of the element for controlling the operation of the pump.

33. The combination with a steam boiler, a steam engine connected thereto and a feed water pump driven by the steam engine, of a conduit connecting the pump and the boiler, said conduit being provided with a restricted aperture through which the water passes, means for adjusting the area of said aperture, a movable element subjected on opposite sides to the pressures produced on opposite sides of the aperture, a solenoid controlling the operation of the pump, a circuit for said solenoid and means operated by the movement of said element for controlling said circuit.

34. The combination with a steam boiler, a steam engine connected thereto and a feed water pump driven by the steam engine, of a conduit connecting the pump and the boiler, said conduit being provided with a restricted aperture through which the water passes, means for adjusting the area of said aperture, a movable element subjected on opposite sides to the pressures produced on opposite sides of the aperture, a solenoid controlling the operation of the pump, a circuit for said solenoid, means operated by the movement of said element for controlling said circuit and means operative by variations in boiler pressure for controlling said circuit.

35. The combination with a steam boiler and an engine connected thereto, of a feed water pump permanently connected to the engine, a conduit connecting the pump with the boiler, means in the conduit arranged to restrict the flow of water therethrough and means arranged to by-pass water around said restricting means, the passage of water through the by-pass being controlled by variations in temperature within the boiler.

36. The combination with a steam boiler and an engine connected thereto, of a feed water pump driven by the engine and a conduit having a restricted aperture therein connecting the pump to the boiler, means controlled by the difference in pressure on opposite sides of the aperture for controlling the rate at which water is pumped into the boiler independent of the speed of the engine, and manually adjustable means for varying the rate.

37. The combination with a conduit having a restricted passage therein through which water flows, the passage of water through said passage serving to produce different pressures on opposite sides of the passage, of a plunger pump connected to said conduit, a chamber connected to said conduit on opposite sides of the passage, and a resiliently mounted wall in said chamber subjected on opposite sides to said different pressures.

38. In an apparatus of the character described, a chamber divided into two compartments by a resilient movable partition, a fluid pump connected to one compartment, a steam boiler connected to the other compartment, a conduit having a restricted passage therein connecting the compartments and means operable by the movement of the partition for controlling the operation of the pump.

39. In an apparatus of the character described, a chamber divided into two compartments by a resiliently mounted movable partition, a fluid pump, a conduit connecting the pump to one compartment, a steam boiler, a second conduit connecting the steam boiler to the other compartment, a third conduit having a restricted passage therein connecting said first and second conduits and means controlled by the movement of said partition for controlling the rate of flow of water through said third conduit.

40. In an apparatus of the character described, a chamber divided into two compartments by a spring loaded partition, a fluid pump, a conduit connecting said pump with the compartment below the partition, a steam boiler, a conduit connecting the boiler with the compartment above the partition, a third conduit having a restricted passage therein connecting said first two conduits, said partition being movable to vary the volumetric capacity of the compartment below the partition and to disable said pump when the partition has moved a predetermined distance.

In testimony whereof, I have hereunto set my hand.

WARREN DOBLE.