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STEAM POWER PLANT

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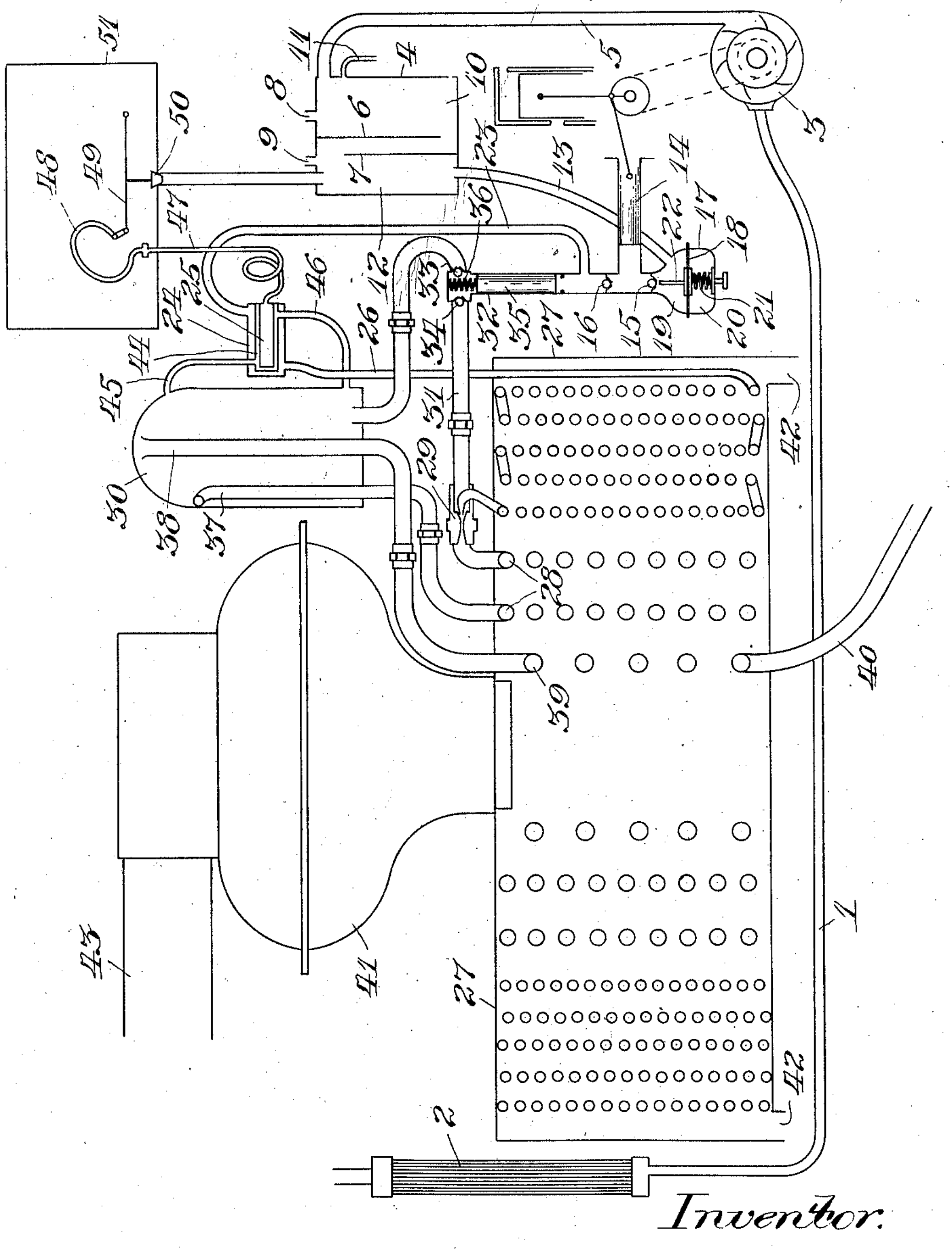

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UNITED STATES PATENT OFFICE.

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STEAM-POWER PLANT.

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My invention relates to steam power plants and particularly to an automotive steam power plant and control system. Steam propelled vehicles have long been acknowledged to be most desirable because of their ease and simplicity of control but have not gone into extensive use because of the relatively short life of the boiler and burner. The boilers heretofore used have usually failed by burning of the tubes due to failure of the water supply or by the opening of the joints between the tubes and headers caused by unequal expansion and frequent and large variations in temperature.

In the plant and control system about to be described, I have endeavored to make the boiler of such form that it cannot be injured by unequal expansion and contraction; so that no joints are subjected to the action of the hot gases, and to have a form permitting of the greatest safety, flexibility, efficiency and compactness. By using a closed system, in which water from the condenser is pumped back into the boiler as fast as steam is taken out, the water supply in the boiler cannot change rapidly. If the condenser is of ample capacity water can be lost out of the system only slowly. Water control devices on previous automotive steam power plants have had to do their work very frequently and rapidly, as the water supply in the boiler was usually rapidly depleted. It is obviously much easier to make a reliable control device if it has an infrequent light duty to perform than would be the case if its duty was severe and frequent.

In my improved automotive steam power plant, I use a boiler without headers or tube sheets but have preheater, evaporator and superheater coils or zones of fixed area. All joints and connections are out of the path of the flame from the burner so that they are not exposed to either frequent or large variations in temperature, therefore, they will not break or leak. The preheater coil discharges into the evaporator coil through an ejector, additional water being picked up from a storage drum into which the wet steam from the evaporator is discharged tangentially, the dry steam from the drum entering the superheater coil from which it is delivered to the engine. The storage drum is located above the coils and is not subjected to the heat of the fire, and is connected to the evaporator coil so that the evaporator and preheater coils will be filled with water by gravity when not otherwise filled. As soon as the burner is turned on, some steam will be generated in the evaporator and be discharged into the drum where the moisture will be separated out by centrifugal action. The dry steam will then enter the superheater coil while pressure is being built up in the system and before the superheater coil can be heated hot enough to injure it. The quantity of water (liquid and steam) in the system is substantially constant and positively circulated so that there is always liquid and steam passing through the evaporator coils. If the quantity of water in the system is sufficient to keep water in the drum, it is evident that there can be no burning of the evaporator tubes or other injury to the boiler through failure of the water supply, since the preheater and evaporator coils will receive an adequate supply of water and the superheater coil will receive steam. If then the supply of water fails for any reason as by leakage or other losses, it will be apparent by the lowering of the water level in the drum. I have, therefore, provided an auxiliary water supply or make-up water means controlled by the water level in the drum so that if the water in the drum drops below a predetermined level, more water will automatically be added to the system to restore the level. I have also provided an improved means for pumping the water to and through the boiler which is controlled by the water supply, so that the pump cannot become air bound.

In the drawings, I have illustrated one embodiment of my invention in which a pipe 1 leads from a condenser 2 to a rotary pump 3 which discharges the air and water into a hot well or skimmer 4 through a pipe 5. The hot well has two baffles 6, 7 and air vents 8, 9 opening to the atmosphere. The air entering the hot well through the pipe 5 passes out through the vent 8 while the water and oil collect in the chamber 10. The oil floating on top of the water drains off through the tube 11 while the water rises between the baffles 6, 7 and overflows the latter into the side 12 of the hot well, which is connected to the pipe 13 leading to the intake of a pump 14. The pump is located below the hot well and has intake and discharge valves 15, 16, the intake valve being controlled by the head of water in the pipe

13 and hot well. A casing 17 below the pump is divided by a diaphragm 18 into two chambers 19, 20, the lower chamber having an adjustable spring 21 bearing on the diaphragm while a push rod 22 in the other chamber is secured to the diaphragm and adapted to lift the inlet 15 from its seat. The spring 21 is adjusted so that it will raise the diaphragm and push rod to unseat the valve 15 before the water in the hot well becomes depleted to the point where there would be danger of drawing air into the pump when the water falls below a predetermined level therein. The pump will then draw in water from the pipe 13 on its intake stroke, but since the valve 16 is held seated by the pressure from the boiler and the valve 15 is held open by the push rod 22, the water will be returned to the pipe 13. This operation continues until sufficient water has accumulated in the hot well so that the pressure of the column on the diaphragm 18 forces it down against the spring 21 permitting the valve 15 to seat. The pump 14 then discharges to the boiler.

The pump 14 discharges through a pipe 23 leading to the jacket 24 of a thermostat 25 for controlling the supply of make-up water as will presently be described. The water leaves the jacket 24 through a pipe 26 leading to the outer bank of coils of the preheater. The preheater comprises the five outer banks of coils within the boiler shell or casing 27, the water entering the coldest part of the boiler and progressing through the coils toward the center or hottest part. The water from the preheater enters the outer coil of the evaporator 28 through an ejector 29 where additional water is added from the drum 30 through the pipe 31 and auxiliary pump 32. The auxiliary pump has intake and discharge valves 33 and 34 at one end while the other end is in open communication with the discharge from the pump 14. A free plunger 35 is engaged by a spring 36 at one end and at the other receives the shock from the water delivered by the pump 14. When the pump 14 is on its intake stroke, the spring 36 forces the plunger 32 downward drawing in water through the valve 33. On the discharge stroke of the pump 14, the shock of the water on the plunger 35 causes it to move upward and discharge water through the pipe 31. While I have shown both the ejector 29 and auxiliary pump 32 for supplying water from the storage drum, it will be understood that each of these devices supplements the action of the other and that in many instances one or the other will be sufficient.

The quantity of water entering the outer evaporator coil 28 is, under full load, several times as much as the fire can evaporate so that the circulation of water through this coil is always proportionate to the load. The burner is controlled by boiler pressure and when there is only a small amount of water passing through the evaporator coils there is a correspondingly light load on the boiler and the fire can only remain on a very short space of time; never under any circumstances long enough to evaporate all of the water or to produce any super-heat in these coils. The inner coil 28 has a tangential discharge 37 into the drum 30. The water is thrown out of the steam in the drum by centrifugal action, the dry steam then entering the dry steam pipe 38 in the drum and passing through the superheater coil 39 which is in the hottest part of the boiler. The superheated steam leaves the boiler through pipe 40 leading to the engine. From the engine, the steam is exhausted to the condenser 2 where it is condensed to be again circulated through the system.

Heat is supplied to the boiler by a burner 41 preferably located on the top of the boiler and discharging its hot gases downward and radially outward over the coils, the gases leaving the boiler through a downwardly discharging flue 42. Fuel and air are supplied to the burner through the conduit 43.

The thermostat 25 is of the type utilizing a liquid of high boiling point and is surrounded by a steam jacket 44 within the jacket 24 and to which two pipes 45, 46 leading to the steam and water spaces of the drum 30 are connected. The bulb of the thermostat 25 is connected by a loop 47 to one end of a Bourdon tube 48, the other end of which is connected to a lever 49 pivoted to a valve 50 controlling the supply of make-up water from the tank 51 to the hot well 4.

During normal operation, the water level in the drum 30 is high enough so that the jacket 44 is filled with water and the bulb 25 is relatively cool, but if the water level falls so that steam enters the jacket 44 through connection 45 the liquid in the bulb evaporates which increases its pressure causing the Bourdon tube to straighten and lift the valve 50 which then supplies more water to the system to restore the normal water level in the drum. As soon as the water level is restored, the bulb 25 cools off and the valve 50 closes. The boiler feed water is circulated through the jacket 24 so as to rapidly cool off the jacket 44 and bulb 25 as the water level rises in the drum.

Having thus described one form in which my invention may be embodied, what I claim as new and desire to secure by Letters Patent is:

1. In a steam power plant of the closed system type, the combination of two sets of coils the one within the other, a connection between the coils whereby the first coil discharges into the second, a drum positioned above said coils, a tangential centrifugal means in connection with said drum for dis-

charging the contents from the second coil and separating the steam from the water, means for supplying water to the first coil under pressure, a connection from the drum to the connection between the coils, and means in the connection from the drum actuated by the first mentioned means to supply water from the drum to the second coil.

2. In a steam power plant of the closed system type, the combination of two sets of coils the one within the other, a connection between the coils whereby the first coil discharges into the second, a drum positioned above said coils, a tangential centrifugal means in connection with said drum and said second coil for discharging the contents from said second coil into said drum and separating the steam from the water, means for supplying water to the first coil under pressure, and a connection from the drum to the connection between the coils.

3. In a steam power plant of the closed system type, the combination of two sets of coils the one within the other, a connection between the coils whereby the first coil discharges into the second, a drum positioned above said coils into which the second coil discharges, means for supplying water to the first coil under pressure, a connection from the drum to the connection between the coils, and means in the connection from the drum actuated by the first mentioned means to supply water from the drum to the second coil.

4. In a steam power plant of the closed system type, the combination of two sets of coils the one within the other, a connection between the coils whereby the first coil discharges into the second, an ejector in said connection, a drum into which the second coil discharges, a pump discharging water into the first coil under pressure, a connection from the drum to the connection between the coils, a second pump in the connection from the drum, and means for actuating the second pump by impulses or shocks in the discharge from the first pump.

5. In a steam power plant of the closed system type, the combination of a boiler, a main constant supply pump for supplying water to the boiler, and an auxiliary pump actuated by impulses in the discharge from the first pump to increase the circulation through the boiler.

6. In a steam power plant of the closed system type, a boiler, a main constant supply pump, a discharge connection from the pump to the boiler, a second pump having a cylinder, a plunger slidable therein, a discharge connection from the cylinder at one end of the plunger to the boiler, a connection from the cylinder at the other end of the plunger to the discharge connection from the first pump whereby the plunger will be moved in one direction by impulse or shock from the first pump, and means for moving the plunger in the opposite direction.

7. In a steam power plant of the closed system type, a boiler having a preheater, an evaporator and a superheater one within the other, a constant supply pump supplying water to the preheater, a connection from the preheater to the evaporator, an ejector in said connection, a second pump, means for delivering water from the evaporator to the second pump, means for returning the water from the second pump to the evaporator, means for operating the second pump by the discharge from the first pump, and means for delivering steam from the evaporator to the superheater.

Signed at Chicago, Illinois, this 30th day of September, 1922.

CHARLES A. FRENCH.