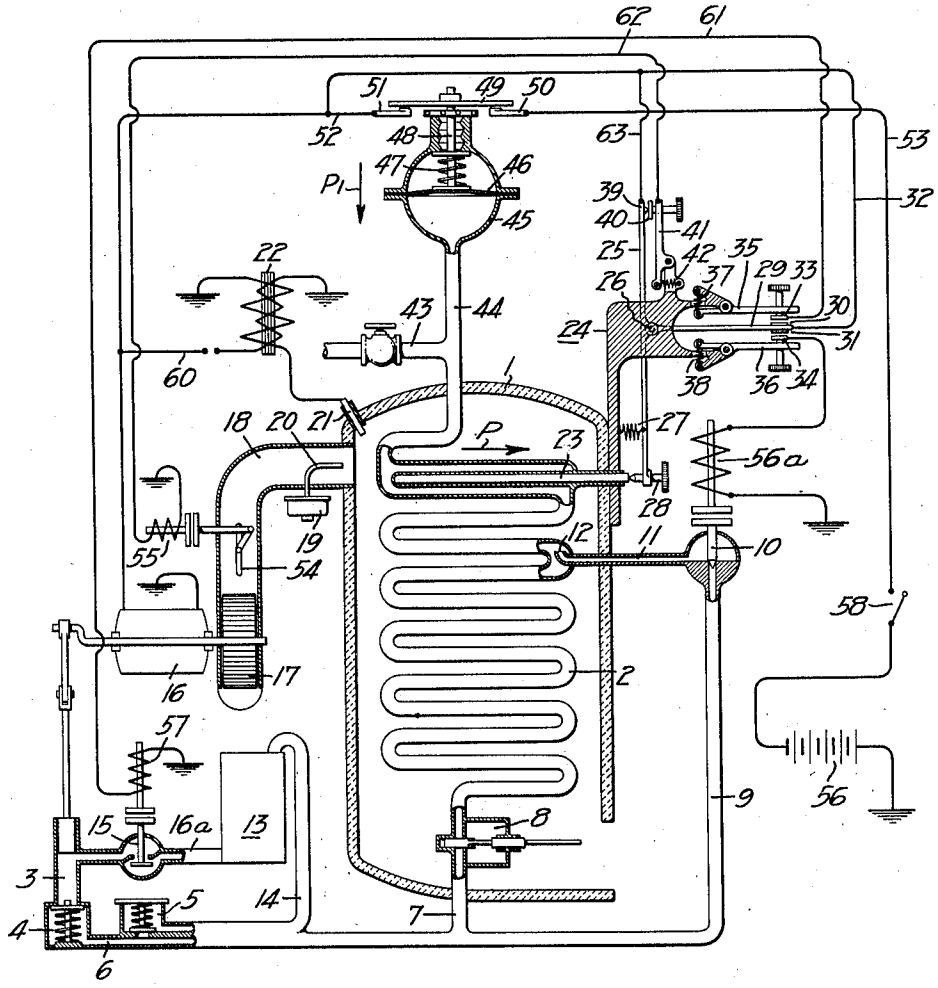
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STEAM POWER PLANT

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STEAM POWER PLANT

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The invention relates to steam power plants for general use, as in marine and stationary installations, and is especially applicable to the operation of power-driven vehicles, for example, automobiles, rail-cars and aeroplanes.

An object of the invention is to provide automatic or substantially automatic regulation of a steam power plant in order to produce steam of the desired characteristics (temperature and pressure) despite fluctuations in the consumption of steam.

According to the present invention, a water tube boiler (also called a "flash", "series tube" or "forced circulation" boiler) is used and is fitted with a thermostat and a pressure responsive device affecting electrical switches in such a way that the temperature and maximum pressure of the plant are automatically regulated by electrical action upon the elements controlling the value of the temperature and pressure.

In general, the power plant includes a pressure-operated switch which is actuated by pressures in excess of a pre-determined pressure to interrupt the supply of heat and water to the boiler, and a temperature-operated or thermostat switch which is actuated by certain predetermined temperatures in such a manner that different groups of the elements serving to regulate the temperature enter into action consecutively.

Upon an increase in temperature, the thermostat switch as a first step endeavors to reduce the temperature in the boiler by the injection of fresh or feed water into the steam space. This additional water is preferably controlled by an electrically actuated needle valve governing flow through a branch pipe leading from the main feed pipe to the boiler. In the main feed pipe at the foot of the boiler is a regulating valve adjusted so that approximately 80 to 90% of the total water supplied passes to the boiler through the main feed pipe while the remainder of the water passes through the branch pipe to the steam space or, in the event the needle valve is closed, back to the feed water source through a relief valve.

If a further increase in temperature occurs, the thermostat switch, as a second step, closes a throttle valve to shut off the air for combustion and thereby stops the aspiration of fuel consequently shutting off the fire.

When the temperature falls below a pre-determined value, the thermostat switch, as a third step, causes the supply of feed water to discontinue by influencing a solenoid operating a valve between the source of feed water and the boiler.

The drawing is a diagrammatic illustration of the invention.

The boiler comprises a casing 1 enclosing a combustion space and a continuous water tube 2. Feed water is supplied to the inlet end of the tube by a pump 3 discharging past a check valve 4 into a pipe 6 connected by a branch pipe 7 to the tube 2. A regulating valve 8, which is manually and/or automatically adjustable, is interposed in the pipe 7 to pass approximately 80 to 90% of the total amount of fresh water, to the inlet of the tube 2, while the remaining 20 or 10% of the feed water can flow through a pipe 9 to a needle valve 10 which, if open, permits the additional water to flow through the pipe 11 and outlet 12 into the steam space of the boiler tube 2.

To care for surplus water, a pressure relief valve 5 is provided on pipe 6 and opens into a return pipe 14 communicating with a feed water tank 13. An outlet pipe 16^a leads from the tank 13 through an electrically actuated valve 15 to the pump 3.

For driving the pump there is provided an electric motor 16 which also operates a blower 17. The discharge pipe 18 of the blower opens into the combustion chamber within the casing 1 and is provided at a suitable point with a carburetor 19 having a fuel nozzle 20 arranged for aspiration of the fuel therein by the air flowing through the pipe 18. The ignition of the combustible mixture so formed is by means of a spark plug 21 energized by an ignition coil 22 connected in a circuit to be hereinafter described.

Adjacent the steam space of the boiler is situated a thermostat 23 which acts in such a manner that upon a decrease in temperature of the steam a movement is initiated in the direction of the arrow P, while when the temperature rises the thermostat acts in the opposite direction. The thermostat is effective upon a thermostat switch 24 which may also be referred to as a step-by-step switch. Included in the switch 24 is a lever pivotally mounted, at 26, and having arms 25 and 29. The lever is held by a spring 27 so that an adjustment screw 28 in the lower arm of the lever is held against the thermostat 23. On the end of the arm 29 are electrical contacts 30 and 31, connected to a lead 32, while counter-contacts 33 and 34 are provided by adjustment screws mounted in levers 35 and 36 acted upon by springs 37 and 38. Similarly, on the upper end of the arm 25 is provided a contact 39 co-operating with a counter-

contact 40 on an adjusting screw mounted in a lever 41 held by a spring 42.

The outlet of the boiler tube 2 forms a steam feed pipe 43 leading to the engine. A branch 44 establishes communication between the pipe 43 and a diaphragm casing 45 within which is situated a diaphragm 46 capable of moving in accordance with the pressure prevailing within the boiler. An adjustable spring 47 presses the diaphragm in the direction of the arrow P_1 which is opposite to the boiler steam pressure. On the stem 48 of the diaphragm is mounted a bridge 49 co-operating with contacts 50 and 51 connected to leads 52 and 53 to control the flow of electrical current therethrough.

In the air duct 18 leading from the blower 17 to the fire box there is provided a throttle valve 54 actuated by a solenoid 55 so that air flow is either unobstructed, partially obstructed or entirely obstructed. As a source of electric current there is provided a battery 56 which not only supplies the current for operation of the motor 16 and the solenoid 55 but also furnishes current for a solenoid 56^a actuating the valve 10 and a solenoid 57 operating the valve 15.

The operation of the plant is as follows:

When the boiler has been idle and is cold, the thermostat 23 maintains in open position the contacts 39 and 40 and the contacts 31 and 34 while the contacts 30 and 33 are closed. Since there is no pressure in the boiler, the diaphragm 46 is pressed by the spring 47 in the direction of the arrow P_1 and the bridge 49 connects the contacts 50 and 51. When the master switch 58 is closed, current flows from the battery 56 through the lead 53, the bridge 49, and the lead 52 to the motor 16 from whence it is grounded. The motor accordingly is set into operation and drives the feed pump 3. However, since the contacts 30 and 33 are closed, current flows through leads 32 and 61 to the solenoid 57 which is thereby energized to close the valve 15 and prevent the introduction of water into the boiler.

The operation of motor 16 also drives the blower 17 to force air through duct 18 since the valve 54 is open, no current flowing to the solenoid 55 over the leads 62 and 63 as the contacts 39 and 40 are open. The air stream in duct 18 aspirates pulverulent or liquid fuel from the nozzle 20 and the resulting combustible mixture is ignited by the spark plug 21 properly energized by the coil 22 which receives current through lead 60 joined to the lead 52. The resulting flame traversing the casing 1 heats the water tube 2 and steam is generated.

As the temperature continues to increase, the thermostat 23 moves in a direction opposite to the arrow P and moves the lever 25 so that contacts 30 and 33 are opened thereby de-energizing the solenoid 57 and permitting the valve 15 to open. As the pump 3 is still being operated by the motor 16, feed water is taken from the supply tank 13 through the pipe 16^a and is discharged past the valve 4 into the pipe 6 from whence it enters the boiler tube 2. The regulating valve 8, however, is adjusted so that the amount of feed water is not quite sufficient to absorb all of the heat supplied by the combustion and the steam temperature therefore continues to rise.

The thermostat 23 continues to move in a direction opposite to the arrow P thereby closing contacts 31 and 34. Current consequently flows from the lead 32 through the contacts 31 and 34 to the solenoid 56^a thereby opening the needle valve 10. A relatively small amount of cool feed water then passes from the pipe 9 through the pipe 11 into the tube 2 relatively close to the thermostat 23 so that the thermostat is quickly cooled. The action upon the thermostat of the water entering through the pipe 11 is much more prompt than it would be if the water entered the boiler at the inlet end of the tube 2. The injected water causes the thermostat to move slightly in the direction of the arrow P and opens the contacts 31 and 34 consequently breaking the circuit to the solenoid 56^a and permitting the valve 10 to close.

After the resulting cessation of flow of the injected water, the thermostat again responds to increasing temperature and moves in a direction opposite to the arrow P again to close the contacts 31 and 34 so that relatively cool water is again injected through the pipe 11. This injection cycle may repeat indefinitely. In case the injection of water is not sufficient to keep the temperature within the desired, predetermined limits, the thermostat 23 moves far enough in a direction opposite to the arrow P not only to close the contacts 31 and 34 but also to close the contacts 39 and 40. Current then flows through the leads 63 and 62 to energize the solenoid 55 whereupon the valve 54 is closed stopping the flow of air through the duct 18. The aspiration of fuel from the nozzle 20 correspondingly stops and combustion ceases. The temperature therefore falls as water continues to be supplied.

When the fall of temperature is great enough the thermostat moves sufficiently far in the direction of the arrow P to return the lever 25 to its original position or nearly to its original position so that the entire cycle just described repeats itself. Usually, however, the thermostat 23 moves in the direction of the arrow P only a sufficient distance to open the contacts 39 and 40 and perhaps additionally the contacts 31 and 34. Upon the opening of contacts 39 and 40, current ceases to flow to the solenoid 55, the valve 54 opens and combustion again occurs so that the temperature again increases.

Depending upon the quantity of steam withdrawn through the pipe 43, and other factors, the pressure in the tube 2 fluctuates and may increase to a high value. To prevent excessive pressure, the spring acting on the diaphragm 46 is adjusted to any desired value. When the boiler pressure reaches this predetermined value, the diaphragm overcomes the spring and moves the bridge 49 to open the circuit between contacts 50 and 51. Since the bridge 49 controls the main lead 53 from the battery 56, the bridge in opening de-energizes all of the electrical apparatus in the system which remains out of operation until the pressure has decreased sufficiently to permit the spring to move the diaphragm 46 so that the contacts 50 and 51 are again bridged.

I claim:

1. A steam power plant comprising a forced circulation boiler having a relatively long tube and a casing, a blower for introducing a combustible mixture into said boiler casing, a pump for introducing feed water into said boiler tube, branch conduits for conducting different proportions of said feed water into the inlet of said tube and into a spaced region of said boiler tube, means for driving said blower and pump, a damper for regulating the introduction of said mixture into said boiler casing, and means responsive to boiler temperature beyond said region for producing a step by step cyclic control of said damp-

er and the flow of feed water through said separate branch conduits.

2. A steam power plant comprising a forced circulation boiler having a relatively long tube and a casing, a blower for introducing a combustible mixture into said boiler casing, a pump for introducing feed water into said boiler tube, branch conduits for conducting different proportions of said feed water into the inlet of said tube and into a spaced region of said boiler tube, means for driving said blower and pump, a damper for regulating the introduction of said mixture into said boiler casing, and means responsive to boiler temperature for producing a step by step cyclic control of said damper and the flow of feed water through said separate branch conduits, said last mentioned means comprising a three-armed switch member responsive to temperature in said tube beyond said region, and suitable electric circuits and control instrumentalities operatively cooperating with said switch member.

3. A steam power plant comprising a forced circulation boiler having a relatively long tube and a casing, a blower for introducing a combustible mixture into said boiler casing, a pump for introducing feed water into said boiler tube, conduits for conducting different proportions of said feed water into the inlet of said tube and into a spaced region of said boiler tube, an electric motor for driving said blower and said pump, a damper for regulating the introduction of said mixture into said boiler casing, and means responsive to a boiler condition such as increasing temperature of said tube beyond said region for successively controlling the operation of said pump, the introduction of said feed water into said spaced region to affect said responsive means, and the operation of said damper.

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