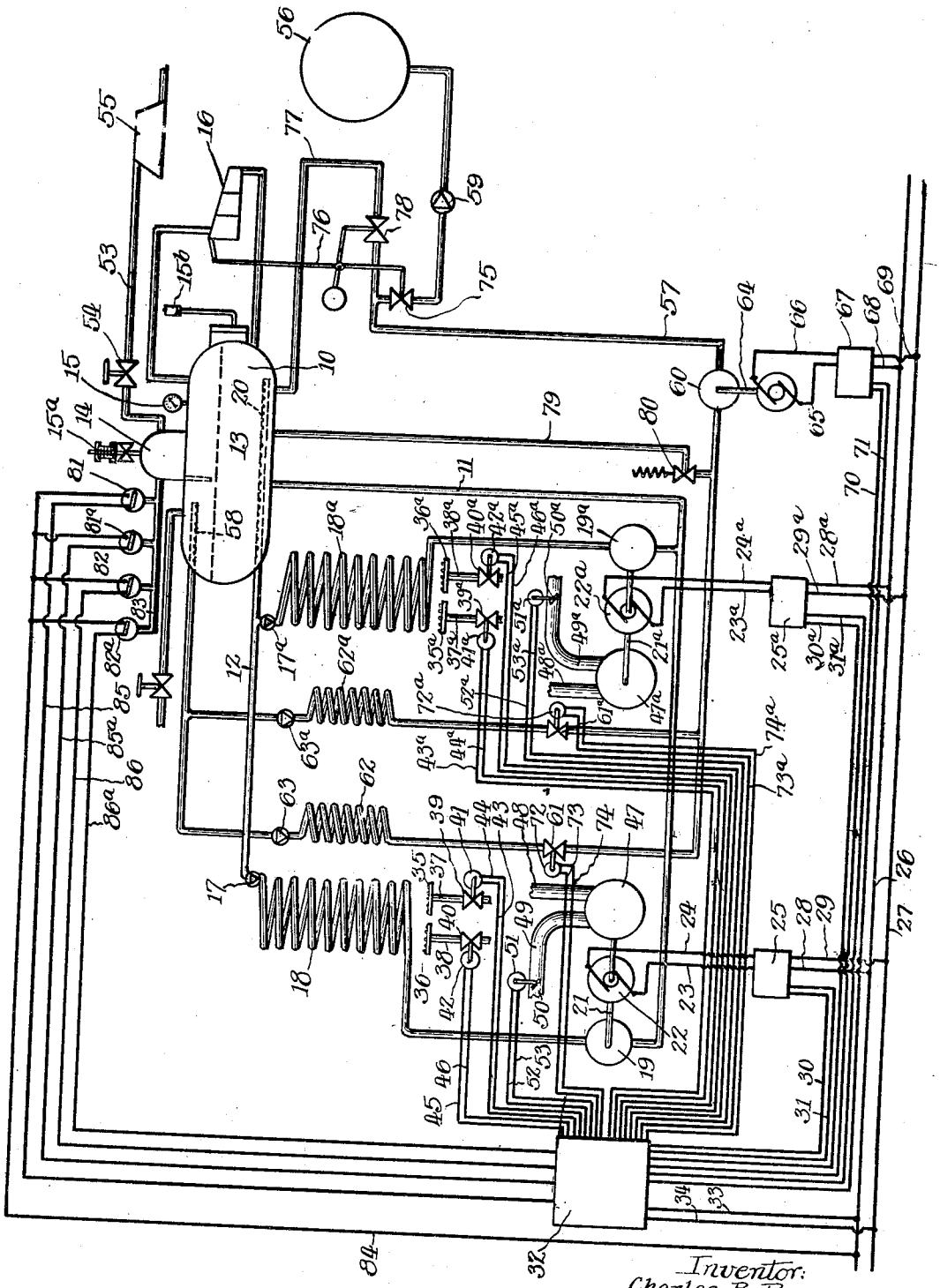
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STEAM POWER PLANT

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Inventor:
Charles B. Page
Warren Dean Burton,
By Chisholm Parker & Carlson
Attys.

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CHARLES B. PAGE AND WARREN DEAN BURTON, OF EVANSTON, ILLINOIS, ASSIGNORS, BY MESNE ASSIGNMENTS, TO THE G. W. DULANY TRUST, OF CHICAGO, ILLINOIS, A COMMON-LAW TRUST

STEAM POWER PLANT

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The present invention relates to improvements in steam power plants.

The primary object of the present invention resides in the provision of a novel steam power plant which is capable of satisfying a highly variable demand for steam.

Another object of the invention resides in the provision of a new and improved power plant comprising automatic controls tending to maintain a steady steam pressure regardless of the demand for steam.

A further object resides in the provision of a novel steam power plant having a plurality of units for generating steam, and automatic means responsive to the pressure of the available steam for selectively rendering said units operable and inoperable.

Other objects reside in the provision in a steam power plant having one or more steam generating units and an accumulator for storing the steam generated in said units, of automatic means for circulating feed water constantly through each heating unit while it is in operation, the feed water being taken from the feed water supply when the water level in the accumulator is below a predetermined point, and being taken from the accumulator when the water level is above a predetermined point.

A general object of the invention resides in the provision of a novel steam power plant which is relatively simple and inexpensive in construction, which is highly efficient in operation, and which has a large and variable capacity and heating surface.

Further objects and advantages will become apparent as the description proceeds.

The figure in the accompanying drawing is a diagrammatic representation of a steam power plant embodying the features of our invention.

While the invention is susceptible of various modifications and alternative constructions, we have shown in the drawing and will herein describe in detail the preferred embodiment, but it is to be understood that we do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring now to the exemplary embodiment of the invention illustrated in the drawing, the steam power plant comprises a circulatory system including a steam accumulator 10 and one or more steam generating units connected in parallel, said units being adapted to take feed water from a common feed water line 11 opening from the bottom of the accumulator, and being adapted to discharge into a common steam line 12 opening into the accumulator below the normal water level therein. In the present instance, we have shown two of these units. Preferably, the units are alike in construction and hence but one unit will be specifically described, and corresponding parts of the other unit will be designated by the same reference characters distinguished by the letter *a*.

The accumulator 10 may be of any suitable construction, and in the present instance comprises a suitable drum adapted to contain a body of water 13. The drum is provided with a steam dome 14, a suitable pressure gage 15, a pressure relief valve 15^a, a suitable water level regulator 16, and a low water alarm whistle 15^b.

Each of the steam generating units comprises a steam generator 18. This generator may be a coil of an suitable construction, and is connected at the inlet through a suitable feed water pump 19 to the line 11, and discharges through a check valve 17 to the line 12. Preferably, the discharge end of the line 12 extends along the bottom of the accumulator, and is perforated as at 20 so as to cause the steam or steam-water mixture from the coil 18 to thoroughly intermingle with the water 13.

Any suitable means may be provided for driving the feed water pump 19, and in the present instance, the pump is operatively connected to the drive shaft 21 of an electric motor 22. This motor is connected through lead wires 23 and 24 to a suitable starter 25 which is adapted to connect the motor directly to the positive and negative mains 26 and 27 through lead wires 28 and 29, as by manual manipulation, or indirectly to the mains

through lead wires 30 and 31 to a suitable automatic relay mechanism 32 connected to the main through lead wires 33 and 34.

Any suitable means may be provided for heating the steam generating coil 18. In the present instance, a plurality of independent heating units are provided preferably comprising suitable gas burners 35 and 36 connected to gas supply pipes 37 and 38 respectively. The supply of fuel to the burners 35 and 36 is controlled respectively by suitable valves 39 and 40 interposed in the pipes 37 and 38. Any suitable means may be provided for actuating the valves 39 and 40, and in the present instance, they are operatively connected respectively to suitable electric motors 41 and 42 connected through lead wires 43 and 44, and 45 and 46 to the relay unit 32.

Any suitable means may be provided for supplying air of combustion to the burners 35 and 36, and in the present instance, this means is a suitable air blower 47, preferably of the centrifugal type. The blower 47 is adapted to be driven by the motor 22, and has two air discharge ducts 48 and 49 for supplying low pressure air respectively to the burners 35 and 36. Interposed in the duct 49 is a suitable valve 50 adapted to be opened and closed by a suitable electric motor 51 connected through lead wires 52 and 53 to the relay unit 32.

The output of the generating coil 18, which may be steam or a steam-water mixture, is discharged to the accumulator 10, and gives up its heat to the water 13 therein. Saturated steam is evolved from the surface of the water, and this steam is available for consumption. In the present instance, steam may be withdrawn through a suitable line 53 controlled by a valve 54 to a steam consumer 55, such as a turbine, steam engine, or heating unit.

Means is provided for automatically replenishing the supply of feed water in the closed circulatory system. To this end, a suitable feed water supply tank 56 is connected through a feed water supply line 57 to the accumulator 10. Preferably, the discharge end of the line 57 opens above the normal level of the liquid 13 in the accumulator, and is perforated as at 58 to form a spray. Interposed in the line 57, in the order named, are a check valve 59 for preventing a back flow of water to the tank 56, a suitable feed water pump 60, a valve 61, a feed water preheater or economizer 62, and a check valve 63 for preventing a discharge of steam from the accumulator 10 to the preheater.

The feed water pump 60 may be driven by any suitable means, and in the present instance is connected to a suitable electric motor 64 connected through lead wires 65 and 66 to a starter 67 adapted to be connected either directly through lead wires 68 and 69 to the mains 26 and 27, as by manual manipulation, or indirectly to said mains through lead wires 70 and 71 to the relay unit 32. The valve 61 is adapted to be actuated by an electric motor 72 connected through lead wires 73 and 74 to the relay unit 32. The preheater 62 preferably comprises a coil nested with the generator coil 18, and adapted to be heated by the burners 35 and 36.

Means is provided for automatically controlling the supply of feed water from the tank 56 in accordance with the water level in the accumulator 10. This means comprises a suitable valve 75 interposed in the line 57 between the check valve 59 and the pump 60, and adapted to be opened and closed by the water level regulator 16 acting through suitable linkage 76, respectively as the water falls below or raises above a predetermined level.

Means is provided for ensuring a flow of water through the coil 62 when the pump 60 is in operation and the valve 61 is open regardless of whether or not the supply of feed water is being replenished from the tank 56. To this end, the bottom of the accumulator 10 is connected through a line 77 controlled by a valve 78 to the line 57 between the valve 75 and the pump 60. The valve 78 is controlled by the water level regulator 16 through the linkage 76, to open or close respectively as the water level rises or falls below a predetermined point. It will be evident that one or the other of the two valves 75 and 78 will be open at all times.

The line 57 between the pump 60 and the valve 61 is connected through a line 79 and an over-flow valve 80 directly to the accumulator 10 so that when only one of the steam generating units is in operation, any excess feed water from the pump 60 will overflow directly to the accumulator.

Means is provided for automatically controlling the steam generating units and the supply of feed water in accordance with pressure changes in the accumulator 10. This means comprises a plurality of switches 81, 81^a, 82, and 82^a, responsive to the pressure in the accumulator 10, and adapted to be closed in sequence as the pressure drops progressively below a predetermined point, for example 150 pounds per square inch. These switches may be of any suitable type, as for example mercury switches, and communicate through a pipe 83 with the interior of the accumulator 10.

The switches 81, 81^a, 82, and 82^a are connected by a common lead wire 84 to the positive main 26, and are connected respectively through lead wires 85, 85^a, 86, and 86^a to the relay unit 32. Two of the switches 81 and 82 are for one of the steam generating units, and two of the switches 81^a and 82^a are for the other of the steam generating units.

The relay unit 32 contains standard relay

switches and circuits (not shown) under the control of the switches 81, 81ª, 82, and 82ª so as to control the operation of the various motors in the system. The specific construction of the relay unit 32 is complicated and per se forms no part of the present invention, and hence it is considered unnecessary to specifically describe the same. It will suffice to state that when the switch 81 is closed, the motors 41 and 72, which are reversible, will be set in operation temporarily to open the valves 39 and 61, and the motors 22 and 64 will be set in operation to supply feed water to the generator coil 18 and the preheater 62 and air for combustion to the burner 35; when the switch 81ª is closed, the motors 41ª and 72ª, which also are reversible, will be set in operation temporarily to open the valves 39ª and 61ª, and the motor 22ª will be set in operation to supply feed water to the generator coil 18ª and air for combustion to the burner 35ª; when the switch 82 is closed, the motors 42 and 51, which are also reversible, will be set temporarily in operation to open the valves 40 and 50; when the switch 82ª is closed, the motors 42ª and 51ª, similar to the motors 42 and 52, will be set temporarily in operation to open the valves 40ª and 50ª. When the switches 81, 81ª, 82, and 82ª are opened, the foregoing sequence is reversed, the motors 22, 22ª and 64 being rendered inoperative, and the motors 41, 42, 51, 72, 41ª, 42ª, 51ª, and 72ª, being set temporarily in operation in the opposite direction to close the valves 39, 40, 50, 61, 39ª, 40ª, 50ª, and 61ª respectively. The valve motors are rendered inoperable on the respective opening or closing of the valves.

The operation will now be briefly described. The feed water preferably is softened, as by the zeolite process, and is stored in the tank 56.

Let it be assumed that the water in the accumulator 10 is at the normal level, and that the accumulator is at the desired pressure, for example 150 pounds per square inch. In this event, all of the switches 81, 81ª, 82 and 82ª will be open, and hence no steam will be generated. The valves 61 and 61ª will be closed.

If the pressure in the accumulator 10 drops below the desired point, as in the event of a heavy steam demand, the switch 81 will close, thereby opening the valves 39 and 61 and setting the pumps 19 and 60 and the blower 47 in operation. Fuel through the pipe 37 and air through the duct 48 will then be supplied to the burner 35, and feed water will be supplied to the coil 18 and the preheater 62. With the valve 50 closed, the blower 47 will operate at half capacity. The burner 36 and the other steam generating unit are cold. Excess feed water from the pump 60, which would pass to the coils 62 and 62ª under full load conditions, will overflow to the accumulator through the line 79.

If the water level in the accumulator falls below the normal level, the regulator 16 will close the valve 78 and will open the valve 75 to take feed water from the tank 56 instead of the accumulator 10 so as to automatically replenish the supply.

If the pressure drops still further, the switch 81ª will close, thereby opening the valves 39ª and 61ª, and setting the pump 19ª and the blower 47ª in operation. This will supply fuel and air to the burner 35ª, and feed water to the coils 18ª and 62ª. Both steam generating units are now operating at half capacity.

If the pressure drops still further, the switch 82 will close, thereby opening the valves 40 and 50 to supply fuel and air to the burner 36. At this point, one steam generating unit is in full operation, and the other steam generating unit is operating under a half load.

If the pressure drops still further, the switch 82ª will close, thereby opening the valves 40ª and 50ª to supply fuel and air to the burner 36ª. Both steam generating units are now operating under maximum load.

If the pressure in the accumulator now rises progressively to the desired point, the valves 81, 81ª, 82 and 82ª will open in reverse order to reverse the operation just described. Thus, the burners 36ª, 36, 35ª, and 35 will be rendered inoperative in sequence, and as both burners of each unit are rendered inoperative, the supply of feed water and air to that unit will be cut off. It will be evident that we have provided a steam power plant, which is extremely flexible, fully automatic, efficient, and which has a highly variable capacity.

We claim as our invention:

1. A steam power plant having, in combination, an accumulator adapted to contain a body of water, a steam generator with its discharge end connected to said accumulator, means for circulating feed water from said accumulator through said steam generator, a plurality of heating units for said steam generator, and means responsive to the pressure in said accumulator for controlling said feed water supply and said heating units.

2. A steam power plant having, in combination, an accumulator, a steam generating unit for discharging to said accumulator, a feed water heater for discharging to said accumulator, means for heating said steam generating unit, means responsive to the pressure in said accumulator for controlling said heating means, and means for automatically supplying feed water to said heater when said heating means is in operation.

3. A steam power plant having, in combination, an accumulator adapted to contain a body of water, a steam generating unit for discharging to said accumulator, said unit

comprising a generator, means for supplying feed water to said generator, a pair of burners, means for supplying fuel and air to said burners, and means responsive to the pressure in said accumulator for controlling said first and second mentioned means to render said burners operable and inoperable in sequence.

4. A steam power plant having, in combination, an accumulator, a steam generating unit for discharging to said accumulator, a feed water heater, means for heating said steam generating unit, means responsive to the pressure in said accumulator for controlling said heating means, and means for automatically supplying feed water to said feed water heater when said heating means is in operation.

5. A steam power plant comprising, in combination, an accumulator adapted to contain a body of water, a steam generator for discharging to said accumulator, means for supplying feed water to said generator, a feed water preheater for discharging to said accumulator, a feed water supply, means responsive to the water level in said accumulator for selectively supplying water from said accumulator and said feed water supply to said preheater as the level in said accumulator rises above and falls below a predetermined point, means responsive to the pressure in said accumulator for controlling the supply of water to said feed water preheater, and a line including an overflow valve connecting said second mentioned means to said accumulator.

6. A steam power plant having, in combination, an accumulator adapted to contain a body of water, a pair of steam generators for discharging to said accumulator, means for supplying feed water to said generators, a pair of feed water preheaters for discharging to said accumulator, a feed water supply line, two lines each including a valve respectively connecting said feed water preheaters to said feed water supply line, a source of feed water, means responsive to the water level in said accumulator for selectively supplying water from said accumulator and said feed water source to said feed water supply line as the level in said accumulator rises above and falls below a predetermined point, and a line including an overflow valve connecting said feed water supply line to said accumulator for returning excess water to said accumulator.

In testimony whereof we have hereunto affixed our signatures.

CHARLES B. PAGE.
WARREN DEAN BURTON.