United States Patent [19]

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[11] **3,789,804**

[45] **Feb. 5, 1974**

[54] **STEAM POWER PLANT WITH A FLAME-HEATED STEAM GENERATOR AND A GROUP OF GAS TURBINES**

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[22] Filed: **Dec. 14, 1972**

[21] Appl. No.: **314,963**

[52] **U.S. Cl.** ..... **122/1 R**, 122/7 R

[51] **Int. Cl.** **F22b 33/18**

[58] **Field of Search** ..... 122/1 R, 7 R, 7 B, 479 R

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[57] **ABSTRACT**

At least two gas turbine groups of identical construction are selectively connected to the burner of the steam generator. If one group fails, the other group takes over to deliver the combustion air necessary to continue efficient operation without an interruption in service. In normal operation, one gas turbine group is connected to the burner while the other is connected at a mixing location in the steam generator, e.g. between the preheater and a superheater.

7 Claims, 2 Drawing Figures

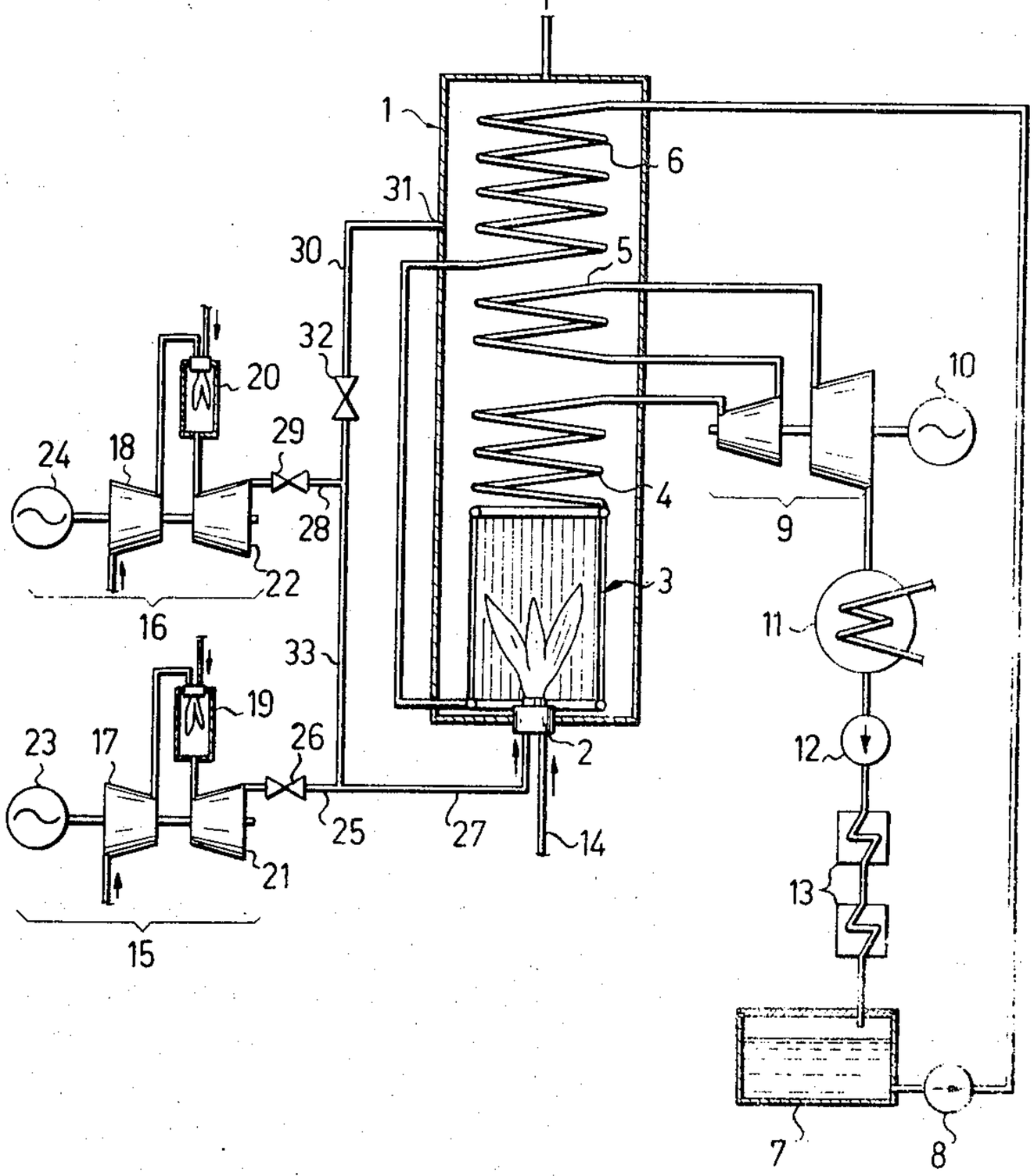

Fig.1

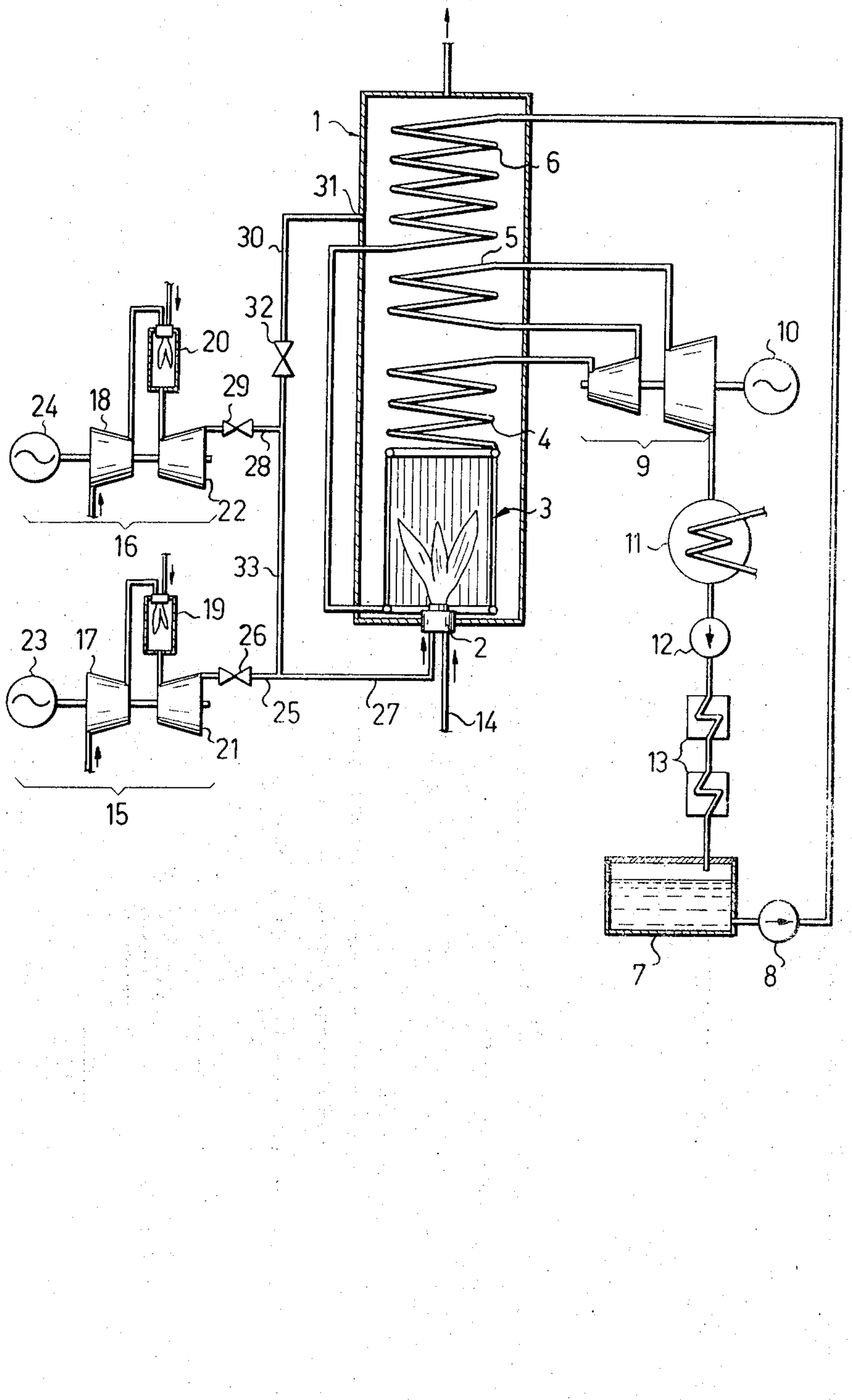
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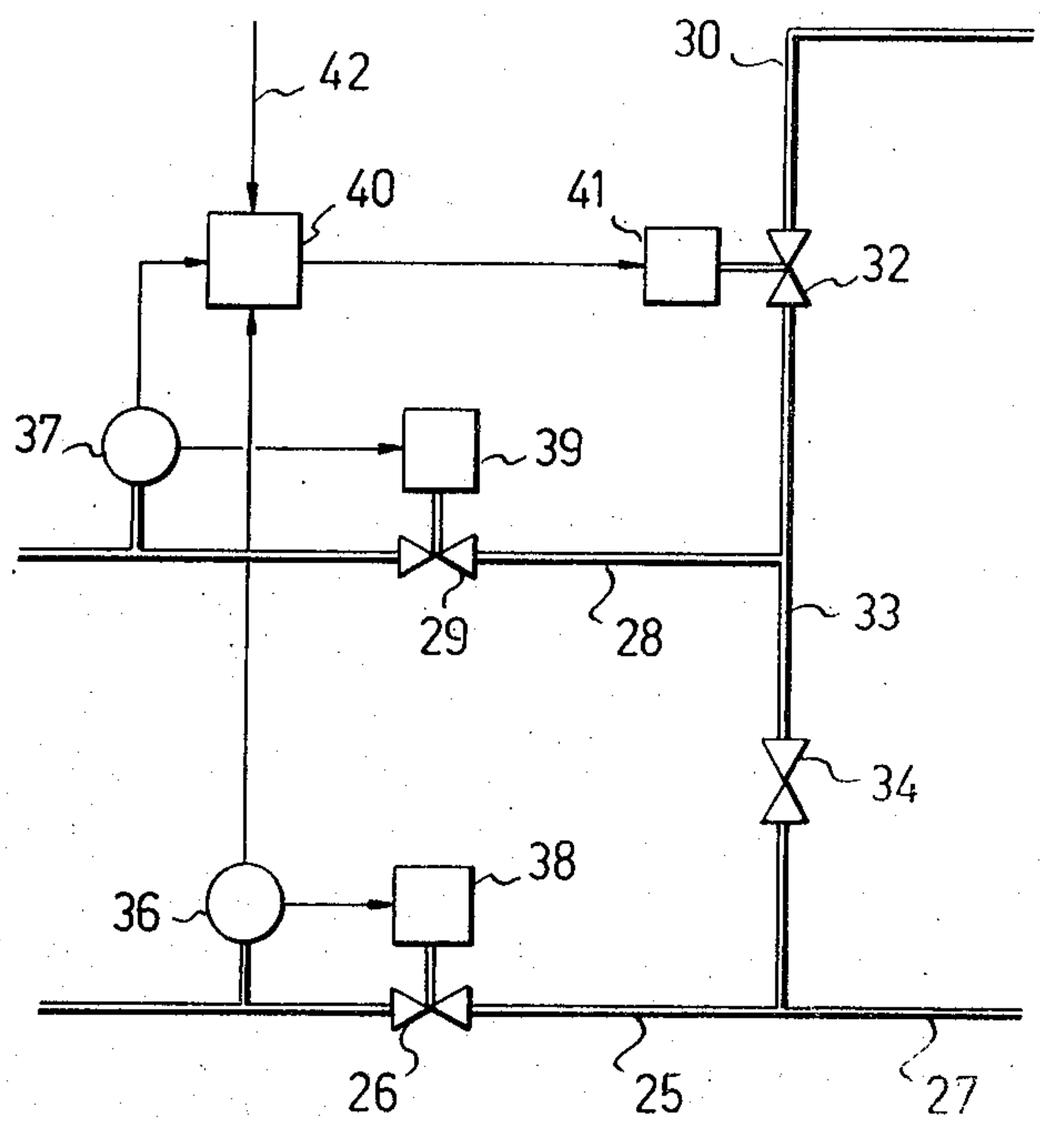
Fig. 2



STEAM POWER PLANT WITH A FLAME-HEATED STEAM GENERATOR AND A GROUP OF GAS TURBINES

This invention relates to a steam power plant. More particularly, this invention relates to a steam power plant having a flame-heated steam generator and a gas turbine combustion gas feed.

Steam power plants of the flame-heated steam generator types have been known in which a gas turbine group has been used to deliver combustion air to a burner of the steam generator in order to support combustion of a fuel delivered to the burner. In some instances, the gas turbine group has also been connected on the exhaust gas side to a mixing location in the generator downstream of the burner to supply combustion gas thereto. Generally, heating surfaces have been positioned between the burner and this mixing location as well as downstream of the mixing location. In order to protect the power plants against failure of the gas turbine group, the power plants have been provided with a forced-draft blower so as to permit continued operation of the steam generator. However, as a forced-draft blower has required some time to be brought into operation, a decrease in the output of the steam generator has been inevitable. This is particularly so since the air supplied by the forced-draft blower is colder than the gas supplied by a gas turbine group.

Accordingly, it is an object of the invention to provide for continuous operation of a steam power plant having a flame heated steam generator which is supplied with combustion air from a gas turbine group should the gas turbine group fail.

Briefly, the invention provides a steam power plant having a flame-heated steam generator including a plurality of heating surfaces, and a burner with at least two gas turbine groups for supplying combustion air to the steam generator. The two gas turbine groups are selectively connected with the burner, each group being dimensioned so that if one group fails, the remaining group or groups can supply at least as much gas as is needed for the full-load fuel for the steam generator. By providing at least two gas-turbine groups, it becomes possible to continue operation of the steam generator immediately and without a drop of temperature in a simple way should one gas-turbine group fail. In the event that one group fails, then the other group immediately supplies the gas needed for combustion, and at the same temperature as previously supplied by the failed group.

In the case of two gas turbine groups, one group is connected to the burner to deliver combustion air thereto while the other group is connected to the steam generator at a mixing location between two of the heating surfaces disposed downstream of the burner to deliver combustion air thereto. A suitable means is also provided for selectively connecting the second of these groups to the burner to deliver combustion air thereto in response to failure of the first group to deliver combustion air to the burner.

The switch-over from one group to the other is simpler and quicker that placing a forced-draft blower into operation.

In accordance with one embodiment of the invention, all the gas turbine groups are connected over a common conduit having an adjusting valve therein with the mixing location. A minimal-value selector means is also connected to each group to receive a signal from each corresponding to the output performance of each group. This selector means is also connected with the adjusting valve through the intermediary of a signal line which is used to conduct a desired-value signal to the valve for the opening of the adjusting valve. In this form of construction, the adjusting valve is always influenced by the gas turbine group having the smaller performance at a given time. An automatic switch-over to the other group is possible because the adjusting valve closes when the performance of a group becomes zero. Thus, the remaining groups automatically become connected with the burner of the steam generator.

In another embodiment, a control valve is positioned at the outlet from each gas turbine group and a measuring means is provided for each group to measure performance. The measuring means is connected to a respective control valve to close the valve in response to a diminishing performance of the group and vice versa.

In a further embodiment, all gas turbine groups are connected with one another through the intermediary of a common conduit having an adjusting valve. By this means, the pressure of the gas at the outlet from the gas turbines may be set differently, for example, in such a way that the pressure difference corresponds to the pressure drop at the heating surfaces between the burner and the mixing location. This permits an improvement of efficiency.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates a circuit diagram of a steam power plant according to the invention; and

FIG. 2 diagrammatically illustrates a control means for influencing the valves between the gas-turbine groups and the steam generator.

In FIG. 1, the steam power plant has a steam generator 1 provided with a burner 2 and having, in the direction of the flow of exhaust gas, various heating surfaces including an evaporator heating surface 3, a superheating surface 4, a reheating surface 5, and a feed water preheater 6. The feed water preheater 6 is in communication with a feed-water tank 7, which has a feed pump 8 for pumping the feed-water to the preheater 6. The steam power plant also has a power machine 9, e.g. composed of a high-pressure turbine part and a low-pressure turbine part which drives an electric generator 10. The high-pressure turbine part is connected to the superheater 5 to receive steam. The high pressure turbine part is also connected to the reheating surface 5 to deliver the partially expanded steam thereto for reheating. The outlet of the reheating surface 5 is connected to the low pressure turbine part to deliver the steam in sequence thereto. This low-pressure part is also connected to a condenser 11, which through the intermediary of a condensate pump 12 and a number of steam-heated preheaters 13, is connected with the feed-water tank 7.

The burner 2 receives the fuel to be burned from a pipe 14. Two gas-turbine groups 15 and 16, which in this example are of the same construction are provided to supply combustion air. Each group 15, 16 consists of a compressor 17 and 18 respectively, a combustion chamber 19 and 20, respectively, and an electric generator 23 and 24, respectively that serves as a motor to start the group running. The outlet from the gas turbine

21 is connected by an outlet pipe 25, which has a control valve 26, with the combustion-air pipe or conduit 27 running to the burner 2. Similarly, at the outlet from gas turbine 22, an outlet pipe 28 is connected which has a control valve 29, and this is connected by a conduit 30 with a mixing location 31 of the steam generator 1. This mixing location 31 is situated downstream of the burner 2 of the steam generator 1. At this location, the exhaust gases of the burner 2 become mixed with the gas flowing through the conduit 30.

An adjusting valve 32 is disposed in the conduit 30 for purposes as explained below. In addition, a connection conduit 33 is provided between the conduit 30 and the pipe 27 to connect the gas-turbine groups 15, 16 in common to the burner 2. As in the conduit 30, the conduit 33 may have an adjusting valve 34 (FIG. 2) therein.

Due to the valves 26, 29, 32 it is possible to connect each of the two gas-turbine groups 15, 16 individually to the burner 2. In addition, each group 15, 16 is dimensioned so that should one of them fail, the other group supplies at least as much gas for the full-load quantity of fuel to be burned in the steam generator 1.

In normal operation of the plant, the gas-turbine group 15 alone delivers a quantity of gas that contains sufficient oxygen to burn the fuel brought through the pipe 14 to the steam generator 1. The other group 16 feeds gas, through the conduit 30 to the mixing location 31, so that the feedwater preheater 6 receives supplementary heat. Should the group 15 fail because of some derangement, then the valves 26, 32 become closed, so that the burner 2 is supplied with gas only from the group 16.

Referring to FIG. 2, in order to actuate the valves 26, 29, 32, quantity-measuring means 36, 37 of suitable construction are connected to the respective outlet pipes 25, 28 of the gas turbines 21, 22. The quantity-measuring means 36 is connected by a signal line with a servomotor 38 of the control valve 26 which serves to open and close the valve 26. There is also a similar connection of the measuring means 37 with a servomotor 39 of the control valve 29. Furthermore, each of the two measuring means 36, 37 is connected by a signal line with a minimal-value selector means 40 of suitable construction whose output is connected over a signal line with a servomotor 41, which controls the adjusting valve 32 in the conduit 30 leading to the mixing location 31. The selector means 40 also receives a load signal 42 from the steam power plant via a suitable line. The selector means 40 works in such a way that the prevailing smaller signal from the two measuring means 36, 37 influences the adjusting valve 32, so that when the quantity of exhaust gas becomes smaller the valve 32 is moved in its closing direction. In addition, with a decreasing quantity of gas in the outlet pipes 25, 28, the control valves 26, 29 are influenced by their associated quantity-measuring means 36, 37, respectively, so as to become moved in the closing direction. The load signal 42 is used so that as the load becomes greater the flow section of the valve 32 becomes smaller, and becomes enlarged as the load diminishes. By way of example, the quantity of live steam, or else the electric output of the generator 10 from the steam power plant is used for the load signal 42.

Instead of measuring flow quantities by the aid of the measuring means 36, 37, it is also possible to measure some other magnitude representing the performance of the turbine group, e.g. the rotary speed of the group concerned. It is furthermore possible to provide three gas-turbine groups, instead of two.

The closure time of the adjusting valve 32 is advantageously made so as to match the normal reduction of rotary speed of the group concerned, so that the pressure of the gas supplied to the burner 2 remains practically constant.

What is claimed is:

1. A steam power plant comprising a flame-heated steam generator including a plurality of heating surfaces for passage of a flow of combustion gas thereover in heat exchange relation with a flow of operative medium therein, a burner for supplying fuel to said generator, at least two gas turbine groups for supplying combustion air to said steam generator, one of said groups being connected to said burner to deliver combustion air thereto and the other of said groups being connected to said steam generator at a mixing location between two of said heating surfaces disposed downstream of said burner to deliver combustion air thereto, and means for selectively connecting said other groups to said burner to deliver combustion air thereto in response to failure of said one group to deliver combustion air to said burner.

2. A steam power plant as set forth in claim 1 wherein said gas turbine groups are of identical construction.

3. A steam power plant as set forth in claim 1 wherein said means includes a conduit connected in common to said gas turbine groups and to said steam generator at said mixing location, an adjusting valve in said conduit, a minimal-value selector means operatively connected to each said gas turbine group to receive a respective signal therefrom corresponding to the output performance thereof, said selector means being operatively connected to said adjusting valve to control said valve in response to the smaller of said signals whereby said valve is closed in response to the smaller of said signals diminishing towards a value representative of a zero output performance.

4. A steam power plant as set forth in claim 3 which further comprises means for delivering a load signal responsive to the operation of said plant to said selector means for opening said adjusting valve in response to a diminishing load and vice versa.

5. A steam power plant as set forth in claim 1 wherein each gas turbine group includes an outlet pipe for flow of combustion gas therefrom, a control valve in said outlet pipe and means for measuring the performance of said gas turbine group, said measuring means being connected to said control valve to close said control valve in response to a diminishing performance of said gas turbine group and vice versa.

6. A steam power plant as set forth in claim 5 wherein said measuring means is connected to said outlet pipe to measure the flow of combustion gas therein as a measure of said performance of said gas turbine group.

7. A steam power plant as set forth in claim 1 wherein said means includes a conduit connected in common to said gas turbine groups and to said burner and an adjusting valve in said conduit for selectively adjusting the pressure difference between the combustion gases delivered from said groups to correspond to a pressure drop at said heating surfaces between said burner and said mixing location.

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