

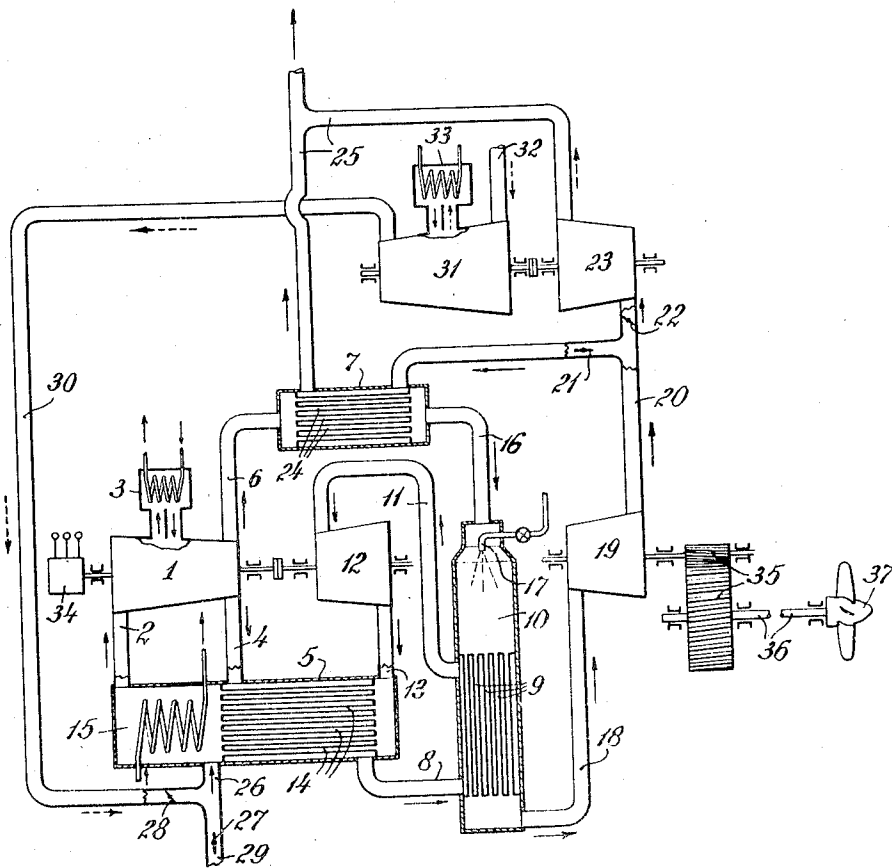
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W. TRAUPEL

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VARIABLE LOAD GAS TURBINE SYSTEM

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INVENTOR

WALTER TRAUPEL.

BY

BY
Parrish, Edwards, Mortimer & Barrows
ATTORNEYS

ATTORNEYS

UNITED STATES PATENT OFFICE

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VARIABLE LOAD GAS TURBINE SYSTEM

Walter Traupel, Winterthur, Switzerland, assignor to Sulzer Freres, Societe Anonyme, Winterthur, Switzerland

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The invention relates to a method of operating gas turbine plants, especially of the type in which an auxiliary turbine serving to drive the compressor is worked by a working medium which flows in a circuit and the main turbine serving to produce useful output is worked by a working medium which is led away from the circuit, and further relates to a plant for carrying out the method.

The aim of the invention is to make possible the operation of a plant in such a way that it works, on the one hand, at highest efficiency during normal load, and can, on the other hand, develop multiples of this normal load with efficiencies that remain reasonable. A plant of this type is particularly of value in the propulsion of war vessels.

According to the invention, the problem is solved by leading away the quantity of working medium exhausted from the plant at normal useful output through a heat exchanger, but at higher useful outputs through an exhaust gas turbine. For carrying out this method, the gas turbine plant is equipped with a heat exchanger, an exhaust gas turbine installed beyond the useful output turbine, and diverting means arranged in the piping from the useful output turbine to the exhaust gas turbine. By these diverting means, the exhaust gases from the useful output turbine are led to the heat exchanger at normal load and to the exhaust gas turbine at higher loads. It is preferable, at normal load, to preheat, by means of this heat exchanger, the combustion air intended for the gas heater of the plant, but at higher loads to drive, by means of this exhaust gas turbine, a compressor to supply the plant with fresh working medium at increased pressure as make-up for the working medium withdrawn from the circuit.

The invention is further explained by reference to the drawing which illustrates, in simplified form, a preferred arrangement of a gas turbine plant for carrying out the disclosed method.

The compressor 1 compresses the working medium flowing in from pipe 2, intermediate cooling during compression being effected in the cooler 3, and delivers it in a compressed state partly through pipe 4 into a heat exchanger 5 and partly through pipe 6 into a heat exchanger 7.

The part of the working medium retained in the circuit is preheated in heat exchanger 5 and flows through pipe 8 into the space surrounding the tube system 9 of the gas heater 10. This working medium, thus heated, then flows through pipe 11 into the turbine 12, and, after expanding in the turbine, passes through pipe 13 into the

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tube system 14 of the heat exchanger 5. Here, a part of the heat still contained in the expanded working medium is transmitted to the working medium arriving through pipe 4 from the compressor 1. A further part of the residual heat is withdrawn from the working medium in cooler 15. After this recooling, the working medium passes through pipe 2 again into the compressor 1, where the circuit described begins anew.

The part of the working medium withdrawn from the circuit through pipe 6 passes through the heat exchanger 7 and pipe 16 as the combustion air for the burner 17 of the gas heater 10. The products of combustion flow through the tube system 9 and give thereby a part of their heat to the working medium coming from pipe 8. With diminished temperature, the products of combustion flow through pipe 18 into the useful output turbine 19. The exhaust pipe 20 from the useful output turbine has diverting means consisting of two valves 21 and 22, by means of which the exhaust gas from the useful output turbine 19 can be led as desired either to the heat exchanger 7 or to the exhaust gas turbine 23. The exhaust gas from the useful output turbine 19 then flows either through the space surrounding the tube system 24 or through the exhaust gas turbine 23 into the outlet pipe 25.

As make-up for the working medium withdrawn from the circuit, air is led to the plant through pipe 26. This air can, depending on the setting of diverting means consisting of two valves 27 and 28, either be taken direct from the atmosphere through pipe 29 or supplied by the precompressor 31 through pipe 30 in a precompressed state. The compressor 31 receives air for its part from the atmosphere through pipe 32. While being compressed, this air passes through an intermediate cooler 33.

Turbine 12, which is worked with pure air, drives the circuit compressor 1. To the set consisting of the turbine 12 and the compressor 1, an electric machine 34 is also coupled, with the help of which the plant can be started, any lack of energy during service made up or superfluous energy led away. The output of the useful output turbine 19 is transmitted to the ship's propeller 37 through the gear 35 and the shaft 36. The compressor 31 is driven by the exhaust turbine 23.

The plant described is particularly suitable for the propulsion of warships. The separate machines and heat exchangers are designed in such a way that the maximum efficiency is obtained at an output intended for cruising speed. The di-

verting means consisting of valves 21, 22, 27 and 28 are then adjusted as shown in the drawing.

The exhaust gases from the useful output turbine 19 flow through the space surrounding the tube system 24 of the heat exchanger 7 and into the exhaust pipe 25. In this way, combustion air intended for the gas heater 10 is preheated and residual heat in the working medium being exhausted from the plant is to a large extent recuperated. The air freshly introduced into the circuit as make-up for the exhausted working medium is introduced into the plant direct from the atmosphere through pipes 29 and 30. The plant thus works with low pressure level in the circuit, for which the form of the blades and the cross-sectional areas of flow of the machines are designed, so that a very high efficiency is ensured. For increasing the output, valves 22 and 28 are opened and valves 21 and 27 closed. The exhaust gases from the useful output turbine 19 consequently flow through the exhaust gas turbine 23 into the exhaust pipe 25. The exhaust gas turbine drives the compressor 31 which draws in air from the atmosphere through pipe 32 and delivers it into the circuit, in a more or less highly compressed state, through pipe 30 and opened valve 28. In this manner the useful output of the plant can be increased to a multiple of the normal output—for instance to 5-10 times that value—and reasonable efficiencies can still be obtained. With the plant shown, an efficiency up to about 28% at normal load can be reached, and at full load of 8 times as much normal output, still about 26%.

I claim:

1. In a gas turbine plant that includes, in combination, a main compressor, an internal-load turbine driving said compressor, a gas heater, a conduit connecting the outlet from said compressor to the inlet to said turbine through said

heater, a conduit connecting the outlet from said turbine to the inlet to said compressor, a first branch conduit supplying combustion air to said gas heater from said compressor outlet, a second branch conduit leading make-up air to said compressor inlet, and an external-load turbine driven by combustion products from said gas heater, the improvement that includes a heat exchanger arranged to heat plant working medium, a conduit supplying said heat exchanger exhaust gas from said external-load turbine as heating fluid, an exhaust gas turbine, a conduit supplying said exhaust gas turbine with exhaust gas as working medium, and diverting means controlling said two last mentioned conduits for diverting exhaust gas between said heat exchanger and said exhaust gas turbine.

2. The improvement of claim 1 in which the heat exchanger is arranged to heat combustion air in the first branch conduit.

3. The improvement of claim 1 in which an auxiliary compressor is driven by the exhaust gas turbine, a conduit connects the outlet of said auxiliary compressor to the second branch conduit, an intake from the atmosphere opens directly into said second branch conduit, and diverting means control the diverting of make-up air induction between said auxiliary compressor and said intake.

WALTER TRAUPEL.

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