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(54) Title: EMISSIONLESS CYCLE WITH STEAM GENERATOR AND HEAT TRANSFORMER

(57) Abstract: The combined-cycle circulation with a steam generator and a heat transformer, featuring the fact that the HP turbine outlet branch (1) is connected via the steam-gas mixture pipeline (16) with the primary side of the steam generator (5) and the heat transformer (9), while the secondary side of the steam generator (5) is connected to the step-up pump (10), and by the HP steam pipeline (18) to the HP steam module (2). Between the steam generator (5) and the HP module (1), at least one more steam generator is placed. One body may accommodate together at least one steam generator and one steam transformer.



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Emissionless Cycle with Steam Generator and Heat Transformer

Scope of Technology

The invention applies to the generation of mechanical – electrical power, the joint generation of mechanical power and heat, as well as other technological plants, e.g. the petrochemical industry, the food industry, and the gas generation.

Present State of Technology

In connection with the increasing problem of the warming of our planet, there is an endeavor to reduce the amount of carbon dioxide and other dangerous substances being released into the atmosphere. New technologies are under development the working substances of which are not the air but pure substances, e.g. fuel, oxygen, water, or carbon dioxide. Abroad, they are also called the CES systems. One of them is the emissionless cycle with a gas-steam turbine, the description of which can be found in the invention application No 2001 3331. Here, the fuel and oxygen are combusted at high pressure and temperature. After this, water is injected into the generated combustion product, generating thus a mixture of superheated steam and carbon dioxide – the steam-gas mixture (hereinafter only SGM) - which enters the thermal machine – the turbine.

Only part of the thermal power conveyed into cycle through the working substance can be used for converting into mechanical power. According to the thermodynamic laws, it is proportional to the nature of the substance - its specific thermal capacity, its temperature before the thermal machine - the turbine - and the pressure ratio before and after the machine.

The maximum cycle pressure – at the turbine inlet – is limited by the properties of the material the machine is manufactured of and which may be used for the particular temperature.

The pressure at the machine outlet is selected so that the condensation in the steam section from the mixture with carbon dioxide would have its course in the following heat transformer

at pressure higher than the ambient one – the atmospheric pressure. This eliminates the necessity of suction off the carbon dioxide from the heat transformer, which requires certain energy, but it may be only relieved from the cycle.

These limitations determine the pressure ratio of the HP section of the gas-steam turbine, which is one of the main reasons why not all the thermal power contained in the steam-gas mixture at the outlet the HP module can be fully utilized. If the thermal efficiency of the cycle is to be increased, then by increasing the temperature of the steam-gas mixture at the inlet into the turbine HP section the temperature at its outlet increases in due proportion.

Subject-matter of Invention

The problems mentioned above are partly solved by the emissionless cycle with a steam generator and a heat transformer, the principle of which consists in the fact that the outlet branch of the HP turbine is connected using a steam-gas mixture piping with the primary side of the steam generator, and then with the heat transformer, while the secondary side of the steam generator is connected to the step-up pump, and by the HP steam piping to the HP steam module.

If the temperature of the gas-steam mixture at the turbine outlet is high, at least one more steam generator may be put before the heat transformer. Here the steam-gas mixture at the primary side is cooled while at the secondary side overheated HP steam is generated and supplied into the turbine. It works at a pressure and temperature steam level different from that of the original generator and the steam transformer. It is put between the original steam generator and the heat transformer admission part.

The pressure and temperature of the generated steam conform to those of the steam-gas mixture, and decrease in the direction of its flow. The steam temperature and pressure at the outlet of the heat transformer and the individual heat generators are selected so as to allow the most effective utilization of the energy contained in the steam-gas mixture at the turbine outlet. The steam generated in the steam generators and the heat transformer is pipelined into the multi-pressure section of the gas-steam turbine. Here it increases its volume as far as

the pressure in the condenser where it condenses. Using a condensate pump, the condensate is discharged from the condenser back into the cycle.

The steam generators and the heat transformer mentioned above may be placed in one body where steam of different pressure is generated.

Survey of Figures

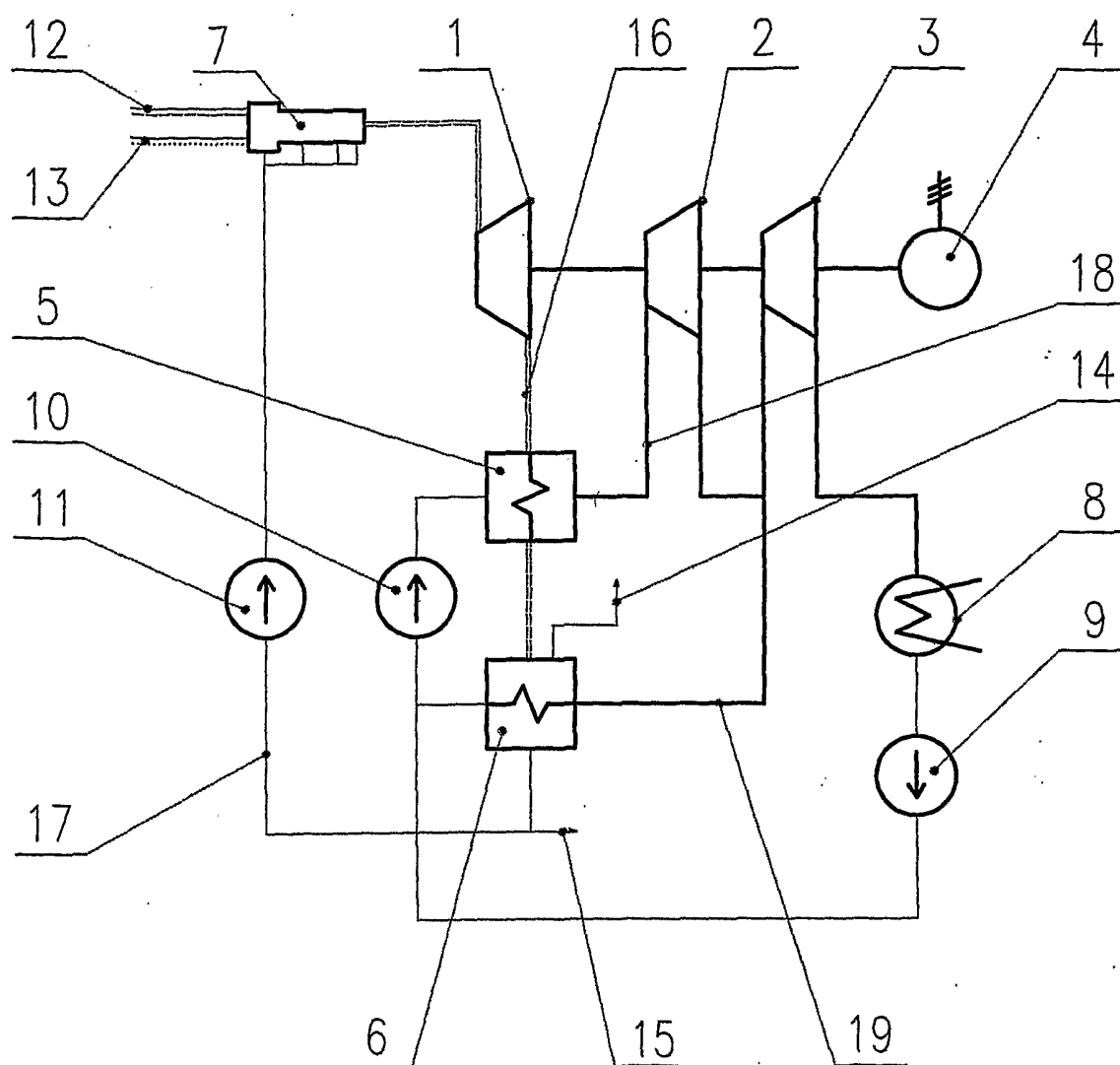
The attached figure shows a simplified scheme of the emissionless thermal cycle with a gas-steam turbine, a steam generator and a heat transformer.

Example of Construction

The enclosed figure shows a scheme of the emissionless cycle with a one-stage steam generator and a heat transformer, consisting of the steam-gas mixture generator 7, connected by the steam-gas mixture piping 16 with the gas-steam turbine 1, the outlet branch of which is connected with the steam generator 5, and the heat-transformer 6, which is connected by the water piping with the feeding pump 11 and the SGM generator 7, while the steam generator 5 is connected by the HP steam pipeline 18 with the HP steam module 2, and the heat transformer 6 is connected by the MP steam pipeline with the LP module 3, which is connected with the condenser 8. The condenser 8 is connected via the condenser pump 9 and the heat transformer 6 and via the step-up pump 10 with the steam generator 5. Via the fuel pipeline 12, the fuel is fed into the gas-steam mixture generator 7, and oxygen is fed via the oxygen pipeline 13. Carbon dioxide is taken off from the heat transformer 6, via the carbon dioxide pipeline 14, and the excessive water via the water drain piping 15. The one-stage steam generator 5 may be replaced with a multi-stage one, producing multi-pressure steam admitted into the multi-stage steam turbine.

PATENT CLAIMS

- 1) The emissionless cycle with a steam generator and a heat transformer, featuring the fact that the HP turbine outlet branch (1) is connected with via the steam-gas mixture pipeline (16) with the primary side of the steam generator (5) and the heat transformer (6), while the secondary side of the steam generator (5) is connected to the step-up pump (10), and by the HP steam pipeline (18) to the HP steam module (2).
- 2) The emissionless cycle with a steam generator and a heat transformer featuring, according to Point 1, the fact that between the steam generator (5) and the HP module (1), at least another steam generator is put.
- 3) The emissionless cycle with a steam generator and a heat transformer, featuring, according to Point 1, the fact that at least one steam generator is placed together with the steam transformer in one body.



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