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COMPOUND GAS TURBINE AND METHOD OF PRODUCING POWER THEREWITH

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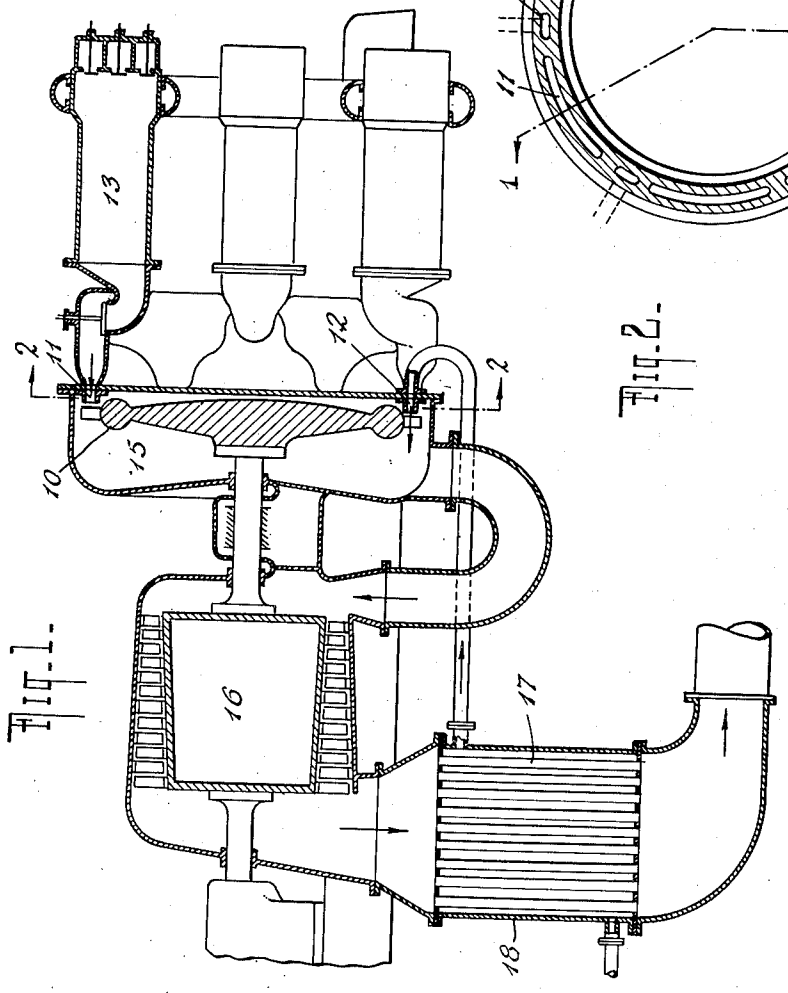


Fig. 1.

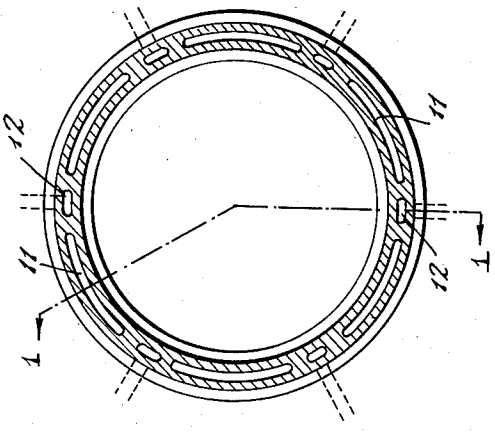


Fig. 2.

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COMPOUND GAS TURBINE AND METHOD OF PRODUCING POWER THEREWITH

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2 Claims. (Cl. 60—49)

In gas turbines of the type invented by me and disclosed in various patents granted to me, the counter-pressure or final pressure to which the driving medium is allowed to expand in the nozzle, has generally been about equal to atmospheric pressure. This was so whether combustion gases alone were employed as a driving medium or whether, in addition to such combustion gases, steam was employed both for the purpose of securing an increase of power and of cooling the turbine. It is true that in one particular instance the counter-pressure was below atmospheric pressure, being about .8 to .85 atmospheres absolute; in this case it was necessary, therefore, to provide a suction device in order to discharge the exhaust gases and the scavenging air into the atmosphere.

I have found that a considerable improvement in efficiency may be effected by increasing the counter-pressure to a point above atmospheric, for instance to 10 atmospheres, the charging pressure being increased at the same time, for instance to the same pressure as the counter-pressure, or 10 atmospheres in the particular case mentioned. When the charging pressure is 10 atmospheres the explosion pressure will rise to about 50 atmospheres. Thus, the combustion gases coming from the explosion chambers will expand in the turbine nozzle or nozzles from 50 atmospheres to 10 atmospheres. Similarly, if steam nozzles are arranged in alternation with the combustion gas nozzles, as in a construction disclosed in my earlier application Serial No. 47,422, Patent No. 1,929,427 issued October 10, 1933, to provide for cooling the rotor of the turbine, this cooling steam will expand in the steam nozzle from 50 atmospheres to 10 atmospheres. In the exhaust chamber receiving exhaust gases, scavenging air and steam from the turbine rotor, these gases, all under a pressure of 10 atmospheres, will become mixed and the temperature of the mixture will be about 450° C.

This exhaust chamber serves, as it were, as a collector for the mixture of combustion gases, steam and scavenging air, and this mixture is then conducted to a multi-stage turbine operated thereby, this latter turbine being preferably arranged to actuate the shaft of the gas turbine, and allowing the mixture to expand gradually to atmospheric pressure. The mixture of combustion gases and steam then passes through a boiler heated by the remaining heat of said gases and steam and thus escapes into the atmosphere, without any condensation. The steam produced in this boiler is utilized for cooling the main gas turbine.

The main gas turbine in which the motive medium expands from say 50 atmospheres to 10 atmospheres, is preferably one in which the rotor has a single set of blades. The second expansion stage, from 10 atmospheres to atmospheric pressure, is preferably utilized in a multi-stage turbine of the reaction type, through which the mixture of combustion gases and steam is caused to pass at a moderate velocity but with a very high degree of efficiency.

Two main advantages are secured by the novel procedure described herein. High initial pressures may be employed in conjunction with structural turbine elements of great efficiency and durability. In other words, the theoretical efficiency ratio becomes very high (60% and more) on account of the use of high pressures, and the mechanical efficiency of the turbine is very high on account of the sub-division or distribution of the pressure drop and on account of the reduction in the jet velocity. Turbines embodying the present invention will have an efficiency of about 40%, which is higher than in heat engines employed hitherto.

Instead of conducting the exhaust from the high pressure stage to a multi-stage reaction turbine, such exhaust (at a pressure of say 10 atmospheres) may be conveyed to any other kind of engine wherein the residual energy of the mixture of gases and steam is converted into mechanical energy.

Experiments have shown that the steam employed for cooling the high pressure turbine has no detrimental effect on the rotor of such turbine, and this enables me to devise the present improved motor operation. A further advantage of my invention resides in the fact that the dimensions and probably the weight of the power plant as well, can be made considerably smaller than according to present practice, this possibility resulting from the use of high pressure and higher number of revolutions of the turbine shaft.

An example of a plant embodying my present invention is illustrated by the accompanying drawing, in which Fig. 1 represents an axial section through the plant on the line 1—1 of Fig. 2, and Fig. 2 a cross-section on the line 2—2 of Fig. 1.

10 designates the rotor of the high pressure turbine around which are arranged the stationary combustion gas nozzles 11, alternating with steam nozzles 12 and receiving their combustion gases

from the explosion chambers 13. In Fig. 1 only one of the steam nozzles 12 is visible, the other steam nozzles being situated behind the structure of the combustion chambers and therefore invisible. The gases escaping from the high pressure turbine, that is to say, combustion gases, scavenging air and steam, pass into an exhaust chamber or collector 15 in which they are mixed, the pressure in said receiver being about 10 atmospheres, while the pressure of the motive fluid in the explosion chambers is about 50 atmospheres. From the exhaust chamber 15 the mixture of gases passes to the second expansion stage engine, indicated at 16. This may be any engine suitable for operation at an initial pressure of about 10 atmospheres, and an exhaust pressure equal to atmospheric pressure or approximately so. In the particular embodiment illustrated, a multi-stage turbine has been indicated at 16 for operation by the mixture of gases above mentioned, but, as stated hereinabove, I might substitute therefor any other kind of engine adapted to employ such mixture of gases under pressure as the driving medium.

The exhaust from the second expansion stage engine being at about atmospheric pressure, passes through a heating coil 17 or equivalent heating device arranged to generate steam in the boiler 18, such steam being then conducted to the nozzles 12. Preferably as illustrated, the second expansion stage engine operates to drive the turbine shaft which is actuated by the high pressure turbine.

Various changes in the specific form shown and described may be made within the scope of the claims without departing from the spirit of my invention.

I claim:

1. A power plant comprising a high pressure turbine having a plurality of explosion chambers, nozzles communicating therewith for the supply of combustion gases under pressure, nozzles for the supply of steam under pressure, a collector for receiving the mixture of the exhaust combustion gases and of the exhaust steam from said turbine at a pressure above atmospheric, and a second expansion stage engine operated by the mixture coming from such collector.

2. A power plant comprising a high pressure turbine having a plurality of explosion chambers, nozzles communicating therewith for the supply of combustion gases under pressure, nozzles for the supply of steam under pressure, a collector for receiving the exhaust combustion gases and the exhaust steam from said turbine at a pressure above atmospheric, a second expansion stage engine operated by the mixture coming from such collector, a steam boiler heated by the exhaust coming from said second expansion stage engine, and a connection for supplying steam from said boiler to the steam nozzles of said high pressure turbine.

HANS HOLZWARTH.