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[54] **GAS-TURBINE PLANT**

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[63] Continuation of Ser. No. 815,668, April 14, 1970, abandoned.

[52] **U.S. Cl.**.....**60/39.32,** 60/39.36

[51] **Int. Cl.**.....**F02c**

[58] **Field of Search**.....60/39.31, 39.32, 39.36; 417/408, 409

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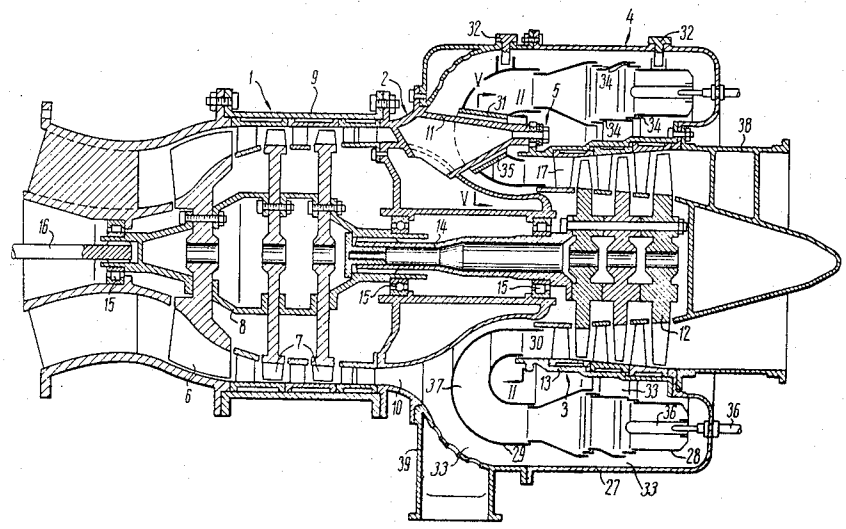
Primary Examiner—Douglas Hart

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[57] **ABSTRACT**

A gas-turbine plant in which the turbine in enclosed in an annular combustion chamber and the inlet portion of the stator of the turbine is connected to the stator of the compressor through the intermediary of the body of the diffusor in such a manner that it is possible to compensate temperature deformations of said body of the diffusor and stator of the turbine. To obtain a compact plant possessing good operating characteristics use is made of a compressor whose first stage is made diagonal and whose subsequent stages are axial.

23 Claims, 5 Drawing Figures



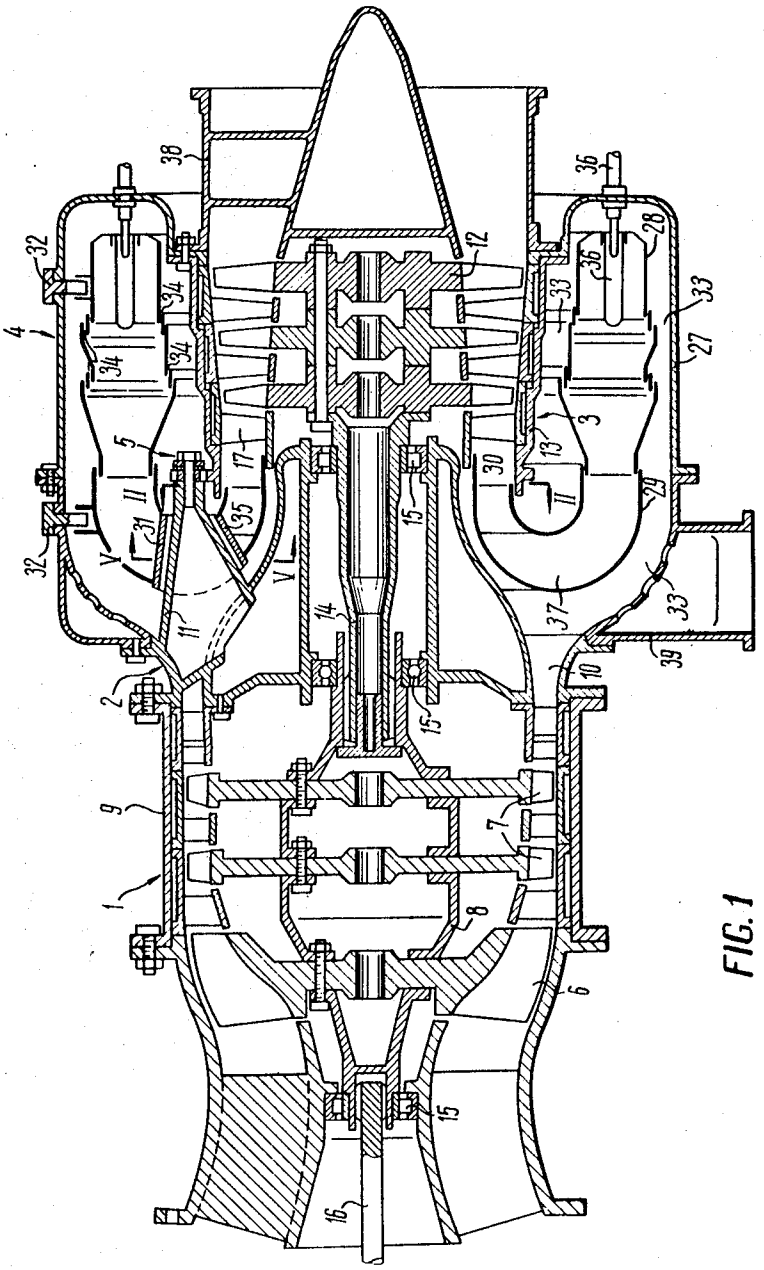


FIG. 1

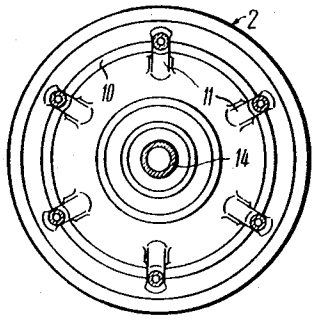


FIG. 2

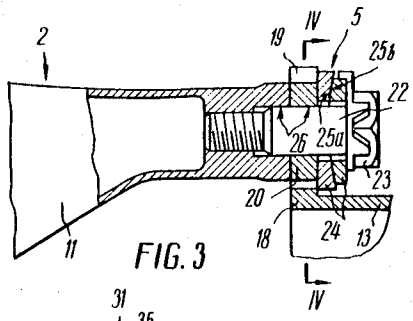


FIG. 3

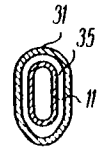


FIG. 5

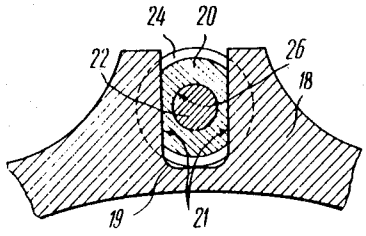


FIG 4

GAS-TURBINE PLANT

This application is a continuation of Ser. No. 815,668, filed Apr. 14, 1970, now abandoned.

The present invention relates to gas-turbine power plants and, more particularly, to plants with a counter-current combustion chamber. In such power plants the turbine is disposed, relative to the direction of the air movement, behind the compressor, and the combustion chamber envelops the turbine along its whole length.

Such characteristics as compactness, weight and resources of operation are of most importance for the gas-turbine power plant.

The characteristic feature of the proposed plant is that the stator of the compressor is coupled with the stator of the turbine.

In conventional plants comprising a counter-current combustion chamber the stator of the compressor is coupled with the turbine stator through the intermediary of the nozzle apparatus of the turbine or the shell of the combustion chamber. In the first case, the nozzle apparatus of the turbine, in addition to great thermal loads, undergoes mechanical loads too, which fact limits the resources of the power plant operation. In the second case, the combustion chamber serves as a power element, which results in an increased weight of the combustion chamber and, hence, of the power plant as a whole.

It is an object of the present invention to provide a gas-turbine plant which does not possess the aforesaid disadvantages. In this power plant the stators of the compressor and the turbine are interconnected in such a manner that the turbine nozzle apparatus and the combustion chamber are not used as elements of this interconnection system, which makes it possible to increase the resources of the plant operation and decrease its weight.

In accordance with the present invention, the stator of the compressor, whose first stage is made diagonal and subsequent stages axial, is connected to the inlet portion of the turbine stator through the intermediary of the diffusor body in such a manner that it is possible to compensate temperature deformations of the diffusor body and the turbine stator.

In the preferred embodiment of the gas-turbine plant it is expedient, in accordance with the present invention, to connect the turbine stator with the diffusor body by means of the struts of the latter.

It is also expedient to provide the gas collector with hollow ribs arranged at the points of disposition of the struts of the diffusor body and designed to house said struts.

To compensate temperature deformations of the diffusor body and the turbine stator it is expedient to provide the unit connecting the diffusor body with the stator with sliders connected to said body by means of bolts, each of which bolts has two washers with spherical adjacent faces, the face of one washer being convex and the face of the other concave. It is expedient to dispose the sliders in radial grooves of the turbine stator.

The following description of the preferred embodiment of the present invention is given with reference to the accompanying drawings, in which:

FIG. 1 is a longitudinal section of a gas-turbine plant according to the invention;

FIG. 2 is an enlarged sectional view taken on the line II—II of FIG. 1;

FIG. 3 is an enlarged view of the unit connecting the struts of the diffusor body with the turbine stator;

FIG. 4 is an enlarged sectional view taken on the line IV—IV of FIG. 3; and

FIG. 5 is an enlarged sectional view taken on the line V—V of FIG. 1.

The gas-turbine plant as shown in FIG. 1 comprises a compressor 1, a diffusor 2, a turbine 3, and a combustion chamber 4 disposed around the turbine 3. The turbine 3 rotates the compressor 1 and serves as a drive for rotating a device (not shown in the drawings).

The body of the diffusor 2 connects the stator of the compressor 1 to the inlet portion of the turbine stator, the temperature deformations of the diffusor body and the turbine stator being compensated in unit 5 connecting the diffusor with the stator of the turbine.

The compressor 1 has a diagonal stage 6 and axial stages 7 disposed in succession after the diagonal stage 6. With its efficiency being the same, the diagonal stage of the compressor, as compared to the axial ones, provides for a higher degree of the pressure increase and higher temperature of air at the outlet. A higher temperature which air acquires in the diagonal stage results in lower values of the Mach number at the outlet thereof, which, as compared to compressors having axial stages only, makes it possible to obtain a higher degree of the pressure increase in the subsequent axial stages. The combined use of the ultrasonic diagonal stage and the subsequent axial stages permits construction of a compressor of a high pressure and, as compared to compressors with axial stages only, having a smaller number of stages, which allows decrease of the axial size of the power plant and its weight.

The compressor 1 has a rotor 8 and a stator 9. The expansion of air taking place in the diffusor 2 mounted behind the compressor 1 results in a decrease of the flow speed and further increase of the pressure. As shown in FIG. 2, disposed along the circumference of the diffusor 2 in annular port 10 are struts 11.

Disposed behind the diffusor 2 (FIG. 1) is the turbine 3 which comprises rotor 12 and stator 13. The rotor 12 is connected by shaft 14 with the rotor 8 of the compressor, both rotors rotating in three supports 15, one of which is disposed on the stator 9 of the compressor and the other two on the diffusor 2. The device driven by the turbine is connected thereto by shaft 16 coupled with the rotor 8 of the compressor. The inlet portion of the stator 13 of the turbine is connected to the struts 11 of the diffusor, the diffusor 2 being centered relative to the stator 13 and connected thereto by means of the unit 5. Since nozzle apparatus 17 of the turbine is not used for connecting the diffusor 2 with the stator 13, it undergoes no mechanical loading.

The diffusor 2 and the stator 13 are disposed in heating zones having different temperatures, which results in their different temperature expansion. The different temperature expansion of the parts 2 and 13 is compensated by the unit 5 which is constricted in the following manner. Disposed on the inlet portion of the stator 13 of the turbine is flange 18 (FIGS. 3,4) which has several radial grooves 19 whose number is equal to that of the diffusor struts 11. Mounted in each of the grooves is a slider 20 which is capable of displacement inside the groove in the radial direction along surface

21. The thickness of the slide 20 may be somewhat greater than the thickness of the flange 18. Passed through the slider 20 is a bolt 22 connected to the strut 11 of the diffusor, the strut 11 contacting the slider 20 and flange 18. Mounted between the slider 20 and the bolt head 23 are two washers 24 with adjacent spherical faces, one washer having a convex face 25*a* and the other a - concave face 25*b*. With the struts 11 of the diffusor radially displacing relative to the flange 18, these washers contribute to decreased mechanical stresses in the bolt 22. The bolt 22 is centered relative to the strut 11 of the slider 20 along cylindrical surface 26.

Disposed around the turbine 3 (FIG. 1) is the combustion chamber 4 whose length equals the length of the turbine. Since the combustion chamber 4 is not used for connecting the compressor stator with the stator of the turbine, it does not serve as a power element, which makes it possible to decrease the weight of the combustion chamber shell, and, hence, the weight of the plant as a whole.

The combustion chamber 4 comprises a shell 27, a fire tube 28 and a gas collector 29. The shell 27 connects the diffusor 2 with the outlet portion of the turbine stator 13, but does not serve as a power element. The fire tube 28 is positioned around the turbine 3 in the annular space between the stator 13 and the shell 27. It may consist of several tubular members, or may be made annular, as shown in FIG. 1. The gas collector 29 connecting the fire tube 28 with the turbine gate 30 effects a 180° change in the direction of the gas flow coming from the fire tube. The annular gas collector 29 has hollow struts 31 (FIGS. 1,5) provided therein and housing the struts 11 connecting the diffusor 2 with the inlet portion of the stator 13. The fire tube 28 and the gas collector 29 are mounted inside the shell 27 by means of radial centering members 32 evenly spaced along the periphery of the shell. The walls of the fire tube 28 (FIG. 1) and gas collector 29 form together with the shell 27 and stator 13 of the turbine annular ports 33 through which compressed air is supplied from the compressor 1 to apertures 34 in the internal and external walls of the fire tube.

As shown in FIG. 5, provided between the hollow strut 31 and the strut 11 disposed thereinside is annular port 35 through which air is passed from the compressor to apertures 34 in the internal wall of the fire tube 28 to cool the struts 11 of the diffusor.

Combustion of the air-fuel mixture takes place in the fire tube 28 (FIG. 1) in which compressed air is mixed with the fuel delivered therein through fuel vaporizers 36. Passed along ports 37 provided between the hollow struts 31, the flow of hot gases is delivered through the gas collector 29 into the turbine. Spent gases are discharged into the atmosphere through outlet device 38.

Compressed air to be used for various purposes may be bled off along tubing 39 mounted behind the diffusor 2.

The afore-described characteristic features of the present invention make it possible to obtain a compact gas-turbine power plant possessing good operating characteristics.

We claim:

1. A gas turbine plant comprising an air compressor including a rotor and a stator; a turbine including a rotor and a stator; means connecting the rotor of the turbine and the rotor of the compressor; a combustion chamber disposed around the turbine for burning fuel and including means for supplying the combustion products to the turbine to drive the rotor thereof; a diffusor for the supply of air from the compressor to the combustion chamber; said diffusor including a body, respective fastener means securing said diffusor body to said stator of the compressor and to said combustion chamber, and a plurality of spaced projecting struts fixed within said body and extending in cantilever fashion from said body towards the stator of the turbine; means connecting the struts at the free ends thereof to said stator of the turbine; and passage means between the struts for the flow of compressed air from said compressor to said combustion chamber.

2. A gas turbine plant as claimed in claim 1 wherein said struts taper in narrowing direction from the diffusor body to the stator of the turbine.

3. A gas turbine plant as claimed in claim 1, wherein said means for supplying the combustion products from the combustion chamber to said turbine comprises a gas collector and a channel connected to said collector and said turbine and having a 180° bend to reverse the direction of flow of the combustion products.

4. A gas turbine plant as claimed in claim 3 comprising hollow struts in said combustion chamber surrounding said projecting struts of the diffusor and defining passages for the flow of air from the compressor to the combustion chamber to cool said projecting struts, said projecting struts and said hollow struts extending through said channel.

5. A gas turbine plant as claimed in claim 4 wherein said combustion chamber includes at least one fire tube connected to said gas collector and having inner and outer surfaces with apertures for admission of compressed air.

6. A gas turbine plant as claimed in claim 5 wherein said fire tube is of annular shape.

7. A gas turbine plant as claimed in claim 5 comprising a nozzle means at the inlet of said turbine facing said channel for receiving the combustion products therefrom, said nozzle means being disconnected from said diffusor.

8. A gas turbine plant as claimed in claim 7 wherein said turbine and combustion chamber have equal lengths.

9. A gas turbine plant comprising an air compressor including a rotor and a stator; a turbine including a rotor and a stator; means connecting the rotor of the turbine and the rotor of the compressor; a combustion chamber disposed around said turbine for burning fuel and including means for supplying the combustion products to the turbine to drive the rotor thereof; a diffusor connected to the stator of the compressor for supplying compressed air to the combustion chamber and including a plurality of spaced projecting struts connected to the stator of the turbine; channels between said struts for the flow of compressed air from said compressor to said combustion chamber and hollow struts in said combustion chamber surrounding said projecting struts of the diffusor and defining passages for the flow of air from the compressor to the combustion chamber to cool said projecting struts.

10. A gas turbine plant as claimed in claim 9 wherein said means for supplying the combustion products from the combustion chamber to said turbine comprises a gas collector and a channel connected to said collector and said turbine and having a 180° bend to reverse the direction of flow of the combustion products.

11. A gas turbine plant as claimed in claim 10 wherein said projecting struts and said hollow struts extend through said channel.

12. A gas turbine as claimed in claim 11 wherein said combustion chamber includes at least one fire tube connected to said gas collector and having inner and outer surfaces with apertures for admission of compressed air.

13. A gas turbine plant as claimed in claim 12 wherein said fire tube is of annular shape.

14. A gas turbine plant as claimed in claim 12 comprising a nozzle means at the inlet of said turbine facing said channel for receiving the combustion products therefrom, said nozzle means being disconnected from said diffusor.

15. A gas turbine plant as claimed in claim 14 wherein said turbine and combustion chamber have equal lengths.

16. A gas turbine plant comprising an air compressor including a rotor and a stator; a turbine including a rotor and a stator; means connecting the rotor of the turbine and the rotor of the compressor; a combustion chamber disposed around said turbine for burning fuel and including means for supplying the combustion products to the turbine to drive the rotor thereof; a diffusor connected to said stator of the compressor for supplying compressed air to said combustion chamber and including a plurality of spaced projecting struts connected to the stator of the turbine; channels between said struts for the flow of compressed air from said compressor to said combustion chamber, and means connecting said projecting struts of the diffusor and the stator of the turbine to compensate for differential temperature deformations of said diffusor and said stator of the turbine.

17. A gas turbine plant as claimed in claim 16 wherein said means connecting the struts of the diffusor and the stator of the turbine comprises sliders mounted in radial slots provided in said stator of the turbine; bolts connected to said projecting struts for coupling the sliders and said projecting struts, and a pair of washers on each side bolt between the head thereof and the associated slider, one washer in each pair having a spherical conves face and the other a mating concave face.

18. A gas turbine plant as claimed in claim 16 wherein said means for supplying the combustion products from the combustion chamber to said turbine comprises a gas collector and a channel connected to said collector and said turbine and having a 180° bend to reverse the direction of flow of the combustion products.

19. A gas turbine plant as claimed in claim 18 comprising hollow struts in said combustion chamber surrounding said projecting struts of the diffusor and defining passages for the flow of air from the compressor to the combination chamber to cool said projecting struts, said projecting struts and said hollow struts extending through said channel.

20. A gas turbine plant as claimed in claim 19 wherein said combustion chamber includes at least one fine tube connected to said gas collector and having inner and outer surfaces with apertures for admission of compressed air.

21. A gas turbine plant as claimed in claim 20 wherein said fire tube is of annular shape.

22. A gas turbine plant as claimed in claim 20 comprising a nozzle means at the inlet of said turbine facing said channel for receiving the combustion products therefrom, said nozzle means being disconnected from said diffusor.

23. A gas turbine plant as claimed in claim 22 wherein said turbine and combustion chamber have equal lengths.

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