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(54) GAS TURBINE ENGINE

(71) We, MOTOREN-UND TURBINEN-UNION MÜNCHEN GmbH, a joint stock company organised under the laws of Germany, of Dachauer Strasse 665, 8000 München 50, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to a gas turbine engine comprising a compressor-drive turbine of the axial flow type, enclosed by a reverse-flow annular combustion chamber arranged co-axially with the longitudinal centerline of the engine.

15 Low-powered gas turbine engines are frequently arranged as described above so that when it is required to achieve high-grade process cycles, i.e., high specific outputs at low specific fuel consumptions, the dimensions, especially of the compressor-drive turbine, become small and make for a great effect of the radial clearance between rotor and stator of the machine on output and efficiency.

25 With conventional engines of this type the stator is flange-bolted to the engine casing via a radially flexible structural connection.

30 As a result, free thermal expansion of the turbine stator is prevented, being governed as it is by the temperature distribution and the flexibility of the turbine stator, the structural connection and the engine casing. The radial clearances between the rotor and the stator are governed by the flexibility of components which otherwise have no direct bearing on the stress/strain and thermal conditions of the turbine. Accordingly, the entire gas turbine engine gives little thermal flexibility, such that operation in applications requiring frequent and rapid changes in output, the engine inevitably needs to have large radial clearances and accordingly has a poor efficiency.

45 It is an object of the present invention to eliminate the disadvantages and to ensure minimum radial clearances between rotor and stator of the compressor-drive turbine even when frequent and rapid changes in output occur.

50 According to this invention a gas turbine

engine comprises a compressor-drive turbine of the axial flow type enclosed by a reverse-flow annular combustion chamber arranged co-axially with the longitudinal centerline of the engine wherein the turbine stator is so designed and arranged that the thermal expansion or contraction of the stator is the same as or comparable with that of the rotor, the turbine stator being connected to the engine outer casing at a single axial position so as to permit free differential thermal expansion or contraction of the turbine stator relative to the outer casing.

In one embodiment, the stator blades of the compressor-drive turbine are separated into individual vanes or into groups of a few vanes each and these vanes or groups of vanes are carried in a longitudinally split casing which on the one side is fitted with a screen to ward off the heat from the combustion chamber area and on the other is connected to the outer casing in a plane behind the combustion chamber by means of a number of radially extending bolts.

This type of connection is to ensure that the longitudinally split casing of the turbine stator, and the nozzle vanes with it, is free to expand with no interference from forces and distortions coming from the engine casing.

The annulus formed by the turbine stator casing and the casing shell between the combustion chamber and the stator casing is energized with air from the outlet of the compressor, this air flowing through the stator casing via a number of radial ports to aerate the stator or conceivably to cool the turbine nozzle vanes.

This arrangement makes it possible to attune the amount and/or rate of thermal expansion or contraction of the turbine stator ideally to be the same as the expansion or contraction of the turbine rotor, so that even when sudden changes in power occur, the engine can be operated at very narrow radial clearances over a wide power range, which will benefit turbine efficiency and with it the specific fuel consumption and specific power output.

An embodiment of this invention will now be

described by way of example with reference to the accompanying drawings in which:—

Fig. 1 is a schematic elevation and shows the lower half of a gas turbine engine; and

5 Fig. 2 is an enlarged, more detailed view of the gas turbine engine shown in Fig. 1 and illustrates a portion of the reverse-flow annular combustion chamber including the compressor drive turbine.

10 The gas turbine schematically shown in Fig. 1 comprises (from right to left), the following components: a radial-flow compressor 1, a reverse-flow annular combustion chamber 2, and an axial-flow turbine 3 driving the compressor, the compressor drive turbine 3 and compressor 1 being arranged on a common shaft 4. A turbine exhaust duct 5 communicates with an exhaust system (not shown).

20 As is more readily apparent from Fig. 2 the compressor-drive turbine of the gas turbine engine is enclosed by the reverse-flow annular combustion chamber 2 extending co-axially with the longitudinal centerline 6 (Fig. 1) of the engine, where part of the outer casing 7 of the engine simultaneously serves as an outer casing of the reverse-flow annular combustion chamber 2.

30 As will also be seen from Fig. 2, a screen 10 is radially spaced from turbine stator casing 8 in continuation of the combustion chamber outer casing between the flame tube 9 of the reverse-flow annular combustion chamber 2, and the casing 8 of the turbine stator where the annulus 11 formed between the screen 10 and the turbine stator casing 8 communicates with the air duct 13 formed between outer casing 7 and flame tube 9 of the reverse-flow combustion chamber through at least one port 12 in the screen 10.

40 Annulus 11 also communicates with air chambers 16, 17 through ports 14, 15 arranged in the casing 8 of the turbine stator, the air chambers essentially being enclosed by the stator casing 8 on the one side and by nozzle vane outer bands 18, 19 and by shroud segments 20, 21.

45 The turbine nozzle vanes are indicated by the numerals 22, 23, and the rotor blades by 24, 25.

50 The flow of cooling air from air duct 13 to the air chambers 16, 17 through annulus 11 is indicated by arrows F. This cooling air could conceivably be used to cool also the nozzle vanes 22, 23.

55 The nozzle vane outer bands 18, 19 and the shroud segments 20, 21 are held together by collar-shaped projections and to casing 8 of the turbine stator with axial and radial clearances.

60 The casing 8 of the turbine stator is attached to the outer casing 7 at a single axial position, by means of radially extending bolts 26 (one shown) secured to the casing 8 on one side and carried in axially projecting

flanges 27 or sections 28 of the outer casing 7 of the engine so that the casing 8 of the turbine stator is free to expand.

This arrangement also makes for ease of separation of the casing 8 of the turbine stator from the outer casing 7.

70 A differently routed flow of cooling air 7¹ serving for cooling especially of the two rotor discs 29, 30, of the compressor drive turbine 3 is indicated by the arrows F¹. This air may, again, provide cooling also for the rotor blades and can be discharged through an opening in an outer casing section of the combustion chamber defining an air duct for cooling the flame tube 9 and supplied with air by the radial-flow compressor 1.

80 Reference 40 (figure 2) shows one of several bolts for the interconnection of the two rotor discs 29 and 30 and reference 41 shows one of several cooling flow passages of the rotor disc 30 being arranged equidistantly between the bolts.

85 The gas turbine engine illustrated in Figs. 1 and 2 is a small engine suitable for various applications, such as aircraft, road vehicle, tank and marine propulsion and for stationary applications.

WHAT WE CLAIM IS:—

95 1. A gas turbine engine comprising a compressor-drive turbine of the axial flow type enclosed by a reverse-flow annular combustion chamber arranged co-axially with the longitudinal centerline of the engine wherein the turbine stator is so designed and arranged 100 that the thermal expansion or contraction of the stator is the same as or comparable with that of the rotor, the turbine stator being connected to the engine outer casing at a single axial position so as to permit free 105 differential thermal expansion or contraction of the turbine stator relative to the outer casing.

110 2. A gas turbine engine according to Claim 1, wherein a portion of the outer casing of the engine simultaneously serves as an outer casing for the reverse-flow annular combustion chamber, the casing of the turbine stator is attached to axially projecting flanges or sections of the engine outer casing by 115 means of radially extending bolts and wherein a screen is arranged at a distance radially from the turbine stator casing in continuation of the engine outer casing essentially between the flame tube of the reverse-flow annular 120 combustion chamber and the casing of the turbine stator, where the annulus formed between the screen and the casing of the turbine stator communicates with an air duct formed between the engine outer casing and the flame 125 tube of the reverse-flow combustion chamber and also with air chambers which are essentially enclosed on the one side by the casing and on the other by nozzle vane outer bands and shroud segments. 130

3. A gas turbine engine according to Claim 2, wherein the nozzle vane outer bands and the shroud segments are conventionally held one to the other by means of collar-shaped projections and to the casing of the turbine stator with axial and radial clearances. 10
- 5 4. A gas turbine engine constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawing.
- WITHERS & ROGERS,
Chartered Patent Agents,
4 Dyers Buildings,
Holborn,
London EC1 2JT.
Agents for the Applicants.

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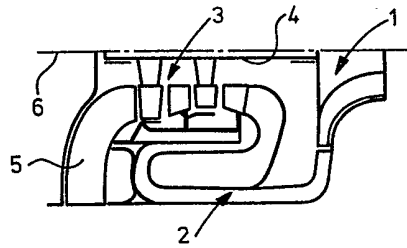


Fig. 1

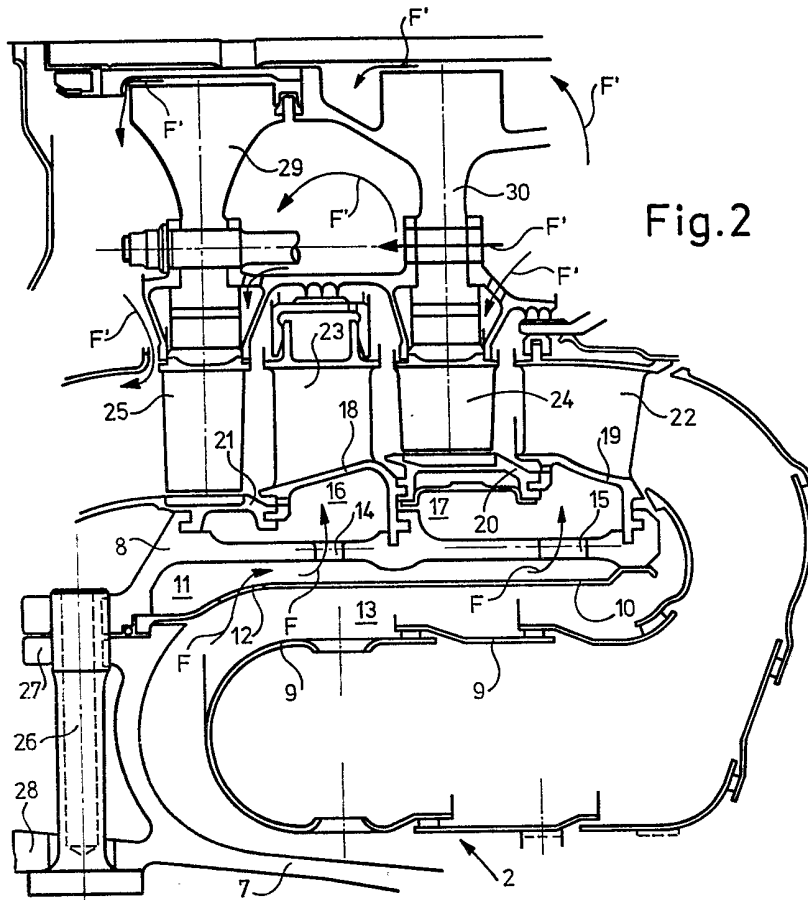


Fig. 2