United States Patent

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[54] **TURBINE ENGINE HAVING MULTISTAGE COMPRESSOR WITH INTERSTAGE BLEED AIR SYSTEM**
5 Claims, 3 Drawing Figs.

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[51] **Int. Cl.** **F01b 25/00**
[50] **Field of Search** 415/112, 115, 144, 145, 199

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ABSTRACT: A bleed system which provides air for other than combustion purposes in a gas turbine engine. Bleed air is diverted from a multistage axial flow compressor through a diffuser flow passageway formed in the casing of the compressor. The entrance to this bleed passageway is defined by an annular lip disposed, in an axial sense, between a row of stator vanes and a row of rotor blades.

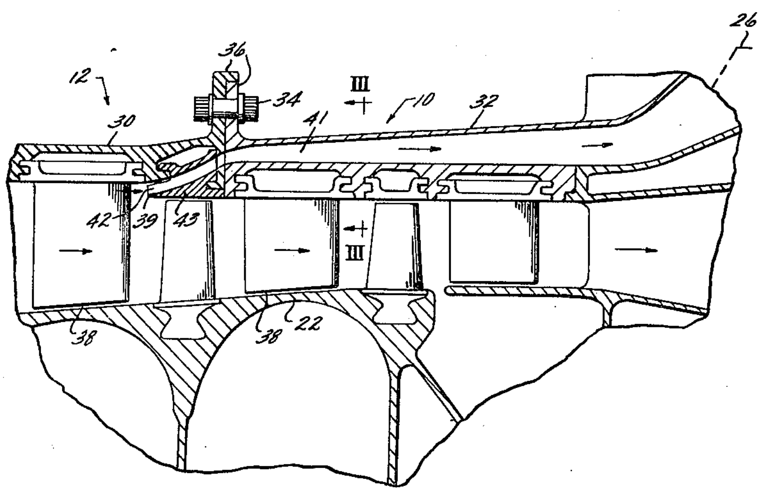


Fig 1

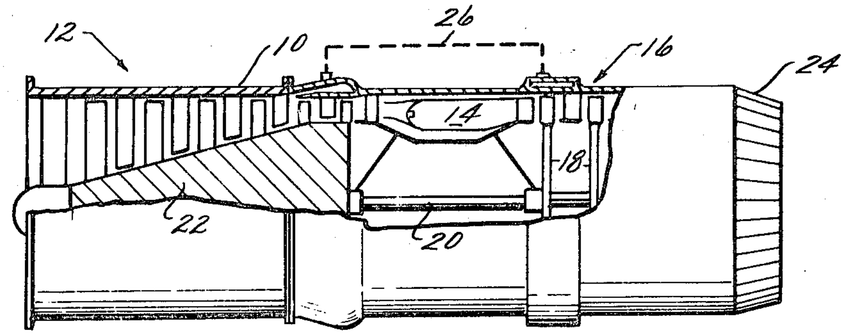


Fig 2

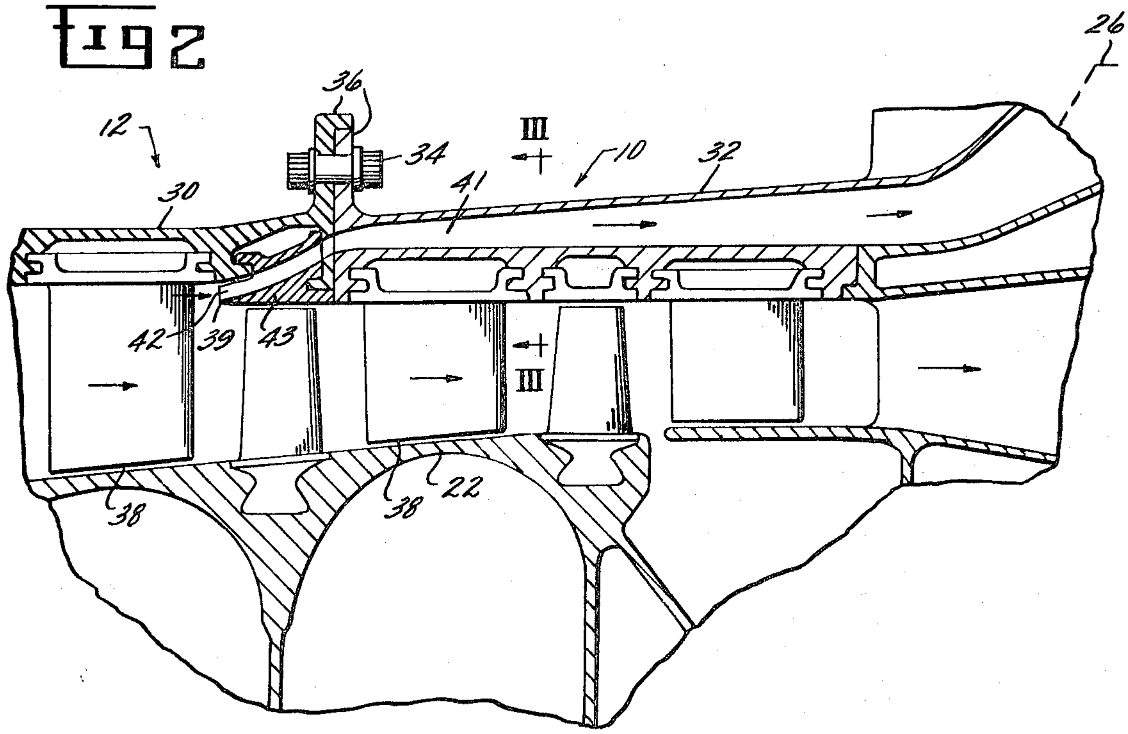
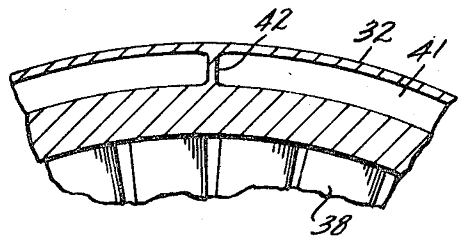


Fig 3



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TURBINE ENGINE HAVING MULTISTAGE COMPRESSOR WITH INTERSTAGE BLEED AIR SYSTEM

The present invention relates to improvements in gas turbine engines having axial flow compressors and, more particularly, to improved interstage bleed air systems therefor. The invention herein described was made in the course of or under a contract, or a subcontract thereunder, with the United States Department of the Air Force.

The primary function of the compressor of a gas turbine engine is to pressurize air so that the energy level of the hot gas stream generated by the engine may be increased. This pressurized air is also utilized for other purposes, such as cooling the hot sections of the engine and pressurizing lubrication sumps for rotating parts.

Much of the air used for other purposes does not require or cannot be utilized at pressurization levels generated at the compressor discharge. It has long been recognized that overall engine efficiency can be improved by bleeding lower pressure air, for cooling or the like, from an intermediate stage of a multistage axial flow compressor, this being the type of compressor commonly employed in high performance gas turbine engines. Bleed air systems have been utilized for such purposes but have failed to fully realize the potential improvements in efficiency, particularly where large quantities of air are to be bled.

The object of the present invention is to improve such bleed air systems and overcome or minimize the limitations of prior systems which have caused relatively high energy losses in the bled air and increased weight and length of the engine in incorporating a bleed system.

These ends are attained by providing an annular bleed flow passageway in the casing of the compressor with the entrance to this passageway being defined by an annular lip disposed between a row of stator vanes and a row of rotor blades at the discharge of the stator vanes. Preferably the bleed passageway is a diffuser to reduce the velocity of the bleed air so that energy losses in its transmission to a point of utilization will be minimized.

It is also preferable that the compressor casing be formed in sections joined by radial flanges adjacent the downstream end of the first rotor blade which is surrounded by the bleed air passageway. This arrangement facilities provision of a replaceable insert to form the entrance lip and initial portion of the bleed passageway. In the event of a blade rub at this point, the insert, which is relatively inexpensive, may be readily replaced in restoring the compressor to its full operating capability.

The above and other related objects and features of the invention will be apparent from a reading of the following description of the disclosure found in the accompanying drawings and the novelty thereof pointed out in the appended claims.

In the drawings:

FIG. 1 is a simplified illustration, partially in section, of a gas turbine engine embodying the present invention;

FIG. 2 is an enlarged, detailed section of the present interstage bleed system; and

FIG. 3 is a section, taken on line III—III, in FIG. 2.

The engine seen in FIG. 1 comprises an outer casing 10 which may be compositely formed by several sections. Air enters an inlet at one end of the casing 10 and is pressurized by a multistage axial flow compressor 12. The pressurized air supports combustion of fuel in a combustor 14 to generate a hot gas stream. A portion of the energy of the hot gas stream is used to drive a turbine 16. The turbine rotor 18 is connected by a shaft 20 to the compressor rotor 22. The remaining energy of the hot gas stream may be converted to a propulsive force by being discharged from a nozzle 24.

As higher operating temperatures have been attained, sophisticated cooling systems have been developed to prevent overtemperaturing of the engine components. As discussed above, air derived from an intermediate stage of the compressor most efficiently serves many cooling functions as well as serving to pressurize and assist in sealing lubrication sumps for rotating components of the engine.

The flow path for bleed air from the compressor to its point of utilization may take many forms which are oftentimes dictated by the type of gas turbine engine and design philosophy. For that reason, broken line 26 is employed to represent the flow path of the bleed to a point of utilization in cooling a portion of the turbine 16. The schematically represented flow path begins at a point after the bleed air has been diverted from the compressor by structure embodying the present invention, which will now be described with reference to FIGS. 2 and 3.

The engine casing surrounding the compressor includes semicylindrical sections 30 and 32 which are joined along a longitudinal split line (not shown) and by bolts 34 extending through radial flanges 36. Stator vanes 38 are mounted in a circumferential row on the casing section 30. The compressor flow path is reduced in area intermediate the vanes 38 and the next successive row of blades 40 mounted on the compressor rotor 22. The reduction in compressor flow area is accomplished with an annular lip 39 which defines the entrance to a bleed air flow passageway 41. The passageway 41 is essentially annular, being interrupted only by longitudinal ribs 42 which connect the inner and outer walls of the passageway 41. It will further be noted that the passageway 41 increases in cross section from its inlet, at lip 39, to its outlet, at the downstream end of the casing section 32, in order that the bleed will be diffused as it travels along this passageway.

Preferably the lip 39 and the initial portion of passageway 41 are formed by curved inserts 43 which are detachably mounted on the casing sections 30 as by the illustrated lug and groove arrangement wherein slots (not shown) in the groove provide for installation and removal after the fashion of a bayonet connection. The initial portion of the passageway 41 surrounds the rotating row of blades 40. The described inserts facilitate repair of the casing in the event the blades 40 rub against the inner wall of the casing. In such event, the inserts 43 may simply be replaced in the same fashion as the inserts which surround other rows of rotor blades. Thus it is possible to have a thin lip 39 and at the same time the facility to economically make repairs.

The low included angle of the annular lip 39 minimizes flow losses and permits the high-velocity air to be diverted from the compressor at a low turning angle. It will also be noted that the outer surface of the bleed passageway 41 is a smoothly curved continuation of the inner surface of the casing section 30. Further, by disposing the lip 39 downstream of the row of stator vanes 38, the bleed air enters the bleed passageway 41 in an essentially axial direction. All of this minimizes losses in the velocity head of the air being diverted. This means that the bleed air is able to be utilized at essentially the total pressure of the compressor stage from which it is diverted. The diffuser action of the passageway 41, built into the compressor sections 32, effectively drops the velocity of the air so that it may pass through the flow path 26 to a point of utilization with a minimum energy loss.

It will be seen that, with the described bleed air diverting means, the axial length of the compressor is essentially unaffected. That is, the spacing between the row of stator vanes 38 and the row of blades 40 is essentially the same as the usual spacing between such rows when bleed air is not to be diverted.

Another feature is found in that the flow path of the compressor, downstream of the bleed passageway, is reduced by reducing the outer diameter of the flow path. This enables the rotor, which is a highly stressed shell, to be optimized in its load-bearing configuration without any abrupt changes in its diameter. The area reduction at the blades 40 approximates the entrance area to the bleed passageway 41 so that there is a minimum disturbance in air flow at this point.

Having thus described the invention, what is claimed as novel and desired to be secured by Letters Patent of the United States is:

1. A gas turbine engine including a multistage, axial flow compressor having a flow path of progressively decreasing area comprising,

an outer casing having axially spaced, circumferential rows of inwardly projecting stator vanes mounted thereon and through which the flow path area is maintained at least as small at the exit as at the entrance thereto,

a rotor having circumferential rows of blades projecting therefrom and respectively spaced upstream of the vane rows,

an annular bleed passageway formed in said casing,

the outer surface of said bleed passageway being formed as a smooth continuation of the outer bounds of the compressor flow path at the downstream end of one of said rows of vanes,

an annular lip spaced inwardly from the outer bounds of flow path through the vanes and also inwardly of the outer ends of said one vane row and defining an upstream facing entrance to said bleed passageway, said lip being relatively sharp and having a low included angle whereby the divergence of said bleed passageway from the compressor flow path is at an relatively low angle, the inner surface of said lip also defining the outer bounds of the flow path past the next succeeding blade row the area of which is proportionately reduced by approximately the area of the entrance to said bleed passageway, and

means providing a flow path from the downstream end of the compressor casing to a point of bleed air utilization.

2. A gas turbine engine as in claim 1 wherein,

the bleed passageway increases in cross-sectional area along its length to diffuse the bleed air to a lower velocity.

3. A gas turbine engine as in claim 1 wherein,

the inner and outer portions of the casing which define the opposite sides of the bleed passageway are interconnected by longitudinal ribs.

4. A gas turbine engine as in claim 1 wherein,

the casing is split into sections along a plane normal to the engine axis and disposed at the downstream end of the first row of rotor blades which the bleed passageway surrounds,

a replaceable insert mounted on the upstream casing section and providing said annular lip and the initial portion of said bleed passageway,

said insert facilitating repair of said casing in the event of a rotor blade rub thereon.

5. A gas turbine engine as in claim 4 wherein,

the bleed passageway increases in cross-sectional area along its length to diffuse the bleed air to a lower velocity and

the inner and outer portions of the casing which define the opposite sides of the bleed passageway are interconnected by longitudinal ribs.

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