FAN BLADE TIP CLEARANCE CONTROL VIA Z-BANDS

BACKGROUND

The present disclosure relates to a blade tip clearance control system, more specifically a fan blade tip clearance control system, to be used in engines such as gas turbine engines.

In a gas turbine engine, fan blades may be formed from an aluminum material, while the casing surrounding the fan blades may be formed from a composite material. There can be large differences in the thermal growth of these two materials. As a result, blade tip clearances may go beyond a desired range and fan efficiency may decrease.

SUMMARY

A system which helps maintain control of the blade tip clearance is highly desirable from the standpoint of obtaining fan efficiency.

In accordance with the present disclosure, there is provided an engine which broadly comprises a blade, a casing surrounding the blade, a seal ring, and a passive system for connecting the seal ring to the casing and for accommodating thermal expansion of the seal ring relative to the casing so as to maintain blade tip clearance control.

Further in accordance with the present disclosure, there is provided a method for maintaining blade clearance tip control in a fan section of an engine, which method broadly comprises the steps of: providing a fan casing formed from a composite material and a plurality of fan blades formed from an aluminum containing material; providing an annular seal ring; and providing a passive system for connecting the seal ring to the casing and for accommodating thermal expansion of the seal ring relative to the casing so as to maintain the blade tip clearance control.

Other details of the fan blade tip clearance control via Z-bands are set forth in the following detailed description and the accompanying drawings, wherein like reference numerals depict like elements.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic representation of a gas turbine engine having a fan section; and

FIG. **2** is a sectional view of a system for maintaining blade tip clearance control.

DETAILED DESCRIPTION

Referring now to FIG. **1**, a gas turbine engine **10** is diagrammatically shown. The gas turbine engine **10** includes a fan section **12**, a compressor section **14**, a combustor section **16**, and a turbine section **18**. The gas turbine engine **10** has an axially extending centerline **22**. Ambient air enters the engine **10** through the fan section **12**. A fraction of that air subsequently travels through the compressor, combustor and turbine sections **14**, **16**, and **18** as core gas flow before exiting through a nozzle.

The fan section **12** includes a fan casing **30** and a plurality of fan blades **32** which rotate about the centerline **22**. The fan blades **32** are each connected to a fan rotor disk **34** which may be driven by a spool or shaft **33** connected to a low pressure turbine array **35** in the turbine section **18**. If desired, each fan blade **32** may be formed from an aluminum containing material such as an aluminum or an aluminum alloy where aluminum is present in an amount greater than **50** percent by weight.

The fan casing **30** may be formed from any suitable material. If desired, the fan casing **30** may be formed from a composite material such as an organic matrix composite material.

Referring now to FIG. **2**, the fan casing **30** is provided with a seal ring **40** such as an abradable seal ring. The seal ring **40** may comprise an annular rub strip **42** formed from an abradable material and an annular backing ring **44**. The backing ring **44** may be formed from a metallic material such as an aluminum containing material including, but not limited to, aluminum and aluminum alloys where aluminum is present in an amount greater than **50** percent by weight. The backing ring **44** thus passively matches the thermal growth of the fan blades **32**.

It is desirable to maintain a clearance distance between the seal ring **40** and the tip **46** of each fan blade **32**. To this end, a passive system **48** for connecting the seal ring **40** to the fan casing **30** is provided. The passive system **48** accommodates thermal expansion of the seal ring **40** relative to the fan casing **30** so as to maintain blade tip clearance control. The system **48** is passive because it does not require the use of sensors, heating elements, piezoelectric materials, shape memory metal elements, fluid control systems, and the like.

The passive system **48** may comprise a plurality of Z-bands **50** extending between an inner wall **52** of an annular duct portion **54** of the fan casing **30** and the abradable seal ring **40**. Each Z-band **50** may be formed from a non-corrugated, solid piece of metallic material such as nickel sheet material, a nickel alloy sheet material such as INCO 718, a steel sheet material, a titanium sheet material, an aluminum sheet material or a composite sheet material. The material which is used for each Z-band may have a thermal growth which falls between the thermal growth of the material forming the fan casing and the thermal growth of aluminum. Each Z-band **50** may have an annular configuration and extend about the entire inner periphery of the duct portion **54**. Alternatively, each Z-band **50** may comprise an arc segment which extends about a portion of the inner periphery of the duct portion **54**. If metallic, each Z-band may have a thickness in the range of 0.015 to 0.030 inches. If composite, each Z-band may have a thickness in a wider range of 0.015 to 0.060 inches due to fiber orientation and lay-up possibilities.

Each Z-band **50** may be attached to the inner wall **52** and to the exterior surface **56** of the backing ring **44**. Any suitable means may be used to attach each Z-band **50** to the inner wall **52** and to the exterior surface **56**. For example, nuts and bolts may be used to join each Z-band **50** to the inner wall **52** and the exterior surface **56**.

As can be seen from the foregoing discussion, the fan casing **30** and the backing ring **44** are formed by different materials having different thermal expansion coefficients.

The Z-bands **50** allow the backing ring **44** to thermally expand relative to the fan casing **30**. Each Z-band **50** may be provided with a thickness which is sufficiently thin so that the alpha thermal differences between the Z-bands **50** and the backing ring **44** have minimal influence on the backing ring **44** and hence blade tip clearance is maintained.

If desired, the passive system **48** may comprise multiple Z-bands, for example, three Z-bands **50** with a first of the Z-bands **50** being attached to a leading edge portion **60** of the seal ring **40**, a second of the Z-bands **50** being attached to a trailing edge portion **62** of the seal ring **40**, and a third of the Z-bands **50** is attached to the seal ring **40** intermediate of the first and second ones of the Z-bands **50**.