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(54) IMPROVEMENTS IN OR RELATING TO SEALING SYSTEM FOR ROTORS

(71) We, ROLLS-ROYCE LIMITED, a British Company of 65 Buckingham Gate, London, SW1E 6AT, 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:—

This invention relates to sealing systems for rotors, particularly between the radially outer peripheries of rotors and the surrounding stationary structure such as turbine rotors.

Considerable losses in efficiency can occur in a turbine if large clearances are provided between the ends of the turbine blades and a turbine casing, due to leakage of the propelling gases past the ends of the blades. But sufficiently large clearances must be provided so that as the speed of the turbine rotor increases and expands due to centrifugal forces and temperature differences, the tips of the turbine blades still remain clear of the casing.

It is an object of the present invention to provide a sealing system for a rotor which will reduce this leakage rate past the outer periphery of the rotor.

According to the present invention a sealing system for a rotor which is adapted to be supplied with a fluid comprises an annulus mounted on the periphery of the rotor and defining an annular clearance between the rotor and a stationary member surrounding the rotor, and meansf or injecting further fluid upstream of the annular clearance, but sufficiently close to the clearance to create a turbulent region in the fluid adjacent to the clearance, whereby the flow of fluid through the clearance is reduced.

The means for injecting further fluid may be located at a distance upstream of the annular clearance of substantially half the width of the clearance.

The annulus may comprise a radially extending flange formed on the periphery of the rotor, the radially outer end defining an annular clearance between it and the stationary member, or the annulus may comprise an axially extending flange formed on the periphery of the rotor, the end of the flange defining an annular gap between it and a radially extending wall portion of the stationary member.

The rotor preferably comprises a bladed rotor having an outer annular shroud ring.

The bladed rotor may be a turbine rotor.

The invention also comprises a gas turbine engine having a sealing system as set forth above.

Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings in which:—

In Figure 1 there is illustrated a gas turbine turbine engine having a rotor in accordance with the invention,

Figure 2 is a scrap view of part of the turbine illustrating part of the turbine blade and the turbine stator,

Figure 3 is a scrap view of part of the turbine illustrating another embodiment of the invention, and

Figure 4 shows the airflow pattern over the end of a turbine blade shroud seal.

In Figure 1 there is illustrated a gas turibne engine comprising an air intake 10, a compressor 12, combustion equipment 14, a turbine 16, a jet pipe 18, and an exhaust nozzle.

The turbine 16 consists of a series of bladed rotors mounted within a casing, and a basic problem with turbines is to prevent hot gases from leaking past the outer ends of the blades and hence doing no work on the blades. This problem is minimised by providing an outer shroud ring on the tips usually with radially outwardly projecting annular seals.

Leakage still occurs, however, since sufficient clearance must be left between the edge of the annular seal and the turbine casing to allow for both differential thermal expansion of the turbine rotor relative to the casing and expansion due to centrifugal forces.

In Figure 2 there is shown part of a turbine blade 22 having a shroud ring 24 and a radially outwardly projecting annular seal 26. The seal 26 is adapted to reduce leakage between it and the turbine casing 28, but an annular clearance *a* must be provided between the outer end of the seal 26 and the casing 28.

To reduce the leakage through this clearance a series of spaced orifices, only one 30 of which is shown, are formed in the turbine casing completely around the turbine rotor and in a plane slightly upstream of the radially outer end of the seal 26. These orifices 30 can have any suitable cross-sectional shape, and can be at an angle of substantially 90° to the internal surface of the turbine casing 28 as shown, or be arranged at an acute angle to the internal surface. They can also be, and are preferably angled tangentially to the internal surface of the turbine casing 28.

During operation of the turbine, pressurised air is supplied along the orifices 30, and spoils the flow of the leaking gas over the seal 26 by causing a disturbance immediately upstream of and adjacent to the end of the seal 26. This is illustrated in Figure 4. Furthermore, a portion of the leaking gas flow is replaced by the cooler pressurised air, thus a greater proportion of the hot gas is used to do useful work on the turbine blade 22. The pressurised air is tapped from the compressor 12 and is substantially cooler than the turbine gases and so the turbine blade shroud 24 and the seal 26 is cooled. Since there is less leakage of the hot gas, an improvement in the efficiency of the turbine can be achieved with a corresponding improvement in the specific fuel consumption of the engine.

It has been found that the best improvement is achieved if the dimension *b* is equal to half the clearance *a*, although improvements are also achieved if *b* is between 0 and $\frac{1}{2}a$, or greater than $\frac{1}{2}a$.

In Figure 3 is shown a turbine blade 22 with an axially upstream extending annular seal 32 formed on the blade shroud 24. This is adapted to extend closely up to a radial wall portion 34 of the turbine casing 28. To minimise leakage past this seal, axially extending orifices 36 are provided in the wall portion 34 which are supplied with pressurised air, as before. These orifices may also be formed at an angle to the interior surface of the wall portion 34. Since the hot gases in this case are attempting to leak radially past the end of the seal 32, the action of the pressurised air is as before, both spoiling the hot gas flow past the end of the seal 32 and replacing a portion of the hot gas flow with cooler air.

WHAT WE CLAIM IS:—

1. A sealing system for a rotor which is adapted to be supplied with a fluid, comprising an annulus mounted on the periphery of the rotor and defining an annular clearance between the rotor and a stationary member surrounding the rotor and means for injecting further fluid upstream of the annular clearance, but sufficiently close to the clearance to create a turbulent region in the fluid adjacent to the clearance whereby the flow of fluid through the clearance is reduced.

2. A sealing system as claimed in claim 1 in which the means for injecting further fluid is located at a distance upstream of the annular clearance of substantially half the width of the clearance.

3. A seating system as claimed in claim 1 or claim 2 in which the annulus comprises a radially extending flange formed on the periphery of the rotor, the radially outer end defining an annular clearance between it and the stationary member.

4. A sealing system as claimed in claim 1 or claim 2 in which the annulus comprises an axially extending flange formed on the periphery of the rotor, the end of the flange defining an annular gap between it and a radially extending wall portion of the stationary member.

5. A sealing system as claimed in any preceding claim in which the rotor comprises a bladed rotor having an outer annular shroud ring.

6. A sealing system as claimed in claim 5 in which the bladed rotor comprises a turbine rotor.

7. A gas turbine engine having a sealing system for a rotor as claimed in any preceding claim.

8. A sealing system constructed and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

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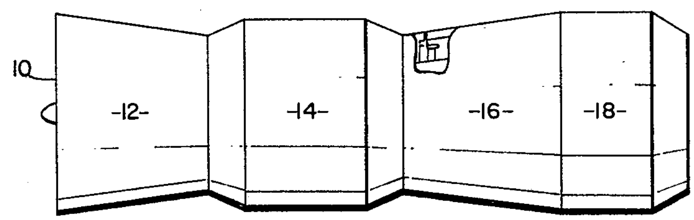

Fig. 1

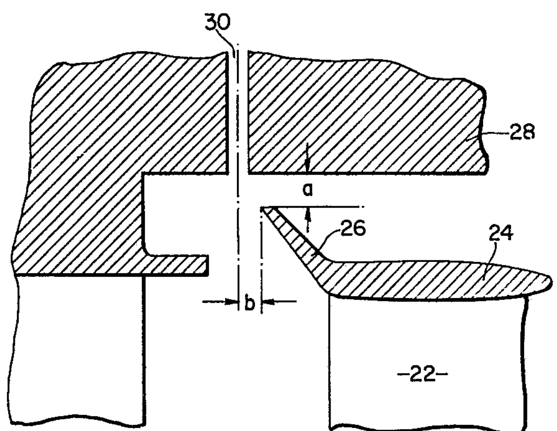

Fig. 2

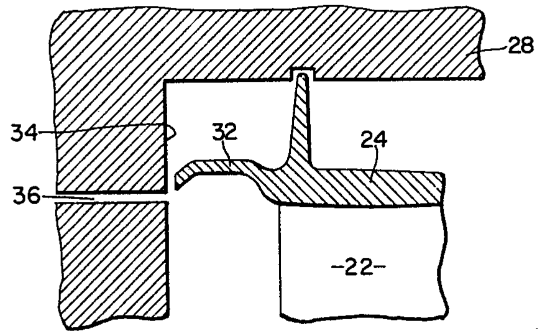

Fig. 3

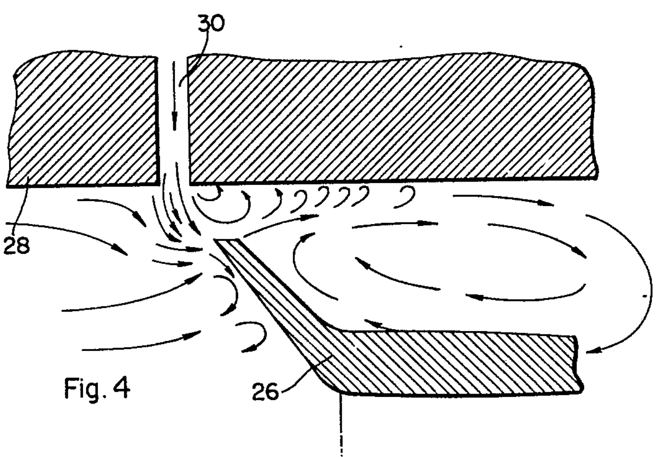

Fig. 4