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Guide vane assembly

Abstract

A guide vane assembly includes a guide vane and a sealing assembly slidable along a span of the guide vane relative to the guide vane and extending along a chordal axis and the span of the guide vane. The sealing assembly includes a plate configured to be disposed around at least a portion of an external surface of the guide vane. The sealing assembly further includes a manifold coupled to the plate and configured to receive pressurized fluid therein. The manifold is disposed around the plate. The sealing assembly further includes a plurality of flow tubes extending between the manifold and the plate. Each of the plurality of flow tubes are configured to receive the pressurized fluid from the manifold.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS
(1) This specification is based upon and claims the benefit of priority from United Kingdom patent application number GB 2316388.4 filed on Oct. 26, 2023, the entire contents of which is incorporated herein by reference.
BACKGROUND
Technical Field
(2) The present disclosure relates to a guide vane assembly, e.g. for a gas turbine engine, a guide vane system that includes the guide vane assemblies, and a rotary machine that includes the guide vane system.

Description Of the Related Art

(3) A gas turbine engine may include a guide vane assembly. The guide vane assembly typically includes a circumferential array of conventionally variable guide vanes. Such a conventionally variable guide vane system may be associated, for example, with a cabin blower system of the gas turbine engine that may be used to maintain a desired pressure inside a cabin of the aircraft. The guide vane assembly may expand an operating range and improve an efficiency of the cabin blower system.

(4) Generally, the guide vane assembly may require multiple rotational bushings, seals, and a complex unison ring to effect consistent actuation of all vanes. The guide vane assembly may include a mechanical seal that may be in direct contact with the guide vane to prevent leakage of a fluid from a flow region, which may otherwise affect an efficiency of the guide vane assembly. Further, such seals may be made from a material that may not be suitable for high temperature applications. In some examples, the seal may include a carbon seal that is prone to wear and may negatively impact a sealing performance and system force margins. Further, failure of the seal may lead to an undesirable increase in maintenance costs associated with the guide vane assembly. Further, some conventional mechanical seals may have moving parts that may lead to wear and tear and may also have a complex design.

(5) Thus, conventional seals of the guide vane assembly may be costly, may not provide efficient sealing, and may be prone to wear and tear. Therefore, an improved sealing assembly may be required for the guide vane assembly to address the above-described shortcomings.

SUMMARY

(6) In a first aspect, there is provided a guide vane assembly. The guide vane assembly includes a guide vane. The guide vane includes an aerofoil. The aerofoil includes a leading edge, a trailing edge, a suction surface, a pressure surface, a root, and a tip. The aerofoil defines a chordal axis of the guide vane between the leading edge and the trailing edge. The aerofoil further defines a span of the guide vane between the root and the tip. The pressure surface and the suction surface together define an external surface of the guide vane. The guide vane assembly further includes a sealing assembly slidable along the span of the guide vane relative to the guide vane and extending along the chordal axis and the span of the guide vane. The sealing assembly includes a plate configured to be disposed around at least a portion of the external surface of the guide vane. The plate is spaced apart from the external surface of the guide vane to define a clearance therebetween. The plate defines a plurality of openings extending therethrough. Each of the plurality of openings is in fluid communication with the clearance between the plate and the guide vane. The sealing assembly further includes a manifold coupled to the plate and configured to receive pressurized fluid therein. The manifold is disposed around the plate. The sealing assembly further includes a plurality of flow tubes extending between the manifold and the plate. Each of the plurality of flow tubes defines a flow passage that is in fluid communication with a corresponding opening in the plate. Each of the plurality of flow tubes are configured to receive the pressurized fluid from the manifold. Each opening in the plate receives the pressurized fluid from a corresponding flow tube of the plurality of flow tubes to direct a jet of pressurized fluid towards the external surface of the guide vane to seal the clearance between the plate and the guide vane.

(7) The sealing assembly described herein provides a non-contacting and non- wearing means to seal the clearance around the guide vane. The sealing assembly uses the pressurized fluid to seal the clearance between the plate and the guide vane. The sealing assembly may prevent the leakage of fluid around a perimeter of the guide vane i.e., around the pressure surface and the suction surface of the aerofoil and may ensure smooth operation of the guide vane assembly. Further, the plate and the manifold may be made of a metallic material and does not include any moving parts. Since the sealing assembly has a substantially smaller number of moving parts and does not mechanically contact the guide vane, the sealing assembly may be capable to withstand high operational temperatures and may be less susceptible to wear and tear. Thus, the sealing assembly

may have an improved life cycle, and may also reduce maintenance as well as replacement costs associated with the guide vane assembly. Also, the sealing assembly may eliminate any frictional sealing translational forces between the guide vane and the plate of the sealing assembly, thereby reducing actuation system force requirements and force margins. Furthermore, the plate and the manifold of the sealing assembly may be less prone to wear thereby increasing an efficiency of the sealing assembly.

(8) The sealing assembly may eliminate mechanical side loading forces such as toeing and heeling of the plate onto each guide vane. The sealing assembly may be simple in construction, may be easy to manufacture in a cost-effective manner, and may increase an efficiency of the guide vane assembly. Furthermore, the sealing assembly may be associated with various guide vane systems that may be disposed upstream or downstream of various types of compressors or turbines. For example, the sealing assembly may be associated with guide vanes on any inward flow radial turbine application. Further, the sealing assembly may be employed in any fixed guide vane, i.e., non-rotational vanes, having a variable flow area geometry based on application requirements.

(9) In some embodiments, a width of the sealing assembly parallel to the span is less than a span length of the guide vane along the span, such that the sealing assembly divides the external surface of the guide vane between a flow region extending from the tip and an intended non-flowing region extending from the root. The sealing assembly is configured to prevent a leakage of fluid between the flow region and the intended non-flowing region. The sealing assembly is further configured to vary an area of the flow region by sliding along the span of the guide vane.

(10) Thus, the sealing assembly is slidable along the span of the guide vane to prevent any leakage of the fluid from the flow region towards the intended non- flowing region, which may in turn increase the efficiency of the guide vane assembly and may ensure a stable operation of the guide vane assembly.

(11) In some embodiments, the guide vane assembly further includes an actuator operatively coupled to the sealing assembly. The actuator is configured to slide the sealing assembly along the span of the guide vane relative to the guide vane. The actuator may include a pneumatic actuator, a hydraulic actuator, a fluidic actuator, an electric actuator, or a passive actuator arrangement that may be configured to slide the sealing assembly along the span. As the actuator facilitates the sliding of the sealing assembly along the span length, the flow region of the guide vane may be varied which may in turn allow tuning of air flow being directed by the guide vane.

(12) In some embodiments, at least some of the plurality of flow tubes include different average cross-sectional areas. The flow tubes with different average cross-sectional areas may be used to modify a pressure drop that the flow experiences as it flows through the flow tubes. Further, flow tubes with different average cross-sectional areas may direct jets of pressurized fluid at different speed, pressure, and flow rates towards the external surface of the guide vane to seal the clearance between the plate and the guide vane. The flow tubes may be designed to balance the delivery pressure proximal to the guide vane with a main gas path pressure at that location around the guide vane.

(13) In some embodiments, each of the plurality of flow tubes has a variable cross-sectional area. The plurality of flow tubes having the variable cross- sectional area may direct jets of pressurized fluid towards the clearance between the plate and the guide vane, thereby providing efficient sealing between the flow region and the intended non-flowing region. The plurality of flow tubes defines a first diameter proximal to the manifold and a second diameter proximal to the plate. The first diameter is greater than the second diameter, such that the flow tubes have a tapering cross-sectional area. Further, the opening in the plate defines a diameter that corresponds to the second diameter of the plurality of flow tubes. Each of the flow tubes may be shaped as a nozzle to accelerate and control the pressurized fluid received from the manifold.

(14) In some embodiments, at least some of the plurality of openings in the plate include different cross-sectional areas. The plurality of openings with different cross-sectional areas may balance a

delivery pressure proximal to the guide vane with a main fluid path pressure at that location around the guide vane. The plurality of openings in the plate may act as a piccolo tube and may form a seal around the corresponding guide vane to prevent the leakage of fluid across the sealing assembly. Further, the plurality of openings with different cross-sectional areas may enhance sealing around the guide vane.

(15) In some embodiments, at least some of the plurality of flow tubes extend orthogonally relative to the plate of the sealing assembly. The plurality of flow tubes may extend orthogonally based on a profile of the guide vane as well as a location of the flow tube relative to the guide vane. For example, the flow tubes disposed along the pressure surface or the suction surface may extend orthogonally relative to the plate of the sealing assembly. It should be noted that, by virtue of the orientation of the flow tubes, the flow tubes jet the pressurized air in a direction that impinges on the guide vane at 90 degrees to the external surface of the guide vane, as may be preferential to minimise leakage across the sealing assembly.

(16) In some embodiments, at least some of the plurality of flow tubes extend obliquely relative to the plate of the sealing assembly. The plurality of flow tubes may extend obliquely based on the profile of the guide vane as well as a location of the flow tube relative to the guide vane. For example, some of the flow tubes disposed proximal to the trailing edge or the leading edge of the guide vane May extend obliquely relative to the plate of the sealing assembly. It should be noted that, by virtue of the orientation of the flow tubes, the flow tubes may be orientated at an inclined angle and as such the jets of pressurized air from the flow tubes impinge the external surface of the guide vane at a compound angle as may be preferential to minimise leakage across the sealing assembly.

(17) In a second aspect, there is provided a guide vane system. The guide vane system includes a circumferential array of guide vane assemblies of the first aspect. The guide vane system further includes an annular ring fixedly coupled to each guide vane assembly and including an annular chamber disposed in fluid communication with the manifold of the sealing assembly of each guide vane assembly. The annular chamber is configured to receive the pressurized fluid and direct the pressurized fluid towards the manifold of the sealing assembly of each guide vane assembly. The annular chamber may receive the pressurized fluid bled from a rotary machine, such as a compressor. Alternatively, the annular chamber may receive the pressurized air from the leading edge or the trailing edge of the guide vane.

(18) In some embodiments, the guide vane system further includes a pair of end plates coupled to the guide vane of each guide vane assembly. The pair of end plates are spaced apart from each other along the span of the guide vane. The sealing assembly is slidable along the span of the guide vane between the pair of end plates. The sealing assembly may slide along the span of the guide vane between the pair of end plates to prevent leakage from the flow region towards the intended non-flowing region, which may increase an efficiency of the guide vane system and facilitate stable operation of the guide vane system.

(19) In a third aspect, there is provided a rotary machine. The rotary machine includes a rotor assembly including an upstream end and a downstream end. The rotary machine further includes the guide vane system of the second aspect. The annular chamber of the guide vane system is configured to receive the pressurized fluid from the upstream end or the downstream end of the rotor assembly. In other words, the annular chamber may receive the pressurized fluid bled from the upstream end or the downstream end of the rotary machine.

(20) In some embodiments, the rotor assembly includes a compressor. Thus, the annular chamber may receive the pressurized fluid bled from the upstream end or the downstream end of the compressor.

(21) In some embodiments, the guide vane system is disposed downstream of the rotor assembly. In such an example, the guide vane system is embodied as an exit guide vane system that may increase an efficiency of the rotor assembly and may facilitate stable operation of the rotor

assembly by controlling a desired flow rate of the fluid being directed by the rotor assembly.
(22) In some embodiments, the guide vane system is disposed upstream of the rotor assembly. In such an example, the guide vane system is embodied as an inlet guide vane system that may increase the efficiency of the rotor assembly and may facilitate stable operation of the rotor assembly by controlling a desired flow rate of the fluid being directed towards the rotor assembly.
(23) In a fourth aspect, there is provided a cabin blower system of an aircraft. The cabin blower system includes the rotary machine of the third aspect. The cabin blower system may control a temperature and a pressure inside a cabin of the aircraft, thereby ensuring habitable conditions within the cabin. Further, the sealing assembly may maximise an efficiency of the rotary machine of the cabin blower system by preventing flow separation and/or turbulence.
(24) In a fifth aspect, there is provided a gas turbine engine including the guide vane system of the second aspect.
(25) As used herein, the term “configured to” and like is at least as restrictive as the term “adapted to” and requires actual design intention to perform the specified function rather than mere physical capability of performing such a function.
(26) The skilled person will appreciate that except where mutually exclusive, a feature or parameter described in relation to any one of the above aspects may be applied to any other aspect. Furthermore, except where mutually exclusive, any feature or parameter described herein may be applied to any aspect and/or combined with any other feature or parameter described herein.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) Embodiments will now be described by way of example only, with reference to the Figures, in which:
(2) FIG. **1** is a schematic side view of a gas turbine engine;
(3) FIG. **2** is a schematic view of a cabin blower system of an aircraft;
(4) FIG. **3** is a schematic perspective view of a guide vane associated with a guide vane assembly of the cabin blower system of FIG. **2**;
(5) FIG. **4** is a schematic view of the guide vane assembly;
(6) FIG. **5** is a schematic sectional side view of a guide vane system including the guide vane assembly of FIG. **4**, associated with the cabin blower system of FIG. **2**;
(7) FIG. **6** is an enlarged schematic view of a portion of a sealing assembly associated with the guide vane system of FIG. **5**; and
(8) FIG. **7** is a schematic sectional top view of the guide vane system of FIG. **5**.
DETAILED DESCRIPTION
(9) Aspects and embodiments of the present disclosure will now be discussed with reference to the accompanying figures. Further aspects and embodiments will be apparent to those skilled in the art.
(10) FIG. **1** illustrates a schematic side view of a gas turbine engine **10** having a principal rotational axis **9**. The gas turbine engine **10** comprises an air intake **12** and a propulsive fan **23** that generates two airflows: a core airflow A and a bypass airflow B. The gas turbine engine **10** comprises an engine core **11** that receives the core airflow A. In other words, the core airflow A enters the engine core **11**. The fan **23** is located upstream of the engine core **11**. The fan **23** generates the core airflow A and the bypass airflow B. The engine core **11** comprises, in axial flow series, a compressor, a combustor, and a turbine. Specifically, the engine core **11** comprises, in axial flow series, a low pressure compressor **14**, a high pressure compressor **15**, a combustor **16**, a high pressure turbine **17**, a low pressure turbine **19**, and a core exhaust nozzle **20**. A nacelle **21** surrounds the gas turbine engine **10** and defines a bypass duct **22** and a bypass exhaust nozzle **18**. The bypass airflow B flows through the bypass duct **22** surrounding the engine core **11**. The bypass airflow B flows

through the bypass duct **22** to provide propulsive thrust, where it is straightened by a row of outer guide vanes **40** before exiting the bypass exhaust nozzle **18**. The outer guide vanes **40** extend radially outwardly from an inner ring **70** which defines a radially inner surface of the bypass duct **22**. Rearward of the outer guide vanes **40**, the engine core **11** is surrounded by an inner cowl **80** which provides an aerodynamic fairing defining an inner surface of the bypass duct **22**. The inner cowl **80** is rearwards of and axially spaced from the inner ring **70**. A fan case **42** defines an outer surface of the bypass duct **22**. The inner ring **70** defines the inner surface of the bypass duct **22** towards the rear of the fan case **42**. The gas turbine engine **10** includes a shaft **26**. The fan **23** is attached to and driven by the low pressure turbine **19** via the shaft **26** and an epicyclic gearbox **30**.
(11) In use, the core airflow A is accelerated and compressed by the low pressure compressor **14** and directed into the high pressure compressor **15** where further compression takes place. The compressed air exhausted from the high pressure compressor **15** is directed into the combustor **16** where it is mixed with fuel and the mixture is combusted. The resultant hot combustion products then expand through, and thereby drive, the high pressure and low pressure turbines **17**, **19** before being exhausted through the core exhaust nozzle **20** to provide some propulsive thrust. A core shaft **27** connects the turbine **17**, **19** to the compressor **14**, **15**. Specifically, the high pressure turbine **17** drives the high pressure compressor **15** by the suitable core shaft **27** or an interconnecting shaft. The fan **23** generally provides the majority of the propulsive thrust. The epicyclic gearbox **30** is a reduction gearbox.
(12) FIG. **2** is a schematic view of a cabin blower system **100** of an aircraft. The aircraft is not shown for illustrative purposes. The cabin blower system **100** is associated with the gas turbine engine **10** of FIG. **1**. The cabin blower system **100** includes a hydraulic system **102**. The hydraulic system **102** includes a valve assembly **104**. The hydraulic system **102** further includes a first hydraulic device **106** and a second hydraulic device **108**. In some examples, each of the first hydraulic device **106** and the second hydraulic device **108** may include a digital displacement pump capable of acting both as a hydraulic pump and as a hydraulic motor. The second hydraulic device **106** may be mechanically coupled to a spool (not shown) of the gas turbine engine **10** (see FIG. **1**). The hydraulic system **102** further includes a hydraulic circuit **110**. The valve assembly **104** is communicably coupled to the second hydraulic device **108** via the hydraulic circuit **110** that may control the actuation of the second hydraulic device **108**. The hydraulic system **102** further includes a conduit **112**. The valve assembly **104** is communicably coupled to the first hydraulic device **106** via the conduit **112** that may control the actuation of the first hydraulic device **106**.
(13) The cabin blower system **100** further includes a rotary machine **118**. The first hydraulic device **104** of the cabin blower system **100** is mechanically coupled to the rotary machine **118** via an epicyclic gearbox **120**. The rotary machine **118** includes a rotor assembly **122** including an upstream end **124** and a downstream end **126**. In some embodiments, the rotor assembly **122** includes a compressor. Alternatively, the rotor assembly **122** may include any other rotating component. Accordingly, the rotor assembly **122** may include a high speed wheel. When, in use, a driving force supplied by the spool of the gas turbine engine **10** causes the second hydraulic device **108** to pump liquid provided in the hydraulic circuit **110** and thereby to drive the first hydraulic device **106**, which in turn rotates the rotor assembly **122**. Although the cabin blower system **100** described herein employs a hydraulic variator system for speed control, it should be noted that the cabin blower system **100** may include any one of an electric variator system, a mechanical variator system, and the like for speed control. It should be noted that the cabin blower system **100** described herein is exemplary in nature, and the cabin blower system **100** may include any other combination of components to perform the intended function.
(14) The rotary machine **118** further includes guide vane systems **200**, **201**. The guide vane system **200** is disposed downstream of the rotor assembly **122** of the rotary machine **118**. The guide vane system **200** disposed downstream of the rotor assembly **122** may be embodied as an exit guide vane system. The guide vane system **201** is disposed upstream of the rotor assembly **122** of the rotary

machine **118**. The guide vane system **201** disposed upstream of the rotor assembly **122** may be embodied as an inlet guide vane system. Each guide vane system **200**, **201** may increase an efficiency of the rotor assembly **122** and may facilitate stable operation of the rotor assembly **122** by controlling a desired flow rate of the fluid being directed by the rotor assembly **122**. Each guide vane system **200**, **201** includes a circumferential array of guide vane assemblies **202** (schematically illustrated herein). The guide vane assemblies **202** will be explained in greater detail later in this section. The rotor assembly **122** compresses the fluid into a pressurized fluid that is directed towards the array of the guide vane assemblies **202**.
(15) FIG. **3** is a schematic perspective view of a guide vane **204** associated with the guide vane assembly **202** (see FIGS. **2**, **4**, and **5**). The guide vane assembly **202** includes the guide vane **204**. The guide vane **204** is embodied as a stationary vane herein. The guide vane **204** includes an aerofoil **206**. The aerofoil **206** includes a leading edge **208**, a trailing edge **210**, a suction surface **212**, a pressure surface **214**, a root **216**, and a tip **218**. The pressure surface **214** is opposite the suction surface **212**. The aerofoil **206** defines a chordal axis C**1** of the guide vane **204** between the leading edge **208** and the trailing edge **210**. The aerofoil **206** further defines a span **220** of the guide vane **204** between the root **216** and the tip **218**. The pressure surface **214** and the suction surface **212** together define an external surface **222** of the guide vane **204**.
(16) FIG. **4** is a schematic view of the guide vane assembly **202**. The guide vane assembly **202** includes a sealing assembly **224** slidable along the span **220** of the guide vane **204** relative to the guide vane **204** and extending along the chordal axis C**1** and the span **220** (see FIG. **3**) of the guide vane **204**. A width W**1** of the sealing assembly **224** parallel to the span **220** is less than a span length L**1** of the guide vane **204** along the span **220**, such that the sealing assembly **224** divides the external surface **222** of the guide vane **204** between a flow region **244** extending from the tip **218** and an intended non-flowing region **246** extending from the root **216**. A flow direction F**1** for compressing is also illustrated in FIG. **4**. The sealing assembly **224** is configured to prevent a leakage of fluid from the flow region **244** towards the intended non-flowing region **246**. Specifically, the sealing assembly **224** is configured to prevent a leakage of compressed air from the flow region **244** towards the intended non-flowing region **246**, which may increase the efficiency of the guide vane assembly **202** and may ensure a stable operation of the guide vane assembly **202**. The sealing assembly **224** is further configured to vary an area of the flow region **244** by sliding along the span **220** of the guide vane **204**.
(17) FIG. **5** is a schematic sectional side view of the guide vane system **200**, associated with the cabin blower system **100** of FIG. **2**. The single guide vane **204** is shown herein for illustrative purposes, however, multiple such guide vanes **204** may be arranged in a circumferentially spaced apart manner. The sealing assembly **224** includes a plate **226** configured to be disposed around at least a portion of the external surface **222** (see FIG. **3**) of the guide vane **204**. The plate **226** may include a first portion **252**, a second portion **254**, and a third portion **256**. In some examples, the plate **226** may include a two part design that may be joined via welding, brazing, soldering, diffusion boding, fastening of one or more parts using mechanical fasteners, and the like. In other examples, the plate **226** may be cast using a lost wax process. The plate **226** is spaced apart from the external surface **222** of the guide vane **204** to define a clearance **228** therebetween. The clearance **228** between the plate **226** and the guide vane **204** may be uniform or the clearance **228** may vary, as per application requirements. In some examples, the plate **226** may be made of a metallic material. In other examples, the plate **226** may be made of a composite or any other material, without limiting the scope of the present disclosure. Further, the plate **226** defines a plurality of openings **230** (shown in FIG. **6**) extending therethrough. Each of the plurality of openings **230** is in fluid communication with the clearance **228** between the plate **226** and the guide vane **204**.
(18) The sealing assembly **224** further includes a manifold **232** coupled to the plate **226** and configured to receive pressurized fluid therein. The manifold **232** is disposed around the plate **226**.

The manifold **232** is spaced apart from the plate **226**. The sealing assembly **224** further includes a plurality of flow tubes **234**, **235** extending between the manifold **232** and the plate **226**. In some examples, the manifold **232** may be manufactured via diffusion bonding, welding, brazing, soldering, or fastening of one or more parts using mechanical fasteners. In other examples, the manifold **232** may be cast using a lost wax process. In some examples, the manifold **232** may be made of a metallic material. In other examples, the manifold **232** may be made of a composite or any other material, without limiting the scope of the present disclosure.

(19) Each of the plurality of flow tubes **234**, **235** defines a flow passage **248** (shown in FIG. **6**) that is in fluid communication with a corresponding opening **230** in the plate **226**. In some embodiments, at least some of the plurality of flow tubes **234** extend orthogonally relative to the plate **226** of the sealing assembly **224**. The plurality of flow tubes **234** may extend orthogonally based on a profile of the guide vane **204** as well as a location of the flow tube **234** relative to the guide vane **204**. For example, the flow tubes **234** disposed along the pressure surface **214** (see FIG. **3**) or the suction surface **212** (see FIG. **3**) may extend orthogonally relative to the plate **226** of the sealing assembly **224**.

(20) In some embodiments, at least some of the plurality of flow tubes **235** extend obliquely relative to the plate **226** of the sealing assembly **224**. The plurality of flow tubes **235** may extend obliquely based on the profile of the guide vane **204** as well as a location of the flow tube **235** relative to the guide vane **204**. For example, some of the flow tubes **235** disposed proximal to the leading edge **208** or the trailing edge **210** of the guide vane **204** may extend obliquely relative to the plate **226** of the sealing assembly **224**. In the embodiment illustrated in FIG. **5**, two flow tubes **235** are shown obliquely inclined relative to the plate **226**. In other embodiments, any number of flow tubes **234**, **235** may extend orthogonally or obliquely relative to the guide vane **204**. It should be noted that, by virtue of the orientation of the flow tubes **234**, **235**, the flow tubes **234** jet the pressurized air in a direction that impinges on the guide vane **204** at 90 degrees to the external surface **222** of the guide vane **204** and the flow tubes **235** are orientated at an inclined angle and as such the jets of pressurized air from the flow tubes **235** impinge the external surface **222** of the guide vane **204** at a compound angle as may be preferential to minimize leakage across the sealing assembly **224**. As the air moves across the guide vane **204** from the leading edge **208** to the trailing edge **210**, when operating as a diffuser in a compressing mode, the air velocity decelerates and the air pressure increases. Pressure at the trailing edge **210** will be higher than pressure at the leading edge **208**. The air in the intended non-flowing region **246** of the sealing assembly **224** may attain a mid-point pressure value at a pseudo mid-point. As such, air that flows radially outboard of the pseudo mid-point on the guide vane **204** tends to leak from the flow region **244** through the sealing assembly **224** and into the intended non-flowing region **246** where the pressure is lower, which tends to leak back into the flow region **244** proximal to the leading edge **208** of the guide vane **204**, which is not desirable. Hence, it may be advantageous to angle the jets of pressurized air radially outboard of the pseudo mid-pressure point of the guide vane **204** away from normal to the guide vane **204** and slightly towards the flow region **244** of the guide vane **204**. Similarly, it may be preferential to angle the jets of pressurized air inboard of the pseudo mid-pressure point of the guide vane **204** and slightly towards the intended non-flowing region **246** of the guide vane **204**. Thus, employing tilted flow tubes may be beneficial in discouraging the re-circulatory leakage flows.

(21) FIG. **6** is an enlarged schematic view of a portion of the sealing assembly **224**. Each of the plurality of flow tubes **234**, **235** are configured to receive the pressurized fluid from the manifold **232**. Each opening **230** in the plate **226** receives the pressurized fluid from a corresponding flow tube **234**, **235** (see FIG. **5**) of the plurality of flow tubes **234**, **235** to direct a jet of pressurized fluid towards the external surface **222** (see FIG. **3**) of the guide vane **204** to seal the clearance **228** (see FIG. **5**) between the plate **226** and the guide vane **204** (see FIG. **5**).

(22) In some embodiments, at least some of the plurality of flow tubes **234**, **235** include different

average cross-sectional areas. The flow tubes **234**, **235** with different average cross-sectional areas may be used to modify a pressure drop that the flow experiences as it flows through the flow tubes **234**, **235**. Further, the flow tubes **234**, **235** with different average cross-sectional areas may direct jets of pressurized fluid at different speed, pressure, and flow rates towards the external surface **222** of the guide vane **204** to seal the clearance **228** between the plate **226** and the guide vane **204**. The flow tubes **234**, **235** may be designed to balance the delivery pressure proximal to the guide vane **204** with a main gas path pressure at that location around the guide vane **204**.

(23) In some embodiments, each of the plurality of flow tubes **234**, **235** has a variable cross-sectional area. The plurality of flow tubes **234**, **235** having the variable cross-sectional area may direct jets of pressurized fluid towards the clearance **228** between the plate **226** and the guide vane **204**, thereby providing efficient sealing between the flow region **244** (see FIG. **4**) and the intended non-flowing region **246** (see FIG. **4**). The plurality of flow tubes **234**, **235** defines a first diameter D**1** proximal to the manifold **232** and a second diameter D**2** proximal to the plate **226**. The first diameter D**1** is greater than the second diameter D**2**, such that the flow tubes **234**, **235** define a tapering cross-sectional area. Further, the opening **230** in the plate **226** defines a diameter D**3** that corresponds to the second diameter D**2** of the plurality of flow tubes **234**, **235**. Each of the flow tubes **234**, **235** may be shaped as a nozzle to accelerate and control the pressurized fluid received from the manifold **232**.

(24) In some embodiments, at least some of the plurality of openings **230** in the plate **226** include different cross-sectional areas. Specifically, the diameter D**3** of each opening **230** corresponds to the second diameter D**2** of the corresponding flow tube **234**, **235**. Thus, if the second diameter D**2** is different for the flow tubes **234**, **235**, the corresponding diameter D**3** of the openings **230** may also be different. The plurality of openings **230** with different cross-sectional areas may balance a delivery pressure proximal to the guide vane **204** with a main fluid path pressure at that location around the guide vane **204** (see FIG. **5**). The plurality of openings **230** in the plate **226** may act as a piccolo tube and may form a seal around the corresponding guide vane **204** to prevent the leakage of fluid across the sealing assembly **224**. Further, the plurality of openings **230** with different cross-sectional areas may enhance sealing around the guide vane **204**.

(25) Referring again to FIG. **5**, the guide vane system **200** further includes an annular ring **236** fixedly coupled to each guide vane assembly **202**. The annular ring **236** includes an annular chamber **238** disposed in fluid communication with the manifold **232** of the sealing assembly **224** of each guide vane assembly **202**. The annular chamber **238** is configured to receive the pressurized fluid and direct the pressurized fluid towards the manifold **232** of the sealing assembly **224** of each guide vane assembly **202**. Specifically, the annular chamber **238** of the guide vane system **200** is configured to receive the pressurized fluid from the upstream end **124** (see FIG. **2**) or the downstream end **126** (see FIG. **2**) of the rotor assembly **122** (see FIG. **2**). The design of the annular chamber **238** described herein is exemplary in nature, and the annular chamber **238** may have a different geometry that may allow to receive and direct a desired volume of the pressurized fluid towards the manifold **232**. Thus, the annular chamber **238** may receive the pressurized fluid bled from the upstream end **124** or the downstream end **126** of the rotor assembly **122**. In other words, the annular chamber **238** may receive the pressurized fluid bled from the upstream end **124** or the downstream end **126** of the rotary machine **118** (see FIG. **2**), such as the compressor. Alternatively, the annular chamber **238** may receive the pressurized air from the leading edge **208** or the trailing edge **210** of the guide vane **204**. Further, the sealing assembly **224** may maximize an efficiency of the rotary machine **118** of the cabin blower system **100** (see FIG. **2**) by preventing flow separation and/or turbulence.

(26) In some examples, the sealing assembly **224** includes a feed chamber **240**. The feed chamber **240** is disposed between the manifold **232** and the annular chamber **238** and provides fluid communication between the manifold **232** and the annular chamber **238**. The feed chamber **240** is configured to receive the pressurized fluid from the annular chamber **238** and direct the pressurized

fluid towards the manifold **232**.

(27) FIG. **7** is a schematic sectional top view of the guide vane system **200**. The guide vane system **200** includes a pair of end plates **242** coupled to the guide vane **204** of each guide vane assembly **202**. The pair of end plates **242** are spaced apart from each other along the span **220** of the guide vane **204**. The sealing assembly **224** is slidable along the span **220** of the guide vane **204** between the pair of end plates **242**.

(28) The sealing assembly **224** may slide along the span **220** of the guide vane **204** between the pair of end plates **242** to prevent leakage from the flow region **244** towards the intended non-flowing region **246**, which may increase the efficiency of the guide vane system **200** and facilitate stable operation of the guide vane system **200**.

(29) The guide vane assembly **202** further includes an actuator **250** operatively coupled to the sealing assembly **224**. The actuator **250** is configured to slide the sealing assembly **224** along the span **220** of the guide vane **204** relative to the guide vane **204**. In some examples, the actuator **250** may include a pneumatic actuator, a hydraulic actuator, a fluidic actuator, an electric actuator, or a passive actuator arrangement that may be configured to slide the sealing assembly **224** along the span **220**. As the actuator **250** facilitates sliding of the sealing assembly **224** along the span length L**1**, the flow region **244** of the guide vane **204** may be varied which may in turn allow tuning of air flow being directed by the guide vane **204**.

(30) In some examples, the actuator **250** may be communicably coupled to a controller (not shown). The controller may control the actuation of the actuator **250** such that the actuator **250** may slide the sealing assembly **224** along the span **220** of the guide vane **204** relative to the guide vane **204** based on a desired pressure and a desired flow area requirement in the flow region **244**. In some examples, the controller may be a control circuit, a computer, a microprocessor, a microcomputer, a central processing unit, or any suitable device or apparatus.

(31) The sealing assembly **224** described herein provides a non-contacting and non-wearing means to seal the clearance **228** (see FIG. **5**) around the guide vane **204**. The sealing assembly **224** of the present disclosure uses the pressurized fluid to seal the clearance **228** between the plate **226** and the guide vane **204**. The sealing assembly **224** may prevent the leakage of fluid around a perimeter of the guide vane **204** i.e., around the pressure surface **214** (see FIG. **3**) and the suction surface **212** (see FIG. **3**) of the aerofoil **206** (see FIG. **3**) and may ensure smooth operation of the guide vane assembly **202**. Further, the plate **226** and the manifold **232** may be made of a metallic material and does not include any moving parts. Since the sealing assembly **224** has a substantially smaller number of moving parts and does not mechanically contact the guide vane **204**, the sealing assembly **224** may be capable to withstand high operational temperatures and may be less susceptible to wear and tear. Thus, the sealing assembly **224** may have an improved life cycle and may also reduce maintenance as well as replacement costs associated with the guide vane assembly **202**. Also, the sealing assembly **224** may eliminate any frictional sealing translational forces between the guide vane **204** and the plate **226** of the sealing assembly **224**, thereby reducing actuation system force requirements and force margins. Furthermore, the plate **226** and the manifold **232** of the sealing assembly **224** may be less prone to wear thereby increasing an efficiency of the sealing assembly **224**.

(32) The sealing assembly **224** may eliminate mechanical side loading forces such as toeing and heeling of the plate **226** onto each guide vane **204**. The sealing assembly **224** may be simple in construction, may be easy to manufacture in a cost-effective manner, and may increase the efficiency of the guide vane assembly **202**. Furthermore, the sealing assembly **224** may be associated with various guide vane systems that may be disposed upstream or downstream of various types of compressors or turbines. For example, the sealing assembly **224** may be associated with guide vanes on any inward flow radial turbine application. Further, the sealing assembly **224** may be employed in any fixed guide vane, i.e., non-rotational vanes, having a variable flow area geometry based on application requirements.

(33) It will be understood that the invention is not limited to the embodiments above-described and various modifications and improvements can be made without departing from the concepts described herein. Except where mutually exclusive, any of the features may be employed separately or in combination with any other features and the disclosure extends to and includes all combinations and sub-combinations of one or more features described herein.

Claims

1. A guide vane assembly comprising: a guide vane including an aerofoil including a leading edge, a trailing edge, a suction surface, a pressure surface, a root, and a tip, the aerofoil defining a chordal axis of the guide vane between the leading edge and the trailing edge, the aerofoil further defining a span of the guide vane between the root and the tip, the pressure surface and the suction surface together defining an external surface of the guide vane; and a sealing assembly slidable along the span of the guide vane relative to the guide vane and extending along the chordal axis and the span of the guide vane, the sealing assembly including: a plate configured to be disposed around at least a portion of the external surface of the guide vane, wherein the plate is spaced apart from the external surface of the guide vane to define a clearance therebetween, wherein the plate defines a plurality of openings extending therethrough, and wherein each of the plurality of openings is in fluid communication with the clearance between the plate and the guide vane; a manifold coupled to the plate and configured to receive pressurized fluid therein, wherein the manifold is disposed around the plate; and a plurality of flow tubes extending between the manifold and the plate, wherein each of the plurality of flow tubes defines a flow passage that is in fluid communication with a corresponding one of the openings in the plate, wherein each of the plurality of flow tubes are configured to receive the pressurized fluid from the manifold, and wherein each opening in the plate receives the pressurized fluid from a corresponding flow tube of the plurality of flow tubes to direct a jet of pressurized fluid towards the external surface of the guide vane to seal the clearance between the plate and the guide vane.
2. The guide vane assembly of claim 1, wherein a width of the sealing assembly parallel to the span is less than a span length of the guide vane along the span, such that the sealing assembly divides the external surface of the guide vane between a flow region extending from the tip and an intended non-flowing region extending from the root, wherein the sealing assembly is configured to prevent a leakage of fluid between the flow region and the intended non-flowing region, and wherein the sealing assembly is further configured to vary an area of the flow region by sliding along the span of the guide vane.
3. The guide vane assembly of claim 1, further including an actuator operatively coupled to the sealing assembly, wherein the actuator is configured to slide the sealing assembly along the span of the guide vane relative to the guide vane.
4. The guide vane assembly of claim 1, wherein at least some of the plurality of flow tubes include different average cross-sectional areas.
5. The guide vane assembly of claim 1, wherein each of the plurality of flow tubes has a variable cross-sectional area.
6. The guide vane assembly of claim 1, wherein at least some of the plurality of openings in the plate include different cross-sectional areas.
7. The guide vane assembly of claim 1, wherein at least some of the plurality of flow tubes extend orthogonally relative to the plate of the sealing assembly.
8. The guide vane assembly of claim 1, wherein at least some of the plurality of flow tubes extend obliquely relative to the plate of the sealing assembly.
9. A guide vane system comprising: a circumferential array of guide vane assemblies of claim 1; and an annular ring fixedly coupled to each guide vane assembly and including an annular chamber disposed in fluid communication with the manifold of the sealing assembly of each guide vane

assembly, wherein the annular chamber is configured to receive the pressurized fluid and direct the pressurized fluid towards the manifold of the sealing assembly of each guide vane assembly.

10. The guide vane system of claim 9, further comprising a pair of end plates coupled to the guide vane of each guide vane assembly, wherein the pair of end plates are spaced apart from each other along the span of the guide vane, and wherein the sealing assembly is slidable along the span of the guide vane between the pair of end plates.

11. A rotary machine comprising: a rotor assembly including an upstream end and a downstream end; and the guide vane system of claim 9, wherein the annular chamber of the guide vane system is configured to receive the pressurized fluid from the upstream end or the downstream end of the rotor assembly.

12. The rotary machine of claim 11, wherein the rotor assembly includes a compressor.

13. The rotary machine of claim 11, wherein the guide vane system is disposed downstream of the rotor assembly.

14. The rotary machine of claim 11, wherein the guide vane system is disposed upstream of the rotor assembly.