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(54) **CONTOURED AXIAL-RADIAL EXHAUST  
DIFFUSER**

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(57) **ABSTRACT**

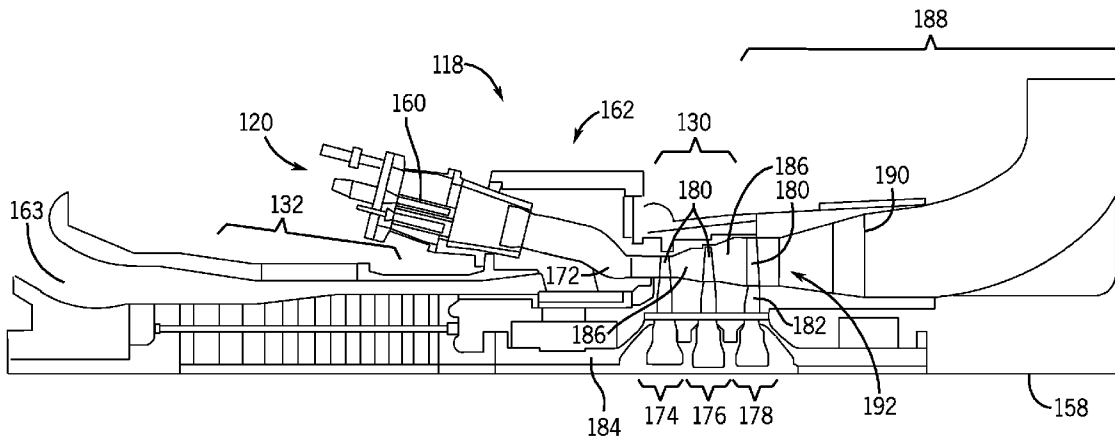
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In accordance with one embodiment, a system includes a gas turbine diffuser. The gas turbine diffuser includes an axial diffuser section including a first duct portion having an axial flow path along a centerline of the gas turbine diffuser. The gas turbine diffuser also includes an axial-radial diffuser section coupled to the axial diffuser section, wherein the axial-radial diffuser section includes a second duct portion having a curved flow path along the centerline from the axial flow path to a radial flow path and the axial-radial diffuser section excludes any turning vane in the second duct portion.



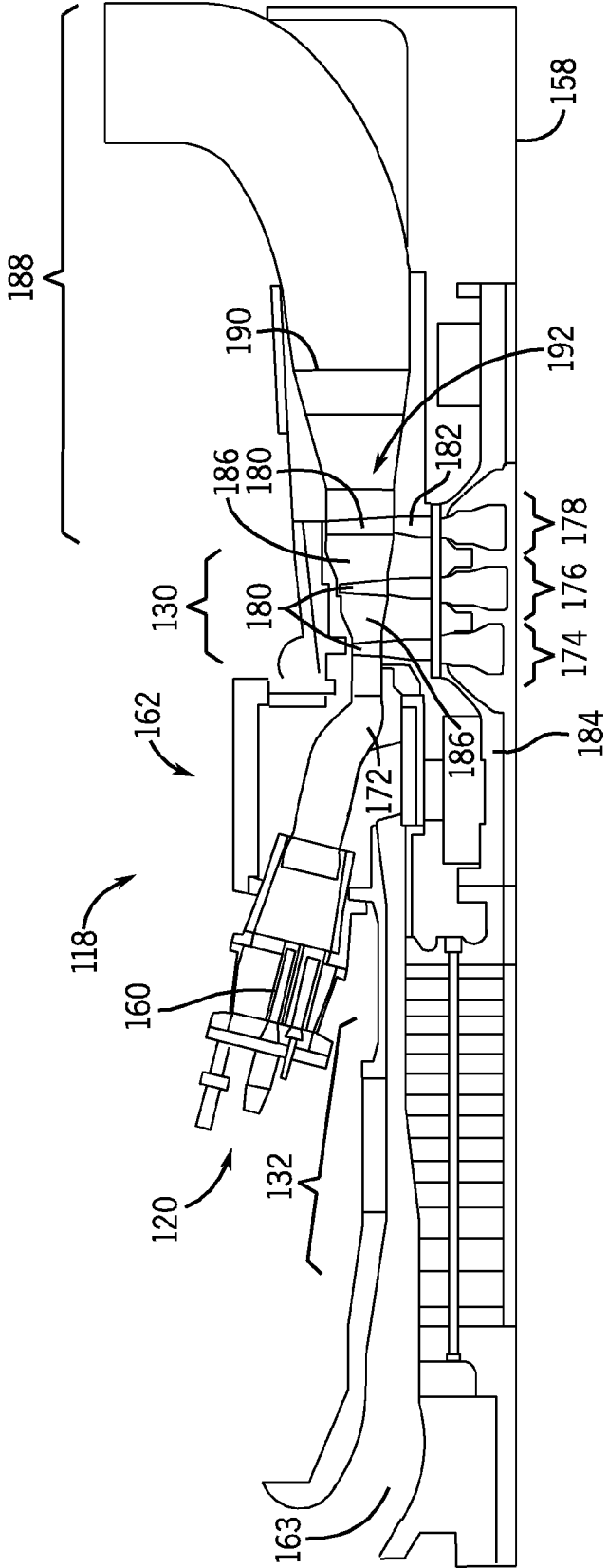


FIG. 1



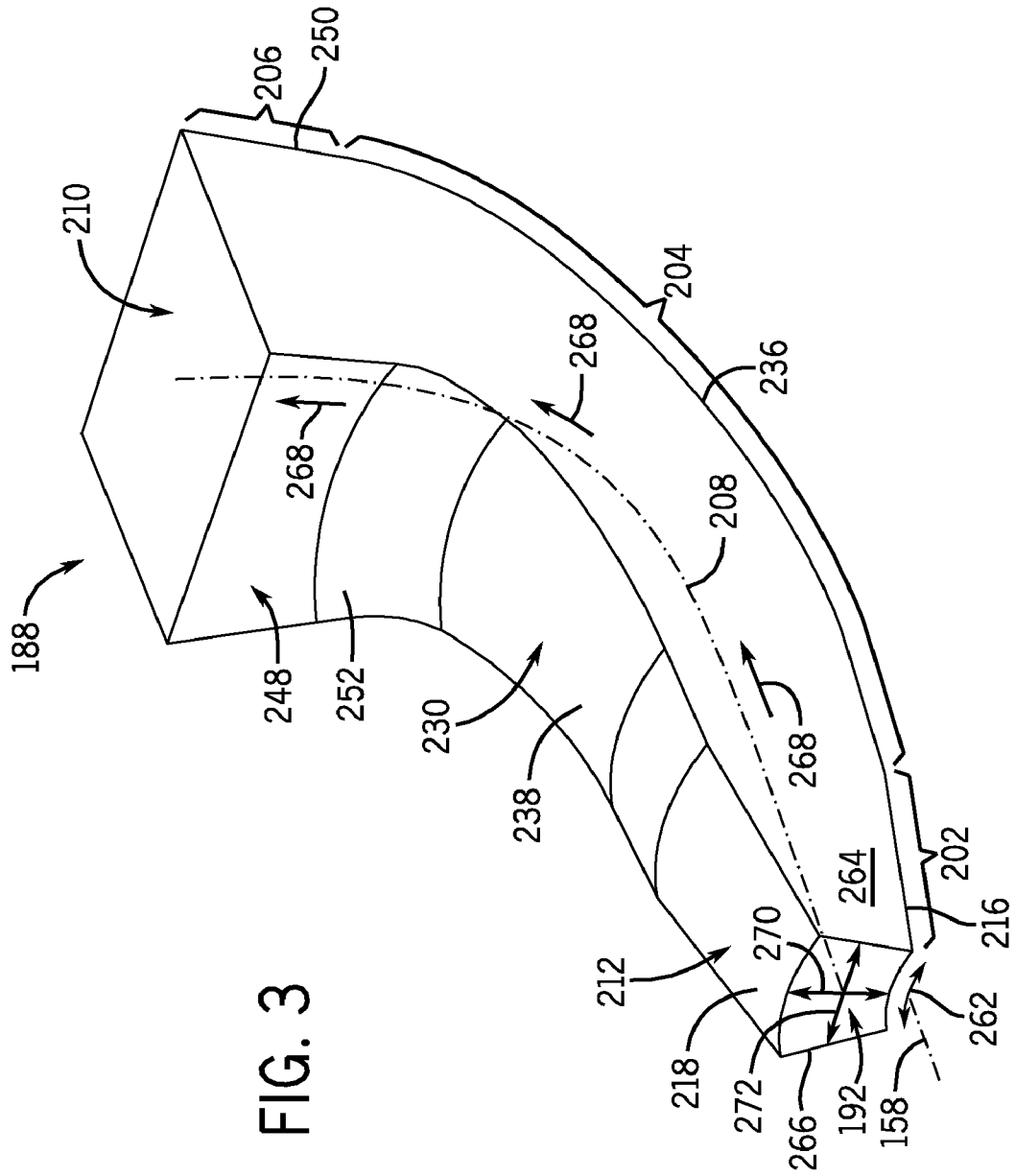


FIG. 3

**CONTOURED AXIAL-RADIAL EXHAUST DIFFUSER**

**BACKGROUND OF THE INVENTION**

[0001] The subject matter disclosed herein relates to turbines, and more specifically, to exhaust diffusers for use with gas turbines and steam turbines.

[0002] Power generation plants often incorporate turbines, e.g., a gas turbine engine. The gas turbine engine combusts a fuel to generate hot combustion gases, which flow through a turbine to drive a load and/or compressor. At high velocities and temperatures, an exhaust gas exits the turbine and enters an exhaust diffuser. The exhaust diffuser may be an axial-radial exhaust diffuser that transitions the flow from an axial direction to a radial direction. Axial-radial exhaust diffusers incorporate internal structural features such as struts and turning vanes. The internal struts hold walls of the diffuser in a fixed relationship to one another and transfer loads from a rotor to a foundation. The internal turning vanes help divert the flow from the axial to radial direction. Unfortunately, the exhaust diffuser design results in significant pressure losses, particularly at the internal struts and turning vanes.

**BRIEF DESCRIPTION OF THE INVENTION**

[0003] Certain embodiments commensurate in scope with the originally claimed invention are summarized below. These embodiments are not intended to limit the scope of the claimed invention, but rather these embodiments are intended only to provide a brief summary of possible forms of the invention. Indeed, the invention may encompass a variety of forms that may be similar to or different from the embodiments set forth below.

[0004] In accordance with a first embodiment, a system includes a gas turbine diffuser. The gas turbine diffuser includes an axial diffuser section including a first duct portion having an axial flow path along a centerline of the gas turbine diffuser, wherein the first duct portion has a first cross-sectional area that expands along the axial flow path. The gas turbine diffuser also includes an axial-radial diffuser section coupled to the axial diffuser section, wherein the axial-radial diffuser section includes a second duct portion having a curved flow path along the centerline from the axial flow path to a radial flow path, the second duct portion has a second cross-sectional area that expands along the curved flow path, the curved flow path has a radius of at least greater than or equal to approximately 30 centimeters, and the axial-radial diffuser excludes any turning vane in the second duct portion.

[0005] In accordance with a second embodiment, a system includes a gas turbine diffuser. The gas turbine diffuser includes an axial diffuser section including a first duct portion having an axial flow path along a centerline of the gas turbine diffuser. The gas turbine diffuser also includes an axial-radial diffuser section coupled to the axial diffuser section, wherein the axial-radial diffuser section includes a second duct portion having a curved flow path along the centerline from the axial flow path to a radial flow path and the axial-radial diffuser section excludes any turning vane in the second duct portion.

[0006] In accordance with a third embodiment, a method includes axially-radially diffusing an exhaust flow from a turbine through a curved duct along a curved flow path without any turning vanes, wherein the curved flow path has a

radius of at least greater than or equal to 2 times a cross-sectional width of the curved duct.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0007] These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0008] FIG. 1 is a cross-sectional view of an embodiment of a gas turbine engine sectioned through a longitudinal axis;

[0009] FIG. 2 is a cross-sectional view of an embodiment of a contoured exhaust diffuser of the gas turbine engine of FIG. 1 according to an embodiment; and

[0010] FIG. 3 is a perspective view of an embodiment of a contoured exhaust diffuser of the gas turbine engine of FIG. 1.

**DETAILED DESCRIPTION OF THE INVENTION**

[0011] One or more specific embodiments of the present invention will be described below. In an effort to provide a concise description of these embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0012] When introducing elements of various embodiments of the present invention, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

[0013] The disclosed embodiments are directed toward a turbine diffuser contoured to provide a smooth flow path to transition the flow from an axial to radial direction without a turning vane, while maximizing the pressure recovery in the diffuser. As discussed below, the disclosed turbine diffuser may include an axial diffuser section, an axial-radial diffuser section, and a radial diffuser section. The axial diffuser section includes diverging walls about one or more struts to reduce pressure losses around the struts and to gradually transition to the axial-radial diffuser section. The axial-radial diffuser section includes a vaneless duct with a large radius of curvature to reduce flow separation and pressure losses. For example, the axial-radial diffuser section gradually turns the exhaust flow without any abrupt changes between the axial and radial directions, thereby eliminating the need for internal turning vanes. Instead of a sharp turn or small radius of curvature, the axial-radial diffuser section has the large radius of curvature along radially inward and outwards walls. The radius of curvature may be at least approximately 1 to 100 times a cross-sectional width of the turbine diffuser. For example, the radius of curvature may be greater than or equal to approximately 1.5, 2, 3, 4, 5, 6, 7, 8, 9, or 10 times the cross-sectional width of the turbine diffuser. In addition, to

improved flow performance, the disclosed turbine diffuser eliminates mechanical issues, such as cracks, associated with turning vanes.

[0014] FIG. 1 is a cross-sectional side view of an embodiment of the gas turbine engine 118 along a longitudinal axis 158. As appreciated, contoured exhaust diffusers without turning vanes may be used in any fluid flow system that includes rotary machines, such as gas turbine engines and stem turbine engines, and is not intended to be limited to any particular machine or system. As described further below, the contoured exhaust diffuser may be used within the gas turbine engine 118 to maximize diffuser performance by providing a smooth flow path to transition the flow through the diffuser from an axial to radial direction. For example, angles may be disposed near the diffuser inlet to provide early flow diffusion to reduce pressure losses around one or more internal struts and to make the flow path from the axial direction to the radial direction less abrupt and more contoured. Furthermore, the diffuser may include portions that gradually expand along the flow path to further enhance the transition of the flow from an axial to radial flow direction, thus, improving the aerodynamics of the diffuser, while eliminating a source of performance loss (e.g., internal turning vanes).

[0015] The gas turbine engine 118 includes one or more fuel nozzles 160 located inside a combustor section 162. In certain embodiments, the gas turbine engine 118 may include multiple combustors 120 disposed in an annular arrangement within the combustor section 162. Further, each combustor 120 may include multiple fuel nozzles 160 attached to or near the head end of each combustor 120 in an annular or other arrangement.

[0016] Air enters through an air intake section 163 and is compressed by a compressor 132. The compressed air from the compressor 132 is then directed into the combustor section 162 where the compressed air is mixed with fuel. The mixture of compressed air and fuel is generally burned within the combustor section 162 to generate high-temperature, high-pressure combustion gases, which are used to generate torque within turbine section 130. As noted above, multiple combustors 120 may be annularly disposed within the combustor section 162. Each combustor 120 includes a transition piece 172 that directs the hot combustion gases from the combustor 120 to the turbine section 130. In particular, each transition piece 172 generally defines a hot gas path from the combustor 120 to a nozzle assembly of the turbine section 130, included within a first stage 174 of the turbine 130.

[0017] As depicted, the turbine section 130 includes three separate stages 174, 176, and 178. Each stage 174, 176, and 178 includes a plurality of blades 180 coupled to a rotor wheel 182 rotatably attached to a shaft 184. Each stage 174, 176, and 178 also includes a nozzle assembly 186 disposed directly upstream of each set of blades 180. The nozzle assemblies 186 direct the hot combustion gases toward the blades 180 where the hot combustion gases apply motive forces to the blades 180 to rotate the blades 180, thereby turning the shaft 184. The hot combustion gases flow through each of the stages 174, 176, and 178 applying motive forces to the blades 180 within each stage 174, 176, and 178. The hot combustion gases may then exit the gas turbine section 130 through an exhaust diffuser 188. The exhaust diffuser 188 functions by reducing the velocity of fluid flow through the exhaust diffuser 188 while also increasing the static pressure to reduce the work of the gas turbine engine 118. The exhaust diffuser includes a strut 190 disposed between the walls of the exhaust

diffuser 188. The strut 190 holds the walls in a fixed relationship to another. The number of struts 190 is variable and may range between 1 to 10 or more. The exhaust diffuser 188 includes a contoured shape to transition the fluid flow from an axial to radial direction without any internal turning vane, while also including angles near an inlet 192 of the exhaust diffuser 188 to allow early flow diffusion.

[0018] FIG. 2 is a cross-sectional side view of the exhaust diffuser 188 of FIG. 1 further illustrating the angles near the inlet 192 and the contoured shape of the exhaust diffuser 188. The exhaust diffuser 188 includes an axial diffuser section 202, an axial-radial diffuser section 204, and a radial diffuser section 206. A centerline 208 generally defining the flow path runs from the inlet 192 of the exhaust diffuser 188 toward an outlet 210. In general, the cross-sectional area of the exhaust diffuser 188 expands downstream along the flow path from the inlet 192 towards the outlet 210.

[0019] The axial diffuser section 202 includes a first duct portion 212 having an axial flow path 214 along the centerline 208 of the exhaust diffuser 188. The first duct portion 212 includes a first wall 216 offset from a second wall 218. Further, the first wall 216 and the second wall 218 are disposed opposite one another about the axial flow path 214. The first wall 216 is mounted nearer or proximate relative to a rotational axis, indicated by dashed line 220, of the turbine 130, while the second wall 218 is more distal relative to the rotational axis 220. The first wall 216 extends along the axial flow path 214 at a first angle 222 relative to the rotational axis 220 of the turbine 130. In certain embodiments, the first angle 222 may be a negative angle that ranges between approximately 0 to 8 degrees, 2 to 6 degrees, or 4 to 5 degrees. For example, the first angle 222 may be at least equal to or greater than approximately 2, 4, 6, or 8 degrees, or any angle therebetween. In addition, the second wall 218 extends along the axial flow path 214 at a second angle 226 relative to the rotational axis 220. In certain embodiments, the second angle 226 may be a positive angle that ranges between approximately 16 to 20 degrees or 17 to 19 degrees. For example, the second angle 226 may be at least equal to or greater than approximately 16, 17, 18, 19, or 20 degrees, or any angle therebetween. In the illustrated embodiment, the first angle 222 and the second angle 226 are not 0 degrees. In some embodiments, the first angle 222 is less than or equal to approximately 8 degrees, and the second angle 226 is greater than or equal to approximately 16 degrees.

[0020] Due to the first and second angles 222 and 226, respectively, the first wall 216 and the second wall 218 diverge from one another along the axial flow path 214. As a result of the divergence of the first wall 216 and the second wall 218, the first duct portion 212, as FIG. 2 illustrates, includes a first cross-sectional area 228 (i.e., perpendicular to centerline 208) that expands along the axial flow path 214 between the first wall 216 and the second wall 218. The expansion of the cross-sectional area 228 across the flow path may provide early flow diffusion that reduces the pressure losses in diffuser performance across strut 190. Further, this expansion smoothes the flow path transition from the axial to radial direction, as described below.

[0021] The axial diffuser section 202 is coupled to the axial-radial diffuser section 204. The axial-radial diffuser section 204 transitions the flow from the axial diffuser section 202 to the radial diffuser section 206. The axial-radial diffuser section 204 includes a second duct portion 230 having a curved flow path 232 along the centerline 208 from the axial

flow path **214** to a radial flow path **234**. The second duct portion **230** includes a first curved wall **236** offset from a second curved wall **238**. Further, the first curved wall **236** and the second curved wall **238** are disposed opposite one another about the curved flow path **232**. The first curved wall **236** is mounted nearer or proximate relative to the rotational axis **220** of the turbine **130**, while the second curved wall **238** is more distal relative to the rotational axis **220**. The first and second angles **222** and **226** extend toward the first and second curved walls **236** and **238**, respectively. Indeed, in some embodiments, the first and second angles **222** and **226** may extend directly to the first and second curved walls **236** and **238**, respectively. The extension of the angles **222** and **226** to the curved walls **236** and **238** makes the flow path transition from the axial diffuser section **202** to the axial diffuser section **204** more aerodynamic, thereby reducing pressure losses in diffuser performance normally associated with sharp transitions in the flow path direction.

[0022] The first curved wall **236** curves along the curved flow path **232** with a first radius of curvature **240**, while the second curved wall **238** curves along the curved flow path **232** with a second radius of curvature **242**. The average of these radii **240** and **242** may be defined by an average radius of curvature **243** relative to the centerline **208** along the curved flow path **232**. In certain embodiments, the radii of curvature **240**, **242**, and **243** may vary along the lengths of the first curved wall **236** and the second curved wall **238**. Accordingly, centers **241** of the radii **240**, **242**, and **243** may shift to increase or decrease the radii **240**, **242**, and **243**. At certain points along the length of the second duct portion **230**, the first radius of curvature **240** and the second radius of curvature **242** may be different from each other, while at other points the first radius of curvature **240** and the second radius of curvature **242** may be the same. Alternatively, the first radius of curvature **240** and the second radius of curvature **242** may be different along the entire lengths of the first curved wall **236** and the second curved wall **238**. In certain embodiments, the difference between the first radius of curvature **240** and the second radius of curvature **242** may range between approximately 0 to 50 percent, 10 to 40 percent, or 20 to 30 percent. For example, the difference may be approximately 15, 20, 25, 30, or 35 percent, or any percent therebetween. In certain embodiments, the first radius of curvature **240** may be larger than the second radius of curvature **242**. In alternative embodiments, the second radius of curvature **242** may be larger than the first radius of curvature **240**. In other embodiments, the first radius of curvature **240** and the second radius of curvature **242** may be the same.

[0023] In certain embodiments, the first radius of curvature **240** may range approximately from 30 centimeters to 390 centimeters, 80 to 340 centimeters, 130 to 390 centimeters, 180 to 300 centimeters, or 220 to 260 centimeters. For example, the first radius of curvature **240** may be approximately 30, 40, 50, 60, 70, 80, 90, or 100 centimeters, or any distance therebetween. In some embodiments, the first radius of curvature **240** may be at least greater than or equal to approximately 100 centimeters. In certain embodiments, the second radius of curvature **242** may range approximately from 30 centimeters to 510 centimeters, 80 to 460 centimeters, 130 to 410 centimeters, 180 to 360 centimeters, or 230 to 310 centimeters. For example, the second radius of curvature **242** may be approximately 30, 40, 50, 60, 70, 80, 90, or 100 centimeters, or any distance therebetween. In some embodiments, the first radius of curvature **240** may be at least greater

than or equal to approximately 100 centimeters. In certain embodiments, the radius **243** of the curved flow path **232** may range approximately from 30 centimeters to 450 centimeters, 80 to 400 centimeters, 130 to 350 centimeters, 180 to 300 centimeters, or 220 to 260 centimeters. For example, the radius **243** may be approximately 30, 40, 50, 60, 70, 80, 90, or 100 centimeters, or any distance therebetween. In some embodiments, the radius **243** may be at least greater than or equal to approximately 30 centimeters. In other embodiments, the radius **243** may be at least greater than or equal to approximately 100 centimeters.

[0024] The curvature of the walls **236** and **238** provides a smoother, more aerodynamic, flow path transition that eliminates the need for an internal turning vane in the second duct portion **230**. Thus, the axial-radial diffuser section **204** excludes any internal turning vane. Indeed, the first and second curved walls **236** and **238**, respectively, diverge from one another along the curved flow path **232** to allow greater diffusion during the transition from the axial to radial direction. The curved second duct portion **230** has a second cross-sectional area **244** (i.e., perpendicular to the centerline **208**) that expands along the curved flow path **232** between the first curved wall **236** and the second curved wall **238**. In other words, the cross-sectional area **244** has a cross-sectional width **246** that expands along the curved flow path **232**. The expansion of the cross-sectional width **246** within the axial-radial diffuser section **204** allows diffusion of the flow to increase, while also transitioning the flow from an axial to radial direction.

[0025] In the certain embodiments, the radii **240**, **242**, and **243** may be at least approximately 1 to 100, 1 to 50, 1 to 25, or 1 to 10 times the cross-sectional width **246** of the curved flow path **232**. For example, radii **240**, **242**, and **243** may be at least greater than or equal to approximately 1.5, 2, 3, 4, 5, 6, 7, 8, 9, or 10 times the cross-sectional width **246**.

[0026] From the axial-radial diffuser section **204**, the flow is transitioned to the radial diffuser section **206**. The axial-radial diffuser section **204** is coupled to the radial diffuser section **206**. The radial diffuser section **206** includes a third duct portion **248** having a radial flow path **234** along the centerline **208** of the diffuser **188**. The third duct portion **248** includes a first vertical wall **250** offset from a second vertical wall **252**. Further, the first vertical wall **250** and the second vertical wall **252** are disposed opposite one another about the radial flow path **234**. The diverging first and second curved walls **236** and **238** of the second duct portion **230** extend into the first vertical wall **250** and second vertical wall **252**, respectively. The first vertical wall **250** also diverges from the second vertical wall **252** along the radial flow path **234**. As a result, the third duct portion **248** includes a third cross-sectional area **254** (i.e., perpendicular to the centerline **208**) that expands along the radial flow path **234** between the first vertical wall **250** and the second vertical wall **252** to increase diffusion and diffuser performance. From the radial diffuser section **206**, the flow is directed to the outlet **210** of the diffuser **188**.

[0027] FIG. 3 is a perspective view of the exhaust diffuser **188** illustrating the contours and expansion of the diffuser **188**. The exhaust diffuser **188** includes the axial diffuser section **202**, the axial-radial diffuser section **204**, and the radial diffuser section **206**, as described above. The axial diffuser section **202** includes the first and second walls **216** and **218**. The axial-radial diffuser section **204** includes the first and second curved walls **236** and **238**. Both the first and

second walls **216** and **218**, as well as, at least portions of the first and second curved walls **236** and **238** include a semi-annular curvature in a circumferential direction, as indicated by arrow **262**, transverse to the longitudinal axis **158** of the gas turbine engine **118**. The annular curvature of the walls **216**, **218**, **236**, and **238** allows for the annular distribution of the exhaust diffuser **188** around the exit of the turbine **130**. In some embodiments, one or more exhaust diffusers **188** may be distributed around the exit of the turbine **130**. As shown in FIG. 3, the exhaust diffuser **188** includes a third wall **264** and a fourth wall **266** that follow the flow path generally defined by the centerline **208**. The third wall **264** and the fourth wall **266** are disposed opposite from each other and located between the first wall **216** and the second wall **218**, the first curved wall **236** and the second curved wall **238**, and the first vertical wall **250** and the second vertical wall **252** along the length of the diffuser **188**. The third wall **264** and the fourth wall **266** diverge from each other from the inlet **192** in a downstream direction **268** to the outlet **210**. Also, the cross-sectional area of the exhaust diffuser **188** (i.e., perpendicular to the downstream direction **268**) expands downstream from the inlet **192** to the outlet **210** of the diffuser **188** in both a vertical dimension **270** and a horizontal dimension **272**. The dimension **270** may be defined as a radial dimension relative to axis **158**, whereas the dimension **272** may be defined as a circumferential dimension relative to the axis **158**.

[0028] In accordance with certain embodiments, the exhaust diffuser **188** above may be operated in conjunction with the turbine **130**. For example, a method of operation may include axially-radially diffusing an exhaust flow from the turbine through a curved duct along the curved flow path **232** without any turning vanes, wherein the curved flow path **232** has an enlarged radius **243** to reduce flow separation and pressure losses. In some embodiments, the radius **243** may be at least greater than or equal to approximately 30 centimeters and/or 1 to 10 times the width **246**. In other embodiments, the radius **243** may be at least greater than or equal to at least 2 times the width **246**. Also, in the method, axially-radially diffusing the exhaust flow may include expanding the exhaust flow between the first curved wall **236** and the second curved wall **238** that curve along the curved flow path **232**. As discussed above, the first curved wall **236** may be oriented nearer to the rotational axis **220** of the turbine **130** than the second curved wall **238**. The method may further include axially diffusing the exhaust flow prior to axially-radially diffusing the exhaust flow. Axially diffusing the exhaust flow includes expanding the exhaust flow between a first angled wall **216** and a second angle wall **218** that are angled relative to the axial flow path **214**. As discussed above, the first angled wall **216** may be oriented nearer to the rotational axis **220** of the turbine **130** than the second angled wall **218**.

[0029] Technical effects of the disclosed embodiments include providing angled walls **216** and **218** to provide early flow diffusion to reduce the pressure losses across the struts **190**. In addition, the angled walls **216** and **218** allow for a smoother transition from the axial diffuser section **202** to the axial-radial diffuser section **204** to decrease pressure losses during the axial to radial shift in flow direction. Providing an axial-radial diffuser section with curved walls **236** and **238** also smoothes the axial-to radial transition, while eliminating the need for turning vanes. Further, diverging walls along the axial diffuser section **202**, the axial-radial diffuser section **204**, and the radial diffuser section **206** allows the flow to expand along the flow path and to increase diffuser perfor-

mance. Overall, the aerodynamic design of the diffuser **188** improves diffuser performance, while eliminating a source of performance loss and mechanical problems (i.e., the turning vanes).

[0030] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

1. A system, comprising:

a gas turbine diffuser, comprising:

an axial diffuser section comprising a first duct portion having an axial flow path along a centerline of the gas turbine diffuser, wherein the first duct portion has a first cross-sectional area that expands along the axial flow path; and

an axial-radial diffuser section coupled to the axial diffuser section, wherein the axial-radial diffuser section comprises a second duct portion having a curved flow path along the centerline from the axial flow path to a radial flow path, the second duct portion has a second cross-sectional area that expands along the curved flow path, the curved flow path has a radius of at least greater than or equal to approximately 30 centimeters, and the axial-radial diffuser excludes any turning vane in the second duct portion.

2. The system of claim 1, wherein the gas turbine diffuser comprises a radial diffuser section coupled to the axial-radial diffuser section, the radial diffuser section comprises a third duct portion having the radial flow path along the centerline of the gas turbine diffuser, and the third duct portion has a third cross-sectional area that expands along the radial flow path.

3. The system of claim 1, wherein the radius is at least greater than or equal to approximately 100 centimeters.

4. The system of claim 1, wherein the second duct portion comprises a first curved wall offset from a second curved wall, the first curved wall curves along the curved flow path with a first radius of curvature, and the second curved wall curves along the curved flow path with a second radius of curvature.

5. The system of claim 4, wherein the first curved wall is proximate relative to a rotational axis of a gas turbine, and the second curved wall is distal relative to the rotational axis of the gas turbine.

6. The system of claim 4, wherein the first and second radii are the same as one another.

7. The system of claim 4, wherein the first and second radii are different from one another.

8. The system of claim 4, wherein the first and second curved walls diverge from one another along the curved flow path.

9. The system of claim 1, wherein the first duct portion comprises a first wall offset from a second wall, the first wall is proximate relative to a rotational axis of a gas turbine, the second wall is distal relative to the rotational axis of the gas turbine, and the first and second walls diverge from one another along the axial flow path.

**10.** The system of claim **9**, wherein the first wall extends along the axial flow path at a first angle relative to the rotational axis, the second wall extends along the axial flow path at a second angle relative to the rotational axis, and the first and second angles are not 0 degrees.

**11.** The system of claim **10**, wherein the first angle is less than or equal to approximately 8 degrees, and the second angle is greater than or equal to approximately 16 degrees.

**12.** The system of claim **10**, wherein the second duct portion comprises a first curved wall offset from a second curved wall, the first curved wall curves along the curved flow path with a first radius of curvature, the second curved wall curves along the curved flow path with a second radius of curvature, and the first and second angles of the first duct portion extend directly to the first and second curved walls.

**13.** A system, comprising:

a gas turbine diffuser, comprising:

an axial diffuser section comprising a first duct portion having an axial flow path along a centerline of the gas turbine diffuser; and

an axial-radial diffuser section coupled to the axial diffuser section, wherein the axial-radial diffuser section comprises a second duct portion having a curved flow path along the centerline from the axial flow path to a radial flow path, and the axial-radial diffuser section excludes any turning vane in the second duct portion.

**14.** The system of claim **13**, wherein the first duct portion comprises first and second walls disposed opposite from one another about the axial flow path, the first wall is configured to mount nearer to a rotational axis of a turbine than the second wall, the first wall extends along the axial flow path at a first angle relative to the rotational axis, the second wall extends along the axial flow path at a second angle relative to the rotational axis, and the first and second angles are not 0 degrees.

**15.** The system of claim **14**, wherein the second duct portion comprises first and second curved walls disposed oppo-

site from one another about the curved flow path, the first curved wall is configured to mount nearer to the rotational axis than the second curved wall, the first curved wall curves along the curved flow path with a first radius of curvature, the second curved wall curves along the curved flow path with a second radius of curvature, and the first and second angles of the first duct portion extend toward the first and second curved walls.

**16.** The system of claim **15**, wherein the first and second angles of the first duct portion extend directly to the first and second curved walls.

**17.** The system of claim **15**, wherein the first angle is less than or equal to approximately 8 degrees, the second angle is greater than or equal to approximately 16 degrees, the first radius of curvature is at least greater than 100 centimeters, and the second radius of curvature is at least greater than 100 centimeters.

**18.** A method, comprising:

axially-radially diffusing an exhaust flow from a turbine through a curved duct along a curved flow path without any turning vanes, wherein the curved flow path has a radius of at least greater than or equal to 2 times a cross-sectional width of the curved duct.

**19.** The method of claim **18**, wherein axially-radially diffusing the exhaust flow comprises expanding the exhaust flow between first and second curved walls that curve along the curved flow path, wherein the first curved wall is oriented nearer to a rotational axis of the turbine than the second curved wall.

**20.** The method of claim **19**, comprising axially diffusing the exhaust flow prior to axially-radially diffusing the exhaust flow, wherein axially diffusing the exhaust flow comprises expanding the exhaust flow between first and second angled walls that are angled relative to an axial flow path, wherein the first angled wall is oriented nearer to the rotational axis than the second angled wall.

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