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(54) **Diffuser for a gas turbine**

(57) A diffuser 200 for a gas turbine includes an inlet 211 adapted for coupling to the gas turbine. The diffuser 200 also includes at least one outlet 220 located proximate a diffuser end 222, wherein the diffuser end is 222 located downstream of the inlet 211. The diffuser 200 further includes an outer wall 206 and an inner barrel 202 that extends substantially to the diffuser end 222.

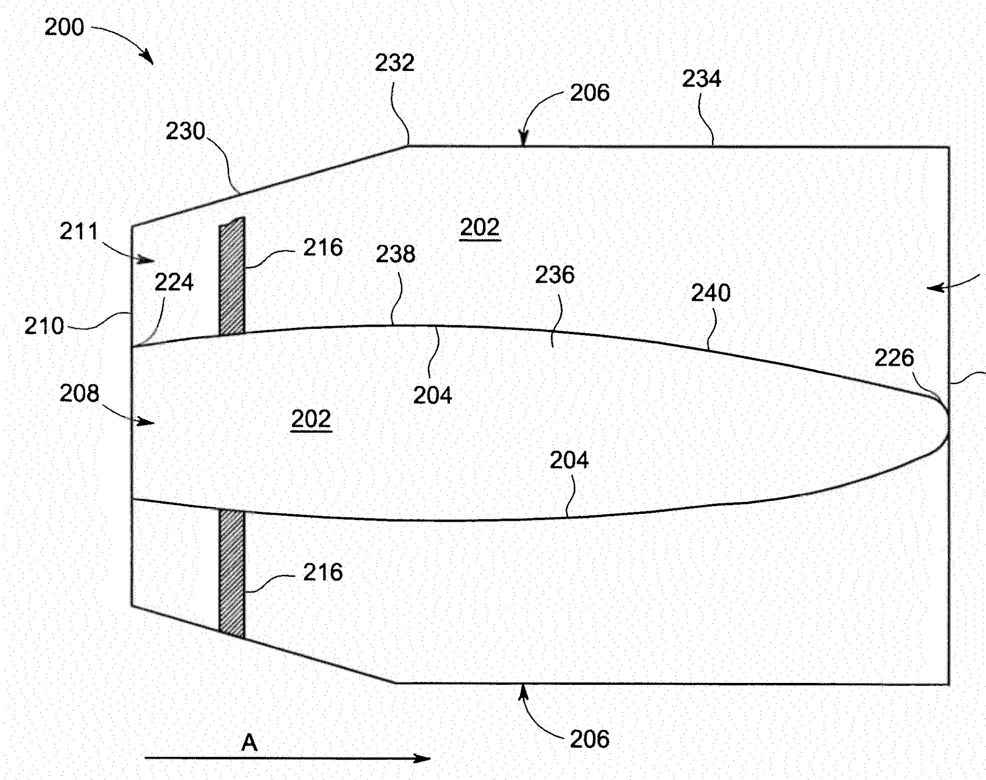

FIG. 1

Description

[0001] The subject matter disclosed herein relates generally to turbines and, in particular, to diffusers for use with gas turbines and steam turbines.

[0002] Typical gas turbines include a diffuser cone, or diffuser, coupled to the last stage bucket of the rotor. The diffuser serves, generally, to increase static pressure of the exhaust gas by decreasing the kinetic energy of the exhaust gas. Generally, this may be achieved by increasing the cross-sectional area of the diffuser in the direction of exhaust gas flow.

[0003] Often, gas turbines are not operated at full load, but are designed for efficiency under such a full load. Therefore, part load performance efficiency is sacrificed, based on the full load design. Such inefficiencies are due, at least in part, to flow separation on the diffuser inner barrel, leading to tip strong flow profiles. Other factors, such as operation of the last stage of the turbine, may influence the flow profile. Additionally, flow passing over a center body of the diffuser generates large vortices that result in yet further system inefficiency.

[0004] According to one aspect of the invention, a diffuser for a gas turbine includes an inlet adapted for coupling to the gas turbine. The diffuser also includes at least one outlet located proximate a diffuser end, wherein the diffuser end is located downstream of the inlet. The diffuser further includes an outer wall and an inner barrel extending substantially to the diffuser end.

[0005] According to another aspect of the invention, an exhaust gas diffuser includes an inlet and an outlet. The exhaust gas diffuser also includes an inner barrel extending from substantially the inlet to substantially the outlet. The diffuser further includes an outer wall radially spaced apart from the inner barrel, wherein the outer wall and the inner barrel define a varying radius along a length of the diffuser between the inlet and the outlet.

[0006] According to yet another aspect of the invention, a gas turbine includes a turbine casing that surrounds a portion of the gas turbine. The gas turbine also includes an exhaust gas diffuser coupled to the turbine casing. The diffuser includes an inlet adapted for coupling to the gas turbine, an outer wall, an inner barrel and a diffuser end downstream from the inlet, the inner barrel extending substantially to the diffuser end.

[0007] Various advantages and features will become more apparent from the following description taken in conjunction with the drawings.

[0008] The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a side, cross-sectional view of a diffuser according to one aspect of the invention;

FIG. 2 illustrates a flow profile associated with the diffuser illustrated in FIG. 1; and

FIG. 3 illustrates a diffuser flow profile exhibiting flow separation.

[0009] The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

[0010] FIG. 1 illustrates one aspect of a diffuser 200 according to one embodiment of the present invention. In operation, exhaust gas from the gas turbine flows through the diffuser 200 in the direction shown by arrow A. In this description, an object is "downstream" of another object or location if it is displaced from it in the direction of arrow A and is "upstream" if it is displaced from it in a direction opposite of arrow A.

[0011] The diffuser 200 includes an inner barrel 202 that includes an inner wall 204 that forms an inner chamber 208 through which a portion of a rotor may pass. The diffuser 200 includes an inlet 211 located proximate a diffuser entry end 210 and an outlet 220 located proximate a diffuser exit end 222. The inlet 211 may be coupled to a turbine, while the outlet 220 may be coupled to an adjacent object, such as a silencer. The diffuser also includes an outer wall 206 radially spaced from the inner wall 204 of the inner barrel 202. The area between the inner wall 204 and the outer wall 206 allows fluid or gas to flow downstream therethrough from the inlet 211 to the outlet 220 of the diffuser 200.

[0012] The diffuser 200 may also include one or more struts 216 formed between the inner wall 204 and the outer wall 206. The strut 216 serves to hold the inner wall 204 and the outer wall 206 in a fixed relationship to one another, as well as providing bearing support. The number of struts 216 is variable and commonly ranges from about four to about ten.

[0013] The inner wall 204 of the inner barrel 202 extends from the inlet 211, or diffuser entry end 210, to the outlet 220, or diffuser exit end 222. The inner barrel 202, and hence the inner wall 204, includes a first end 224 located proximate the inlet 211 and a second end 226 located proximate the outlet 220 and may take on numerous longitudinal contours as the inner barrel 202 extends from the first end 224 to the second end 226. The inner barrel 202 may slightly curve continuously from the first end 224 to the second end 226, may curve slightly for only portions between the first end 224 and the second end 226, may extend in a substantially straight direction, or may comprise segmented portions, where the overall longitudinal direction of the inner barrel 202 comprises any combination of the curvilinear paths described above. Irrespective of the shape of the inner barrel 202, and more particularly the inner wall 204, the inner barrel 202 and inner wall 204 extend to the diffuser outlet 220 or diffuser exit 222.

[0014] The outer wall 206 includes a first portion 230 that extends from the inlet 211, or diffuser entry end 210, in a substantially downstream direction, as well as in a direction away from the inner wall 204. The sloping curvilinear direction of first portion 230 of the outer wall 206 terminates at an outer radius location 232. The outer wall 206 also includes a second portion 234 that extends from the outer radius location 232 in a substantially downstream direction to the outlet 220, or diffuser exit end 222. The first portion 230 of the outer wall 206 angles away from the inner wall 204 more substantially than the second portion of the outer wall 206, with the outer radius location 232 being located further upstream than a longitudinal midpoint 236 of the inner barrel 202. The portion of the inner barrel 202 located upstream of the longitudinal midpoint 236 is an inlet portion 238, while the portion of the inner barrel located downstream of the longitudinal midpoint 236 is an outlet portion 240. Therefore, the outer wall 206 is pushed to an outer radius further upstream than conventional diffuser outer wall constructions.

[0015] FIG. 2 shows a flow path profile in diffuser 200 shown in FIG. 1. As can be seen, the flow profile for the diffuser 200 of FIG. 1 is strong throughout the entire radial area of the diffuser 200, even along the inner wall 204. The diffuser 200 reduces flow separation, thereby improving diffuser performance over a diffuser flow profile exhibiting flow separation, as shown in FIG. 3.

[0016] In addition to reducing flow separation by employing the above-described diffuser 200 structure, the introduction of secondary air flow may be injected into the diffuser 200. Such a secondary air flow into the diffuser 200 and thereby a main diffuser flow alters overall flow by energizing a shear layer that is formed between the main flow and the inner wall 204 and/or outer wall 206, causing a delay of the flow separation itself. The main flow widens and a larger static pressure recovery is achieved.

[0017] Various approaches to achieve introduction of the secondary air flow are contemplated and one such approach is by installing a flow manipulation device, such as a pump, within the inner barrel 202. The inner wall 204 of the inner barrel 202 includes one or more actuator openings and one or more suction openings that are located downstream of the one or more actuator openings. The suction opening allows common weak flow that passes directly over the inner wall 204 to enter the inner barrel 202 and pass through the flow manipulating device with sufficient force to exit the actuating opening in a manner that manipulates the flow profile of the diffuser 200. The manipulation of flow reduces flow separation, thereby increasing diffusion area.

[0018] Advantageously, diffuser 200 flow path is controlled by focusing the diffusion gradient near the region of high velocity and radially redistributing the flow. To reduce flow separation within the diffuser 200, particularly during part load performance of the overall system, the inner barrel 202 extends to the relative outlet 220 of the diffuser 200. Additionally, an outer wall 206 of the diffuser 200 extends radially away from the inner barrel 202 at a rapid rate, starting upstream at the relative inlet 211 of the diffuser 200. The result is a reduction in loss producing vortices associated with wake and a significant improvement in diffuser performance and thereby system heat rate gain. While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

[0019] Various aspects and embodiments of the present invention are defined by the following numbered clauses:

1. A diffuser for a gas turbine comprising:

    an inlet adapted for coupling to the gas turbine;

    at least one outlet located proximate a diffuser end, wherein the diffuser end is located downstream of the inlet;

    an outer wall; and

    an inner barrel extending substantially to the diffuser end.

2. The diffuser of clause 1, wherein the outer wall and the inner barrel define a varying radius along a length of the diffuser between the inlet and the outlet.

3. The diffuser of any preceding clause, wherein the varying radius defined by the outer wall and the inner barrel is greater at the outlet than at the inlet.

4. The diffuser of any preceding clause, wherein the varying radius defined by the outer wall and the inner barrel includes an outer radius location.

5. The diffuser of any preceding clause, further comprising a midpoint located relatively halfway between the inlet and the outlet, an inlet portion defined by the inlet and the midpoint, and an outlet portion defined by the midpoint and the outlet, wherein the outer radius location is proximate the inlet portion.

6. The diffuser of any preceding clause, in combination with an axial-flow turbine.

7. The diffuser of any preceding clause, wherein the outlet is adapted for coupling to an adjacent object.

8. An exhaust gas diffuser comprising:

an inlet;
an outlet;
an inner barrel extending from substantially the inlet to substantially the outlet; and
an outer wall radially spaced apart from the inner barrel, wherein the outer wall and the inner barrel define a varying radius along a length of the diffuser between the inlet and the outlet.

9. The diffuser of any preceding clause, wherein the varying radius defined by the outer wall and the inner barrel is greater at the outlet than at the inlet.

10. The diffuser of any preceding clause, wherein the varying radius defined by the outer wall and the inner barrel includes an outer radius location.

11. The diffuser of any preceding clause, further comprising a midpoint located relatively halfway between the inlet and the outlet, an inlet portion defined by the inlet and the midpoint, and an outlet portion defined by the midpoint and the outlet, wherein the outer radius location is proximate the inlet portion.

12. The exhaust gas diffuser of any preceding clause, in combination with an axial-flow gas turbine.

13. The exhaust gas diffuser of any preceding clause, wherein the inlet is adapted for coupling to the axial-flow gas turbine.

14. The exhaust gas diffuser of any preceding clause, wherein the outlet is adapted for coupling to an adjacent object.

15. A gas turbine comprising:

a turbine casing that surrounds a portion of the gas turbine; and
an exhaust gas diffuser coupled to the turbine casing, the diffuser including:

an inlet adapted for coupling to the gas turbine, an outer wall, an inner barrel and a diffuser end downstream from the inlet, the inner barrel extending substantially to the diffuser end.

16. The gas turbine of any preceding clause, wherein the exhaust gas diffuser further comprises an outlet located proximate the diffuser end.

17. The gas turbine of any preceding clause, wherein the outer wall and the inner barrel define a varying radius along a length of the diffuser between the inlet and the outlet.

18. The gas turbine of any preceding clause, wherein the varying radius defined by the outer wall and the inner barrel is greater at the outlet than at the inlet.

19. The gas turbine of any preceding clause, wherein the varying radius defined by the outer wall and the inner barrel includes an outer radius location.

20. The gas turbine of any preceding clause, wherein the exhaust gas diffuser further comprises a midpoint located relatively halfway between the inlet and the outlet, an inlet portion defined by the inlet and the midpoint, and an outlet portion defined by the midpoint and the outlet, wherein the outer radius location is proximate the inlet portion.

Claims

1. A diffuser for a gas turbine comprising:

an inlet adapted for coupling to the gas turbine;
at least one outlet located proximate a diffuser end, wherein the diffuser end is located downstream of the inlet;
an outer wall; and
an inner barrel extending substantially to the diffuser end.

2. The diffuser of claim 1, wherein the outer wall and the inner barrel define a varying radius along a length of the diffuser between the inlet and the outlet.

3. The diffuser of any preceding claim, wherein the varying radius defined by the outer wall and the inner barrel is greater at the outlet than at the inlet.

4. The diffuser of any preceding claim, wherein the varying radius defined by the outer wall and the inner barrel includes an outer radius location.

5. The diffuser of any preceding claim, further comprising a midpoint located relatively halfway between the inlet and the outlet, an inlet portion defined by the inlet and the midpoint, and an outlet portion defined by the midpoint and the outlet, wherein the outer radius location is proximate the inlet portion.

6. The diffuser of any preceding claim, in combination with an axial-flow turbine.

7. The diffuser of any preceding claim, wherein the outlet is adapted for coupling to an adjacent object.

8. An exhaust gas diffuser comprising:

an inlet;
an outlet;

an inner barrel extending from substantially the inlet to substantially the outlet;
and
an outer wall radially spaced apart from the inner barrel, wherein the outer wall and the inner barrel define a varying radius along a length of the diffuser between the inlet and the outlet.

9. The diffuser of claim 8, wherein the varying radius defined by the outer wall and the inner barrel is greater at the outlet than at the inlet.

10. The diffuser of claim 8 or claim 9, wherein the varying radius defined by the outer wall and the inner barrel includes an outer radius location.

11. The diffuser of any of claims 8 to 10, further comprising a midpoint located relatively halfway between the inlet and the outlet, an inlet portion defined by the inlet and the midpoint, and an outlet portion defined by the midpoint and the outlet, wherein the outer radius location is proximate the inlet portion.

12. The exhaust gas diffuser of any of claims 8 to 11, in combination with an axial-flow gas turbine.

13. The exhaust gas diffuser of any of claims 8 to 12, wherein the inlet is adapted for coupling to the axial-flow gas turbine.

14. The exhaust gas diffuser of any of claims 8 to 13, wherein the outlet is adapted for coupling to an adjacent object.

15. A gas turbine comprising:

a turbine casing that surrounds a portion of the gas turbine; and
an exhaust gas diffuser coupled to the turbine casing, the diffuser including:

an inlet adapted for coupling to the gas turbine, an outer wall, an inner barrel and a diffuser end downstream from the inlet, the inner barrel extending substantially to the diffuser end.

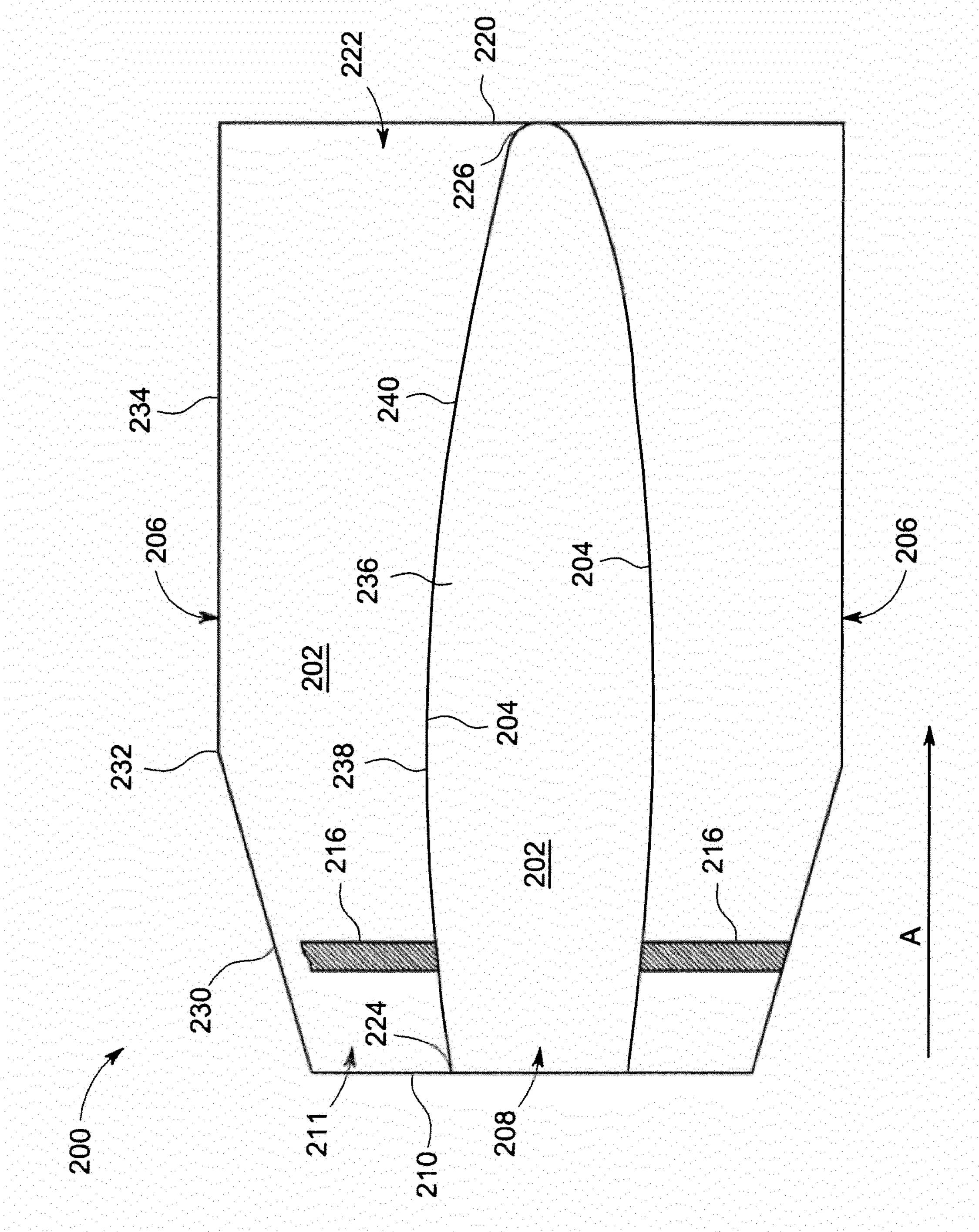
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FIG. 1

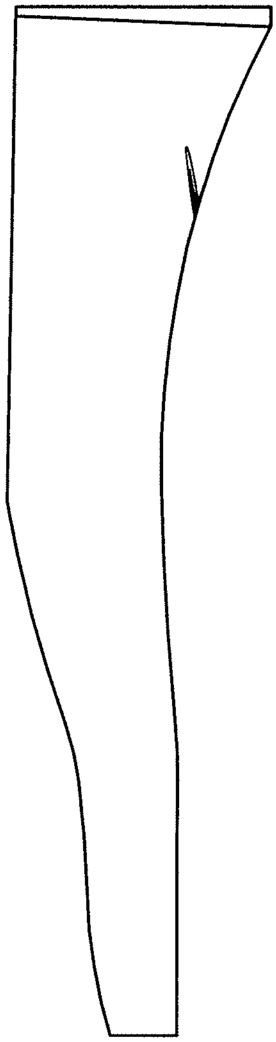

FIG. 2

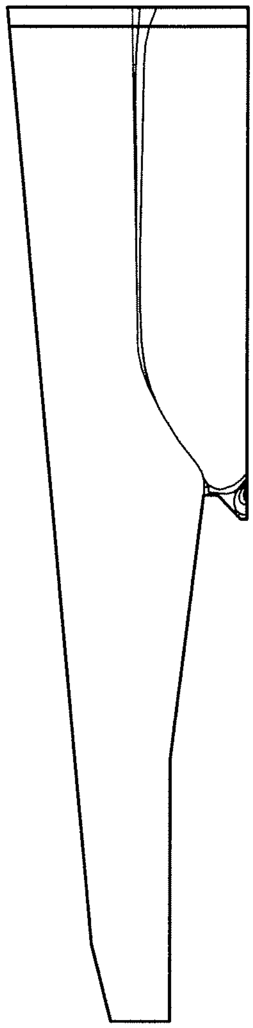

FIG. 3