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(54) DIFFUSER FOR GAS TURBINE SYSTEM

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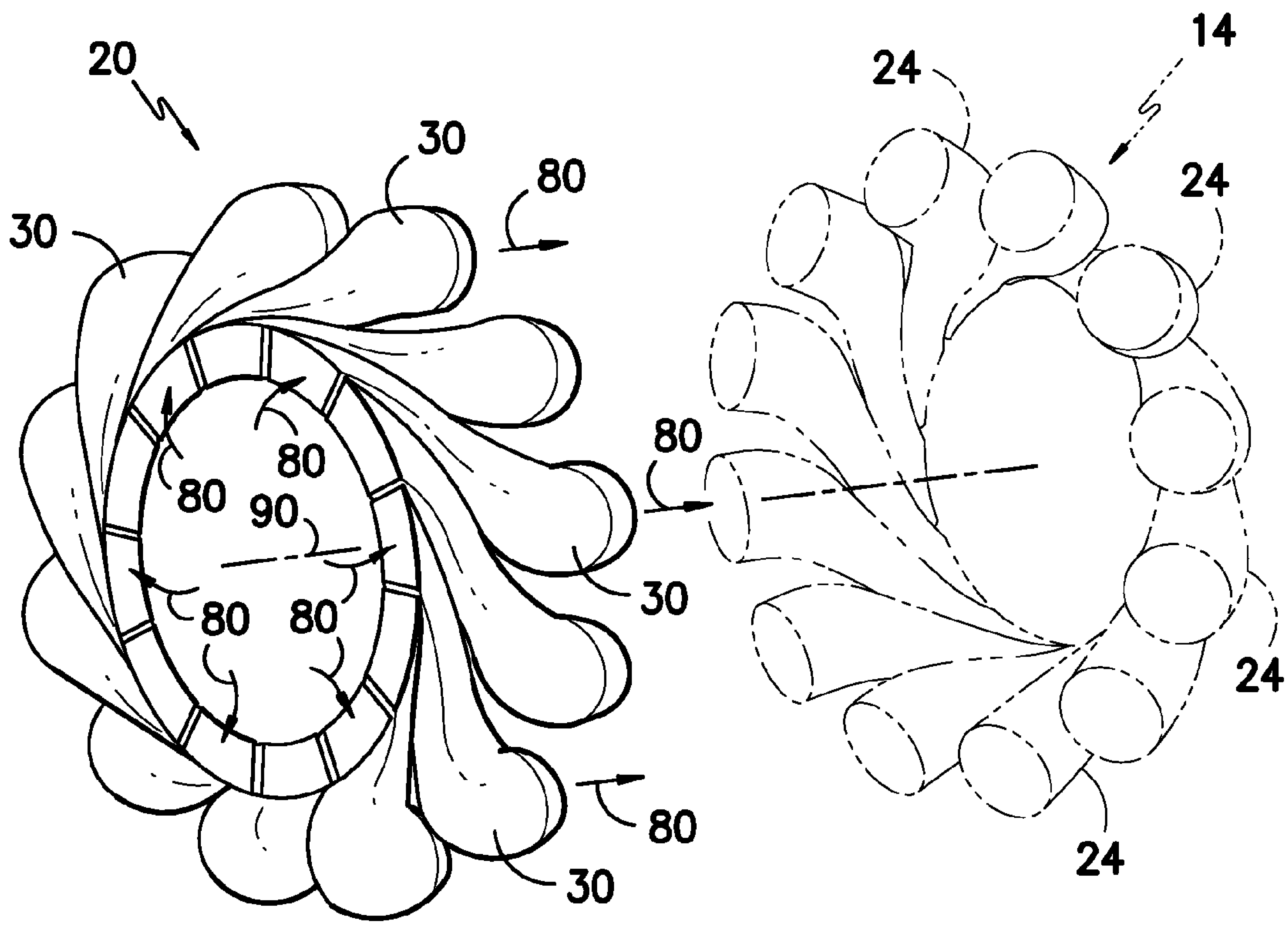
(57) ABSTRACT

A diffuser for a gas turbine system having a longitudinal axis is disclosed. The diffuser includes a plurality of diffuser ducts. Each of the plurality of diffuser ducts is disposed annularly about the longitudinal axis and has an inlet, an outlet, and a passage extending between the inlet and the outlet. The outlet of each of the plurality of diffuser ducts is tangentially offset from the inlet of the respective diffuser duct. Each of the plurality of diffuser ducts is configured to flow a gas flow therethrough, reducing the gas flow velocity.



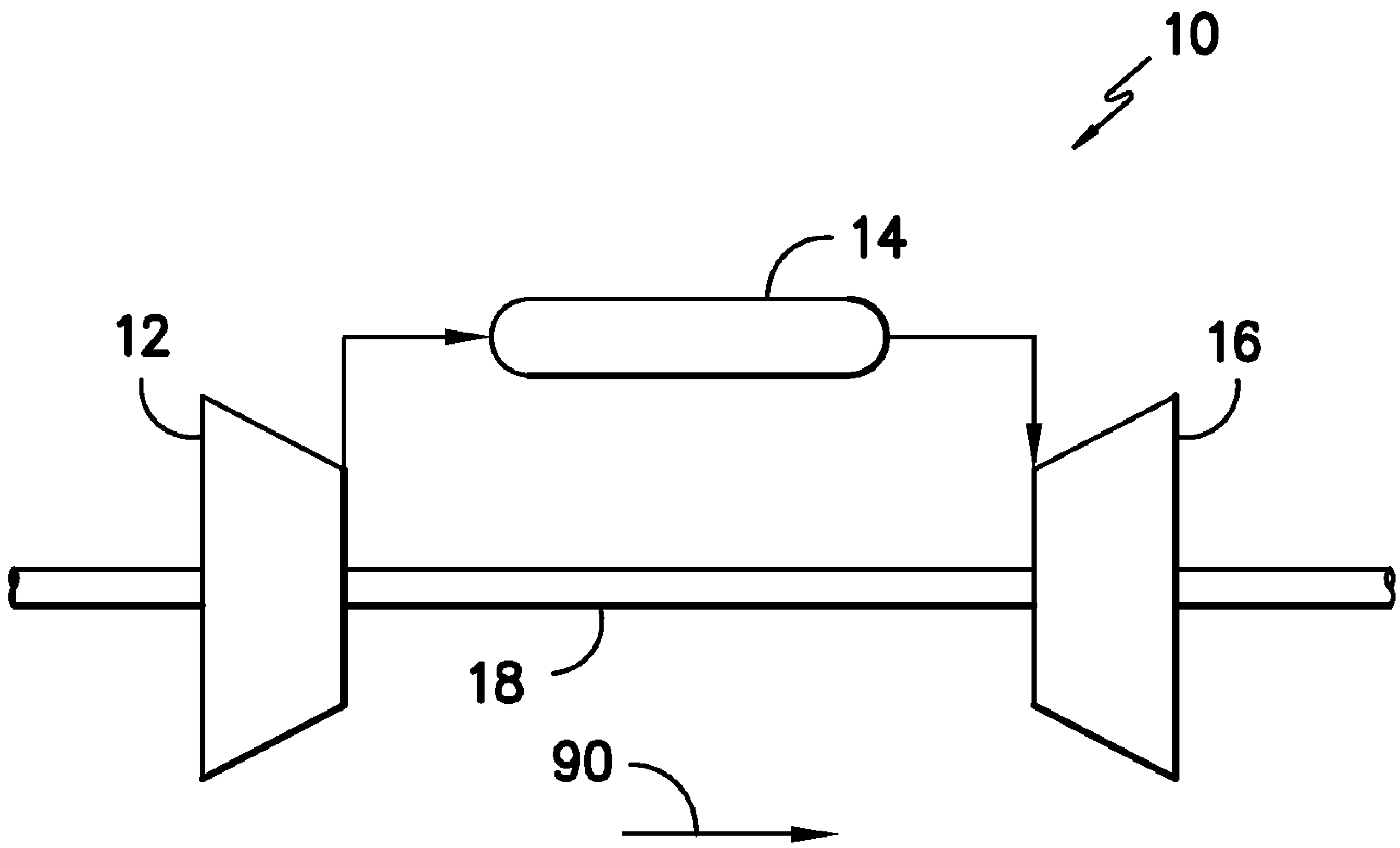
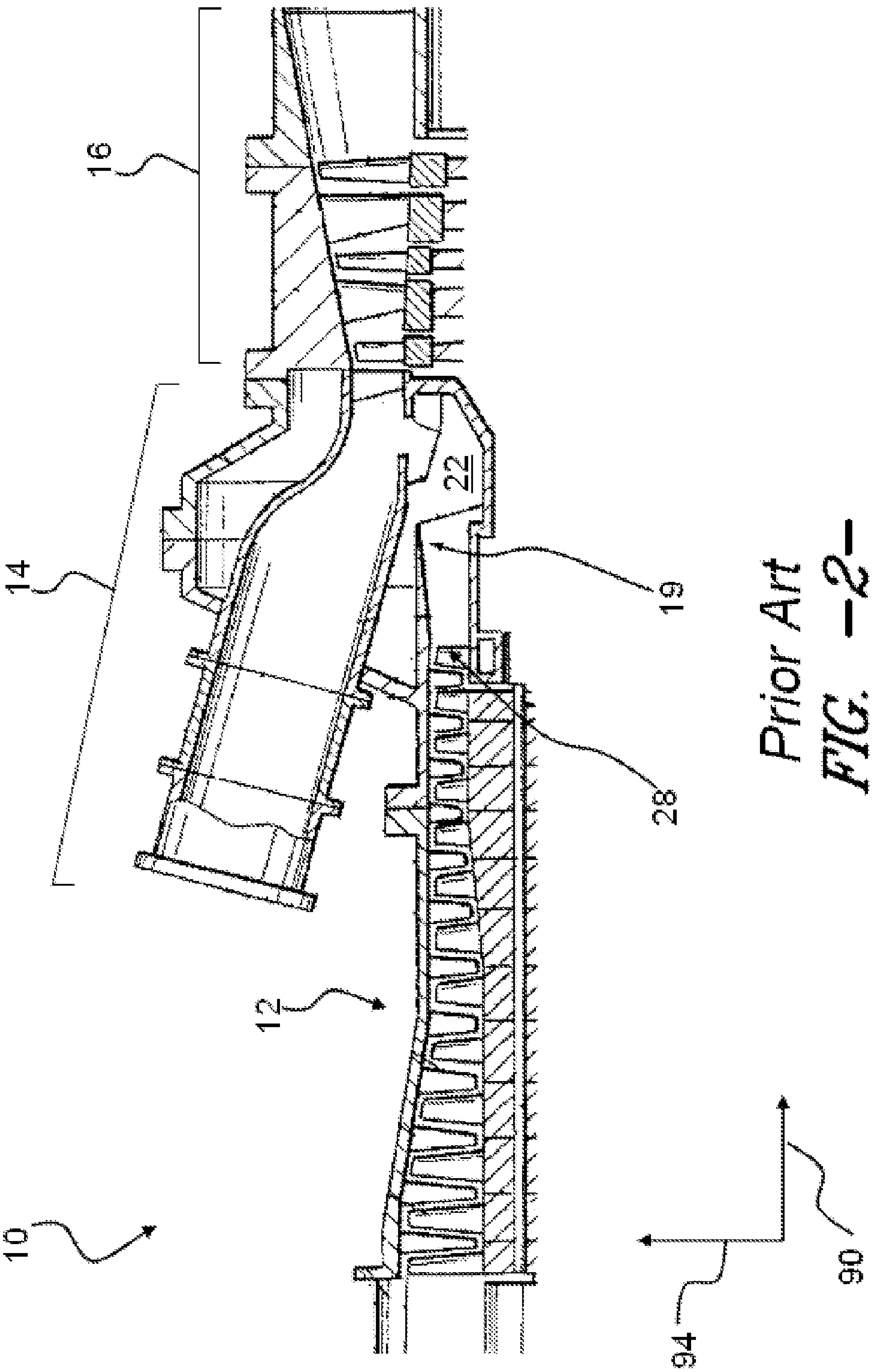
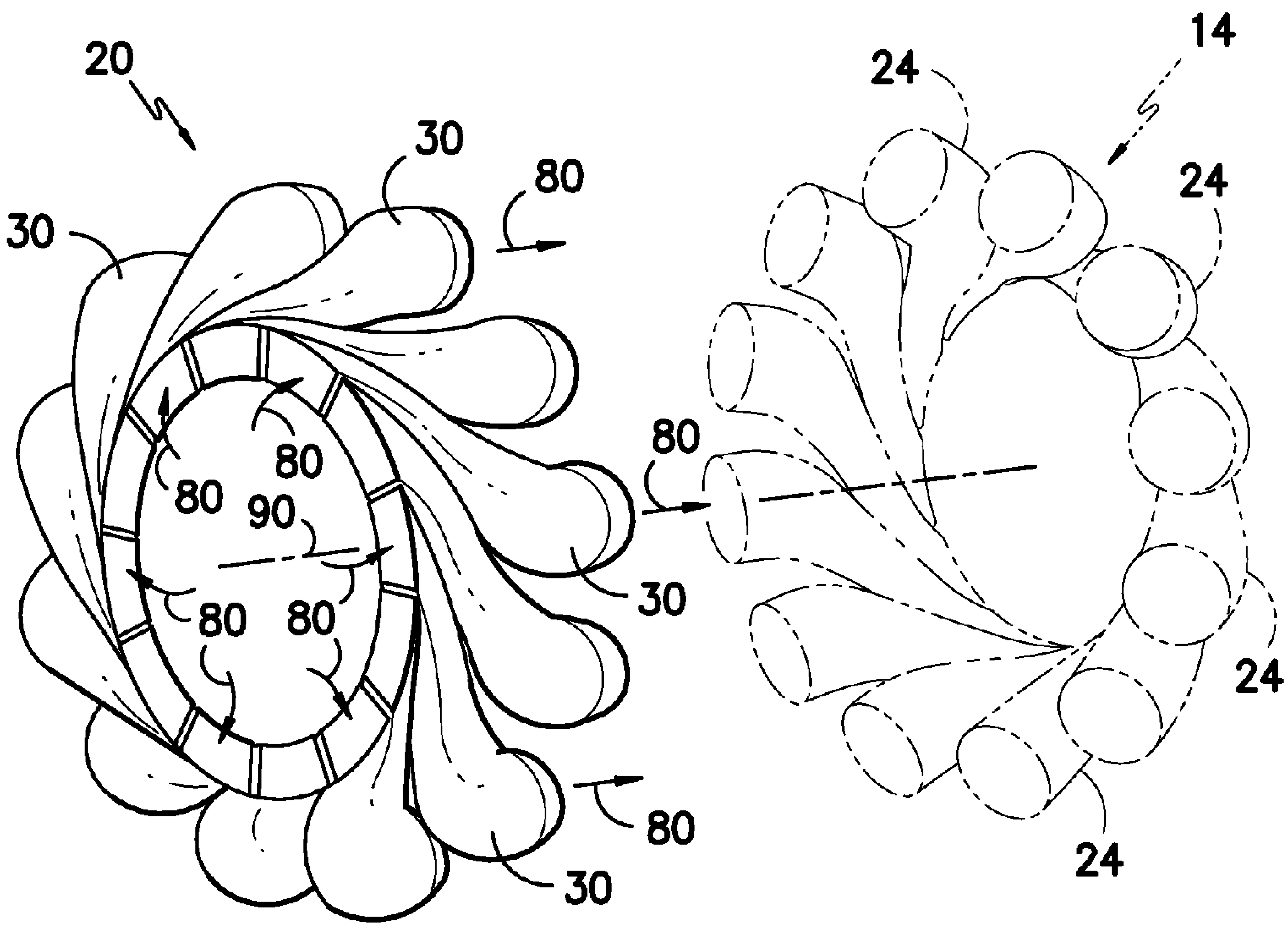


FIG. –1–



Prior Art
FIG. -2-


20
30
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80
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80

FIG. -3-

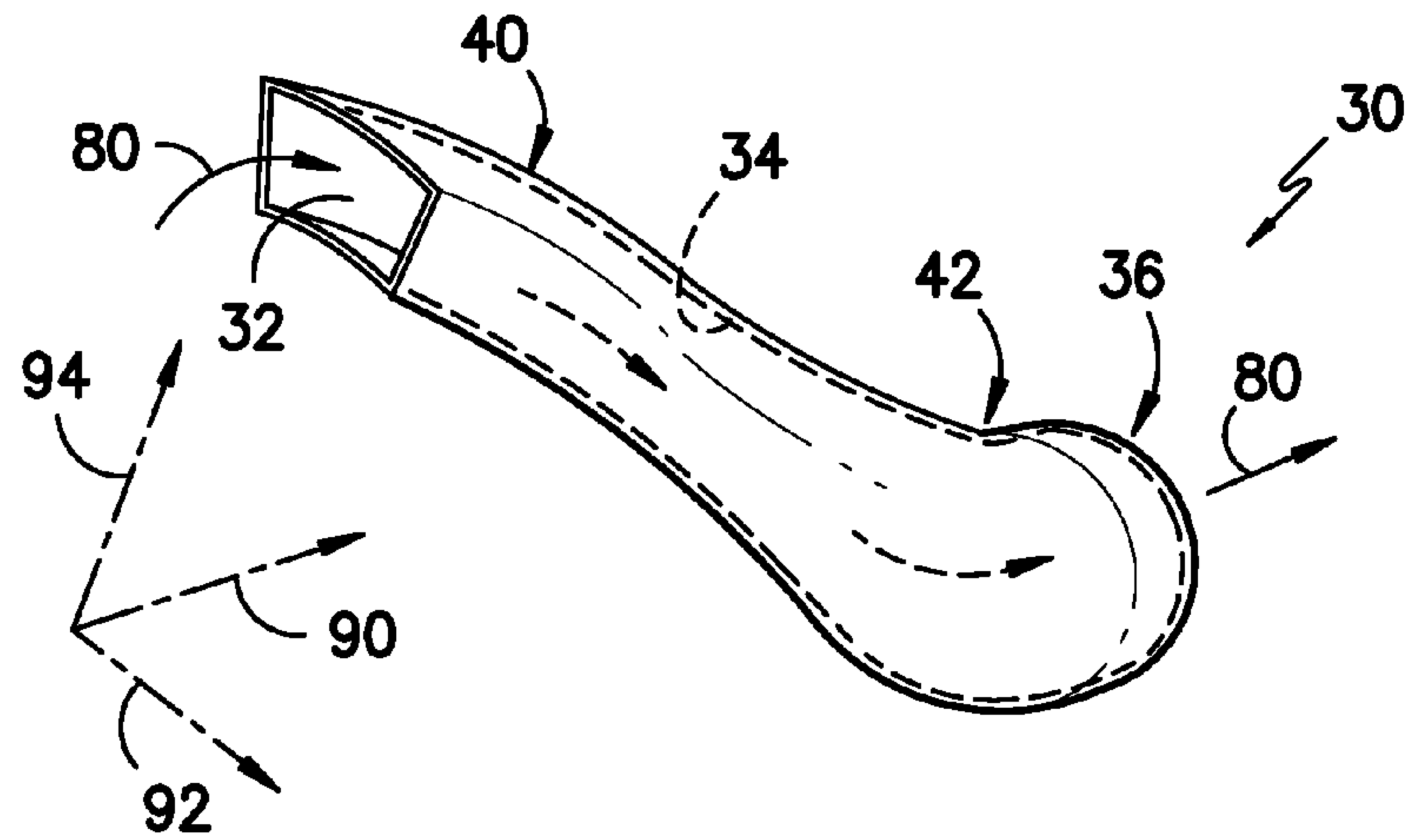
40
80
34
30
32
42
36
94
80
90
92

FIG. -4-

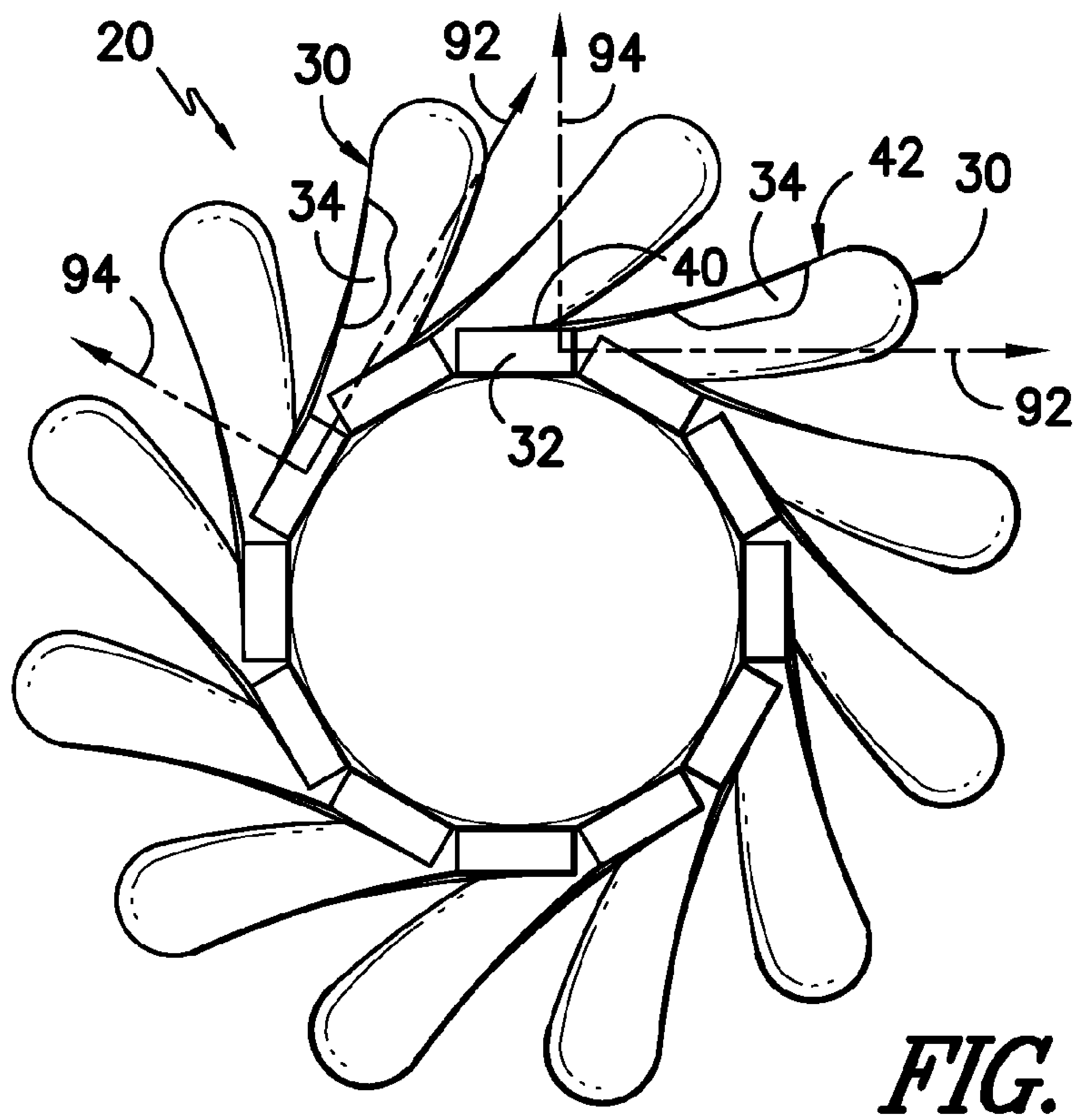

FIG. -5-

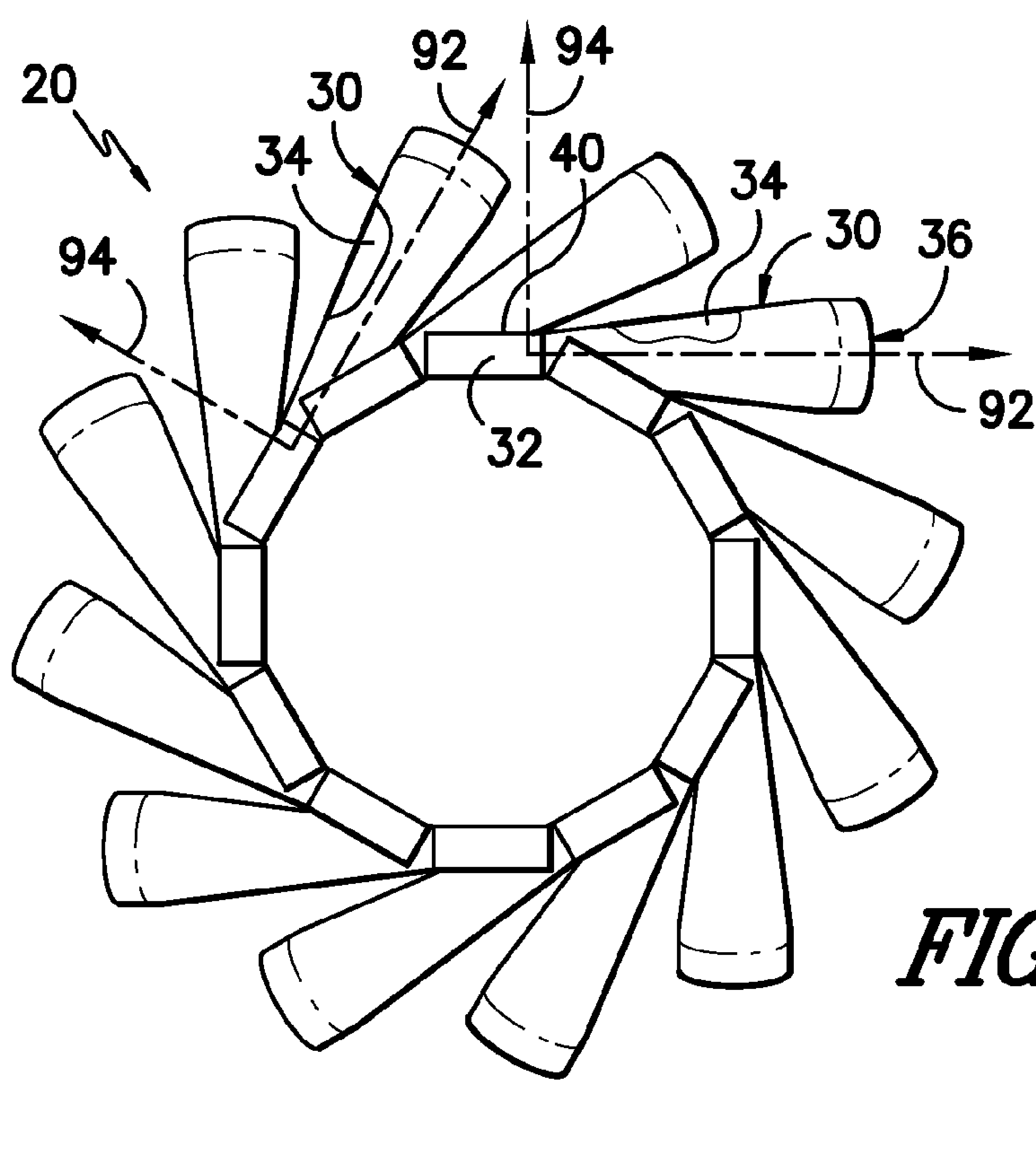

FIG. -6-

DIFFUSER FOR GAS TURBINE SYSTEM

FIELD OF THE INVENTION

[0001] The subject matter disclosed herein related generally to gas turbine systems, and more particularly to diffusers in gas turbine systems.

BACKGROUND OF THE INVENTION

[0002] Gas turbine systems are widely utilized in fields such as power generation. A conventional gas turbine system includes a compressor section, a combustor section, and at least one turbine section. The compressor section is configured to compress air as the air flows through the compressor section. The air is then flowed from the compressor section to the combustor section, where it is mixed with fuel and combusted, generating a hot gas flow. The hot gas flow is provided to the turbine section, which utilizes the hot gas flow by extracting energy from it to power the compressor, an electrical generator, and other various loads.

[0003] In conventional gas turbine systems, the air flow compressed in the compressor section is discharged from the compressor section at a relatively high velocity. The velocity of this air flow generally should be reduced to a velocity that is optimal for entering the combustor section. Thus, typical known compressor sections include an axial diffuser **19**, as shown in FIG. **2**, which acts to reduce the velocity of the air flow exiting the compressor section.

[0004] The utilization of typical known diffusers in gas turbine systems can subject the gas turbine system to a variety of problems. For example, known diffusers typically diffuse the air flow as the air flow travels along a generally longitudinal axis **90** of the gas turbine system. However, the air flow exiting the compressor section generally has an "exit swirl" component, meaning that the air flow is traveling in a generally rotational direction, with tangential and radial flow components, along with traveling in a generally longitudinal direction. To reduce this exit swirl before the air flow enters the axial diffuser **19**, a guide vane or guide vanes **28** are typically disposed upstream of the axial diffuser **19** in the compressor section. The guide vanes **28** are designed to reduce the exit swirl. However, significant air flow pressure drops are associated with the use of guide vanes **28** to reduce the exit swirl, which results in losses in the performance and efficiency of the gas turbine system. Further, after the air flow exits a typical axial diffuser **19**, the air flow must change direction multiple times as it flows to the combustor section, as shown in FIG. **2**. Further significant air flow pressure drops are associated with each change in direction, thus resulting in further losses in the performance and efficiency of the gas turbine system.

[0005] Thus, a diffuser that reduces air flow pressure drops would be desired in the art. Additionally, a diffuser that utilizes the exit swirl associated with the air flow to guide the air flow to the combustor section would be advantageous. Further, a diffuser that eliminates the need for guide vanes in the compressor section would be desired.

BRIEF DESCRIPTION OF THE INVENTION

[0006] Aspects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention.

[0007] In one embodiment, a diffuser for a gas turbine system having a longitudinal axis is disclosed. The diffuser includes a plurality of diffuser ducts. Each of the plurality of diffuser ducts is disposed annularly about the longitudinal axis and has an inlet, an outlet, and a passage extending between the inlet and the outlet. The outlet of each of the plurality of diffuser ducts is tangentially offset from the inlet of the respective diffuser duct. Each of the plurality of diffuser ducts is configured to flow a gas flow therethrough, reducing the gas flow velocity.

[0008] These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWING

[0009] A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

[0010] FIG. **1** is a schematic view of a gas turbine system of the present disclosure;

[0011] FIG. **2** is a cross-sectional view of a known gas turbine system;

[0012] FIG. **3** is an exploded perspective view of one embodiment of a diffuser of the present disclosure;

[0013] FIG. **4** is a perspective view of one embodiment of a diffuser duct of the present disclosure;

[0014] FIG. **5** is a front view of one embodiment of a diffuser of the present disclosure; and

[0015] FIG. **6** is a front view of another embodiment of a diffuser of the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

[0016] Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

[0017] FIG. **1** is a schematic diagram of a gas turbine system **10**. The system **10** may include a compressor section **12**, a combustor section **14**, and a turbine section **16**. Further, the system **10** may include a plurality of compressor sections **12**, combustor sections **14**, and turbine sections **16**. The compressor section **12** and turbine section **16** may be coupled by a shaft **18**. The shaft **18** may be a single shaft or a plurality of shaft segments coupled together to form shaft **18**. The gas turbine system **10** may have a central longitudinal axis **90**. For example, the shaft **18** may be disposed longitudinally along the axis **90**.

[0018] The compressor section **12** may compress a gas flow **80** as the gas flow **80** flows through the compressor section **12**.

The gas flow **80** may be, for example, air or any other suitable gas. The compressor section **12** may then flow the gas flow **80** to the combustor section **14**, which may be configured to accept the gas flow **80**, as discussed below.

[0019] As the gas flow **80** flows through the compressor section **12** after being compressed, it may flow in a generally longitudinal direction with respect to the longitudinal axis **90**. However, the gas flow **80** may generally further include other flow components. For example, the gas flow **80** after being compressed may have flow components known collectively in the art as an "exit swirl." Thus, the gas flow **80** may flow in a generally tangential direction, and may further flow in a generally radial direction.

[0020] In various embodiments, the compressor section **12** may include at least one guide vane **28**. The guide vane **28** may reduce the exit swirl, thus reducing the tangential and radial flow components of the gas flow **80**. In exemplary embodiments of the present disclosure, however, the compressor section **12** may be free from guide vanes **28**.

[0021] As shown in FIGS. **3** through **6**, the compressor section **12** may include a diffuser **20**. The diffuser **20** may be configured to reduce the velocity of the gas flow **80**, as discussed below. The diffuser **20** may further generally flow the gas flow **80** to the combustor section **14**. For example, after being compressed in the compressor section **12**, gas flow **80** may flow through the diffuser **20** and be provided to the combustor section **14**. For example, in one embodiment, the gas flow **80** may exit the diffuser **20** into a plenum **22**. The gas flow **80** may then be provided from the plenum **22** to the combustor section **14**. Alternatively, the gas flow **80** may exit the diffuser **20** directly into the combustor section **14**. For example, the combustor section **14** may include a plurality of combustor cans **24**. Further, in one embodiment as discussed below, the diffuser **20** may comprise a plurality of diffuser ducts **30**. Each of the diffuser ducts **30** may be coupled with a combustor can **24**. The combustor cans **24** may be configured to accept gas flow **80** from one of the plurality of diffuser ducts **30**. For example, each of the combustor cans **24** may be fluidly connected to one of the diffuser ducts **30**, such that gas flow **80** exiting the diffuser ducts **30** immediately enters the combustor cans **24**, and thus the combustor section **14**.

[0022] As mentioned above, the diffuser **20** of the present disclosure includes a plurality of diffuser ducts **30**. As shown in FIGS. **3** through **6**, each of the plurality of diffuser ducts **30** may have an inlet **32**, an outlet **36**, and a passage extending between the inlet **32** and the outlet **36**. The diffuser ducts **30** may be configured to flow a gas flow **80** therethrough, reducing the gas flow **80** velocity. For example, the inlet **32** of each of the plurality of diffuser ducts **30** may have a cross-sectional area that is generally smaller than the cross-sectional area of the outlet **36** of the respective diffuser duct **30**. The inlets **32** and outlets **36** may have generally circular or oval cross-sections, rectangular cross-sections, triangular cross-sections, or any other suitable polygonal cross-sections. Further, it should be understood that the inlet **32** and outlet **34** of a respective diffuser duct **30** need not have similarly shaped cross-sections. For example, in one embodiment, the inlet **32** may have a generally rectangular cross-section, while the outlet **36** may have a generally circular cross-section.

[0023] Further, the passage **34** may be generally tapered between the inlet **32** and the outlet **36**. For example, in an exemplary embodiment, the passage **34** may be generally conically shaped. Alternatively, however, the passage **34** may have a generally rectangular cross-section, triangular cross-section, or any other suitable polygonal cross-section. It should be understood that the cross-sectional shape of the passage **34** may change throughout the passage **34** as the passage **34** tapers from the relatively smaller inlet **32** to the relatively larger outlet **36**.

[0024] The diffuser ducts **30** may be disposed in an annular array about the longitudinal axis **90**. Thus, as gas flow **80** flows in a generally longitudinal direction through the compressor section **12** and into the diffuser **20** after being compressed, the gas flow **80** may flow through the inlets **32** into the annular array of diffuser ducts **30**.

[0025] The outlet **36** of each of the plurality of diffuser ducts **30** may be offset from the inlet **32** of the respective diffuser duct **30**. The term "offset", as used herein, means spaced from along the identified coordinate direction. For example, the outlet **36** of each of the plurality of diffuser ducts **30** may be tangentially offset from the inlet **32** of the respective diffuser duct **30**, such as offset along a tangential axis **92**. Because the outlet **36** of each of the plurality of diffuser ducts **30** is tangentially offset from the inlet **32** of the respective diffuser duct **30**, the diffuser ducts **30** may advantageously utilize the tangential component of the gas flow **80** exit swirl to flow the gas flow **80** through the diffuser duets **30**. In exemplary embodiments, this utilization of the tangential gas flow **80** component may eliminate the need for guide vanes **28** in the compressor section **12**. Further, the utilization of the tangential gas flow **80** component may prevent gas flow **80** pressure losses due to flow direction changes in typical prior art gas turbine systems as the gas flow **80** flows from the compressor section **12** through the diffuser **20** to the combustor section **14**.

[0026] Additionally, in some exemplary embodiments, the outlet **36** of each of the plurality of diffuser ducts **30** may be longitudinally offset from the inlet **32** of the respective diffuser duct **30**, such as offset along the longitudinal axis **90**. Because the outlet **36** of each of the plurality of diffuser ducts **30** is longitudinally offset from the inlet **32** of the respective diffuser duct **30**, the diffuser ducts **30** may advantageously utilize the longitudinal component of the gas flow **80** to flow the gas flow **80** through the diffuser ducts **30**.

[0027] Further, in some exemplary embodiments, the outlet **36** of each of the plurality of diffuser ducts **30** may be radially offset from the inlet **32** of the respective diffuser duct **30**, such as offset along a radial axis **94**. Because the outlet **36** of each of the plurality of diffuser ducts **30** is radially offset from the inlet **32** of the respective diffuser duct **30**, the diffuser ducts **30** may advantageously utilize the radial component of the gas flow **80** exit swirl to flow the gas flow **80** through the diffuser ducts **30**.

[0028] It should be understood that the tangential axis **92** and the radial axis **94** are defined individually for each diffuser duct **30** with respect to the circumference defined by the diffuser **20** and diffuser ducts **30**, as shown in FIGS. **5** and **6**, and that the axes **92** and **94** vary for each diffuser duct **30** about the circumference of the diffuser **20** based on the number of diffuser ducts **30** disposed in an annular array about the longitudinal axis **90** of the diffuser **20**.

[0029] Each of the passages **34** may include a first guide portion **40**, as shown in FIG. **4**. In exemplary embodiments, the first guide portion **40** may be disposed adjacent the inlet **32** of the respective diffuser duct **30**. Alternatively, however, the first guide portion **40** may be any portion of the passage **34** of the diffuser duct **30**. The first guide portion **40** may be that portion of the passage **34** that redirects the general direction of gas flow **80** within a diffuser duct **30**. For example, the first guide portions **40** may be configured to guide the gas flow **80** from a generally longitudinal flow direction to a generally tangential flow direction. Alternatively, the first guide portions **40** may be configured to guide the gas flow **80** from a generally longitudinal flow direction to a generally radial flow direction, a generally tangential and radial flow direction, a generally tangential and longitudinal flow direction, or to a generally tangential, radial, and longitudinal flow direction. It should be understood that gas flow **80** in any general direction, such as in a generally longitudinal direction, may have other flow components, such as radial and tangential flow components, and is not limited to flow strictly in the referenced direction.

[0030] After gas flow **80** passes through the first guide portion **40** of the passage **34** of a diffuser duct **30**, the gas flow **80** may continue to flow through the passage **34** towards the outlet **36**. In certain exemplary embodiments, the passages **34** may extend in a generally linear manner downstream of the guide portion **40** with respect to the gas flow **80**, as shown in FIG. **6**. Thus, the gas flow **80**, after passing through the first guide portion **40** of the passage **34**, may continue through the passage **34** in a generally linear manner. In alternative exemplary embodiments, the passages **34** may extend in a generally curvilinear manner downstream of the guide portion **40** with respect to the gas flow **80**, as shown in FIGS. **3** through **5**. Thus, the gas flow **80**, after passing through the first guide portion **40** of the passage **34**, may continue through the passage **34** in a generally curvilinear manner.

[0031] Each of the passages **34** may further include a second guide portion **42**. In exemplary embodiments, the second guide portion **42** may be disposed adjacent the outlet **36** of the respective diffuser duct **30**. Alternatively, however, the second guide portion **42** may be any portion of the passage **34** of the diffuser duct **30**. The second guide portion **42** may be another portion of the passage **34** that further redirects the general direction of gas flow **80** within a diffuser duct **30**. For example, the second guide portions **42** may be configured to guide the gas flow **80** from a generally tangential flow direction to a generally longitudinal flow direction. Alternatively, the second guide portions **42** may be configured to guide the gas flow **80** from a generally radial flow direction, a generally tangential and radial flow direction, a generally tangential and longitudinal flow direction, or a generally tangential, radial, and longitudinal flow direction to a generally longitudinal flow direction. It should be understood that gas flow **80** in any general direction, such as in a generally longitudinal direction, may have other flow components, such as radial and tangential flow components, and is not limited to flow strictly in the referenced direction.

[0032] It should be understood that before gas flow **80** passes through the second guide portion **42** of the passage **34** of a diffuser duct **30**, the gas flow **80** may flow through the passage **34** towards the guide portion **42** and the outlet **36**. In certain exemplary embodiments, the passages **34** may extend in a generally linear manner upstream of the second guide portion **42** with respect to the gas flow **80**, as shown in FIG. **6**. Thus, the gas flow **80**, before passing through the second guide portion **42** of the passage **34**, may travel through the passage **34** in a generally linear manner. In alternative exemplary embodiments, the passages **34** may extend in a generally curvilinear manner upstream of the second guide portion **42** with respect to the gas flow **80**, as shown in FIGS. **3** through **5**. Thus, the gas flow **80**, before passing through the second guide portion **42** of the passage **34**, may travel through the passage **34** in a generally curvilinear manner.

[0033] After the gas flow **80** flows through the outlet **36** of a diffuser duct **30** of the present disclosure, the gas flow **80** may exit the diffuser **20**. In some exemplary embodiments, the gas flow **80** may exit the diffuser **20** flowing in a generally tangential direction. It should be understood, however, that the gas flow **80** may have radial and longitudinal flow components, and is not limited to flow in a strictly tangential direction. Alternatively, the gas flow **80** may exit the diffuser **20** flowing in a generally longitudinal direction. It should be understood, however, that the gas flow **80** may have tangential and radial flow components, and is not limited to flow in a strictly longitudinal direction. Further, the gas flow **80** may exit the diffuser **20** flowing in a generally radial direction. It should be understood, however, that the gas flow **80** may have tangential and longitudinal flow components, and is not limited to flow in a strictly radial direction.

[0034] As discussed above, after the gas flow **80** exits the diffuser **20** and the compressor section **12**, the gas flow **80** may enter a plenum **22**, or may directly enter the combustor section **14**. For example, each of the diffuser ducts **30** may be coupled to a combustor can **24**, and the gas flow **80** exiting each diffuser duct **30** may enter the combustor can **24** coupled with the diffuser duct **30**. Thus, in exemplary embodiments, the diffuser **20** may include a number of diffuser ducts **20** equal to the number of combustor cans **24** in the combustor **14**. For example, the diffuser **20**, in various embodiments, may include 8, 12, or 16 diffuser ducts **30**, or any other suitable number of diffuser ducts **30**.

[0035] 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 include 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 languages of the claims.

What is claimed is:

1. A diffuser for a gas turbine system having a longitudinal axis, the diffuser comprising:

a plurality of diffuser ducts, each of the plurality of diffuser ducts disposed annularly about the longitudinal axis and having an inlet, an outlet, and a passage extending between the inlet and the outlet,

wherein the outlet of each of the plurality of diffuser ducts is tangentially offset from the inlet of the respective diffuser duct,

and wherein each of the plurality of diffuser ducts is configured to flow a gas flow therethrough, reducing the gas flow velocity.

2. The diffuser of claim **1**, wherein the outlet of each of the plurality of diffuser ducts is longitudinally offset from the inlet of the respective diffuser duct.

3. The diffuser of claim **1**, wherein the outlet of each of the plurality of diffuser ducts is radially offset from the inlet of the respective diffuser duct.

4. The diffuser of claim **1**, wherein gas flow exits the diffuser flowing in a generally tangential direction.

5. The diffuser of claim **1**, wherein gas flow exits the diffuser flowing in a generally longitudinal direction.

6. The diffuser of claim **1**, wherein each of the passages includes a guide portion disposed adjacent the inlet of the respective diffuser duct, the guide portions configured to guide the gas flow from a generally longitudinal flow direction to a generally tangential flow direction.

7. The diffuser of claim **6**, wherein the guide portions are further configured to guide the gas flow to a generally radial flow direction.

8. The diffuser of claim **6**, wherein each of the passages extends in a generally linear manner downstream of the guide portion with respect to the gas flow.

9. The diffuser of claim **6**, wherein each of the passages extends in a generally curvilinear manner downstream of the guide portion with respect to the gas flow.

10. The diffuser of claim **1**, wherein each of the passages includes a guide portion disposed adjacent the outlet of the respective diffuser duct, the guide portions configured to guide the gas flow from a generally tangential flow direction to a generally longitudinal flow direction.

11. The diffuser of claim **10**, wherein the guide portions are further configured to guide the gas flow from a generally radial flow direction.

12. The diffuser of claim **10**, wherein each of the passages extends in a generally linear manner upstream of the guide portion with respect to the gas flow.

13. The diffuser of claim **10**, wherein each of the passages extends in a generally curvilinear manner upstream of the guide portion with respect to the gas flow.

14. The diffuser of claim **1**, wherein each of the passages is generally conically shaped.

15. A gas turbine system having a longitudinal axis, the gas turbine system comprising:

a compressor section for compressing a gas flow;

a diffuser configured to reduce the velocity of the gas flow, the diffuser comprising a plurality of diffuser ducts, each of the plurality of diffuser ducts disposed annularly about the longitudinal axis and having an inlet, an outlet, and a passage extending between the inlet and the outlet, wherein the outlet of each of the plurality of diffuser ducts is tangentially offset from the inlet of the respective diffuser duct, and wherein each of the plurality of diffuser ducts is configured to flow the gas flow therethrough; and

a combustor section configured to accept the gas flow from the diffuser.

16. The gas turbine system of claim **15**, wherein the compressor section is free from guide vanes.

17. The gas turbine system of claim **15**, the combustor section comprising a plurality of combustor cans, each of the combustor cans configured to accept the gas flow from one of the plurality of diffuser ducts.

18. The gas turbine system of claim **15**, wherein the outlet of each of the plurality of diffuser ducts is longitudinally offset from the inlet of the respective diffuser duct.

19. The gas turbine system of claim **15**, wherein the outlet of each of the plurality of diffuser ducts is radially offset from the inlet of the respective diffuser duct.

20. The gas turbine system of claim **15**, wherein each of the passages is generally conically shaped.

* * * * *