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(54) **INLET ORIFICE OF BLOWER FAN OF FAN COIL UNIT**

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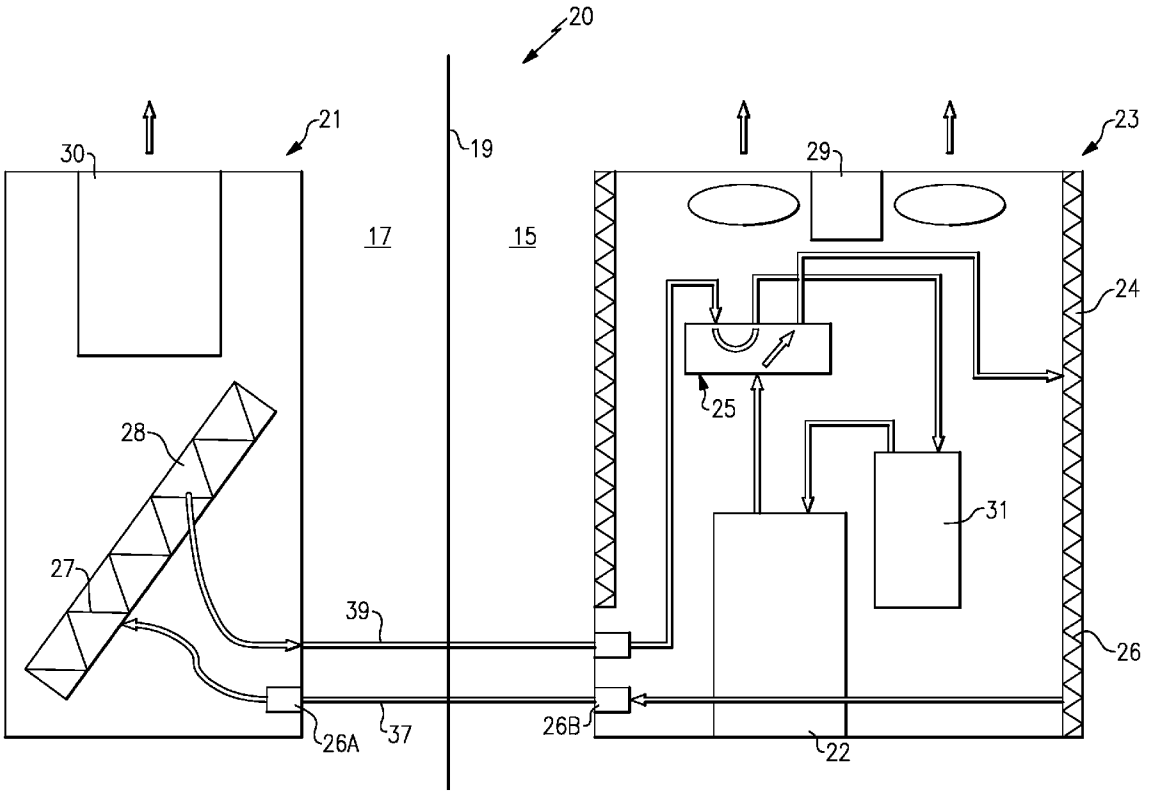
(57) **ABSTRACT**

A blower fan of a fan coil unit includes a fan wheel including a first end ring, a second end ring, and a plurality of blades that extend between the first end ring and the second end ring. The plurality of blades define a wheel inner diameter, and each of the first end ring and the second end ring define an end ring inner diameter. The blower fan also includes a housing including an inlet orifice having an orifice diameter. The fan wheel is located within the housing. The orifice diameter is substantially equal to the end ring inner diameter and greater than the wheel inner diameter.



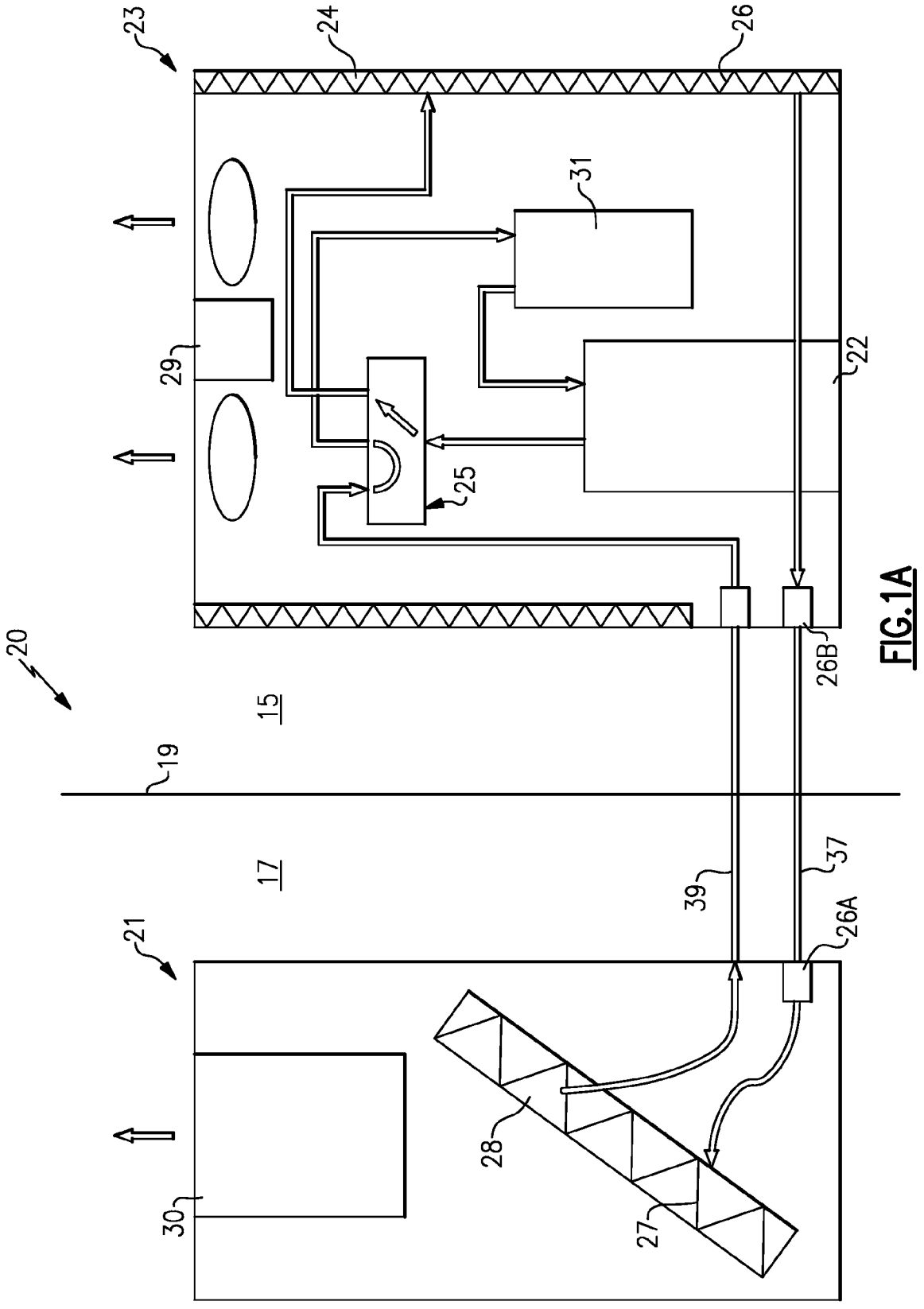


FIG.1A

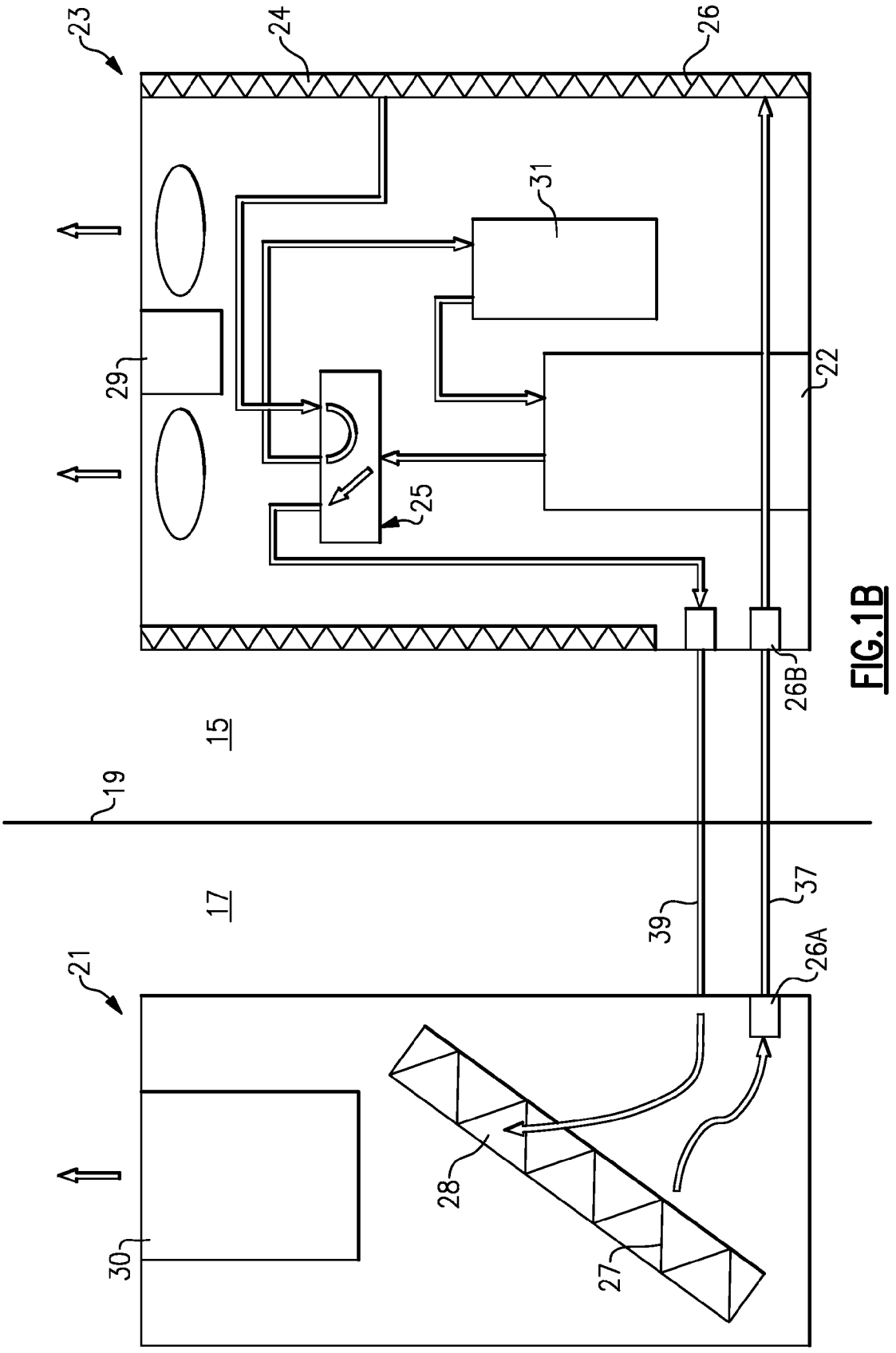


FIG.1B

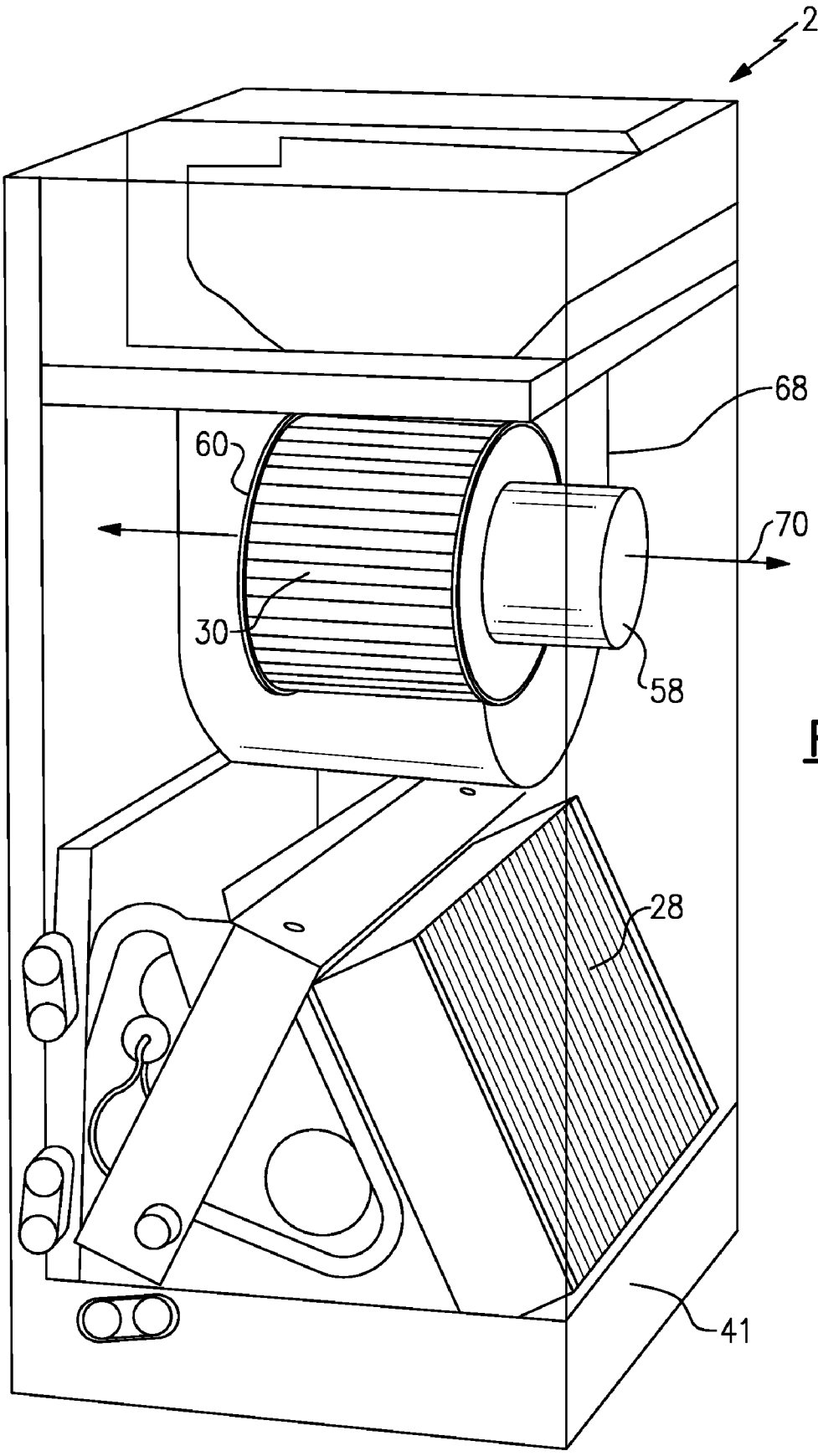


FIG.2

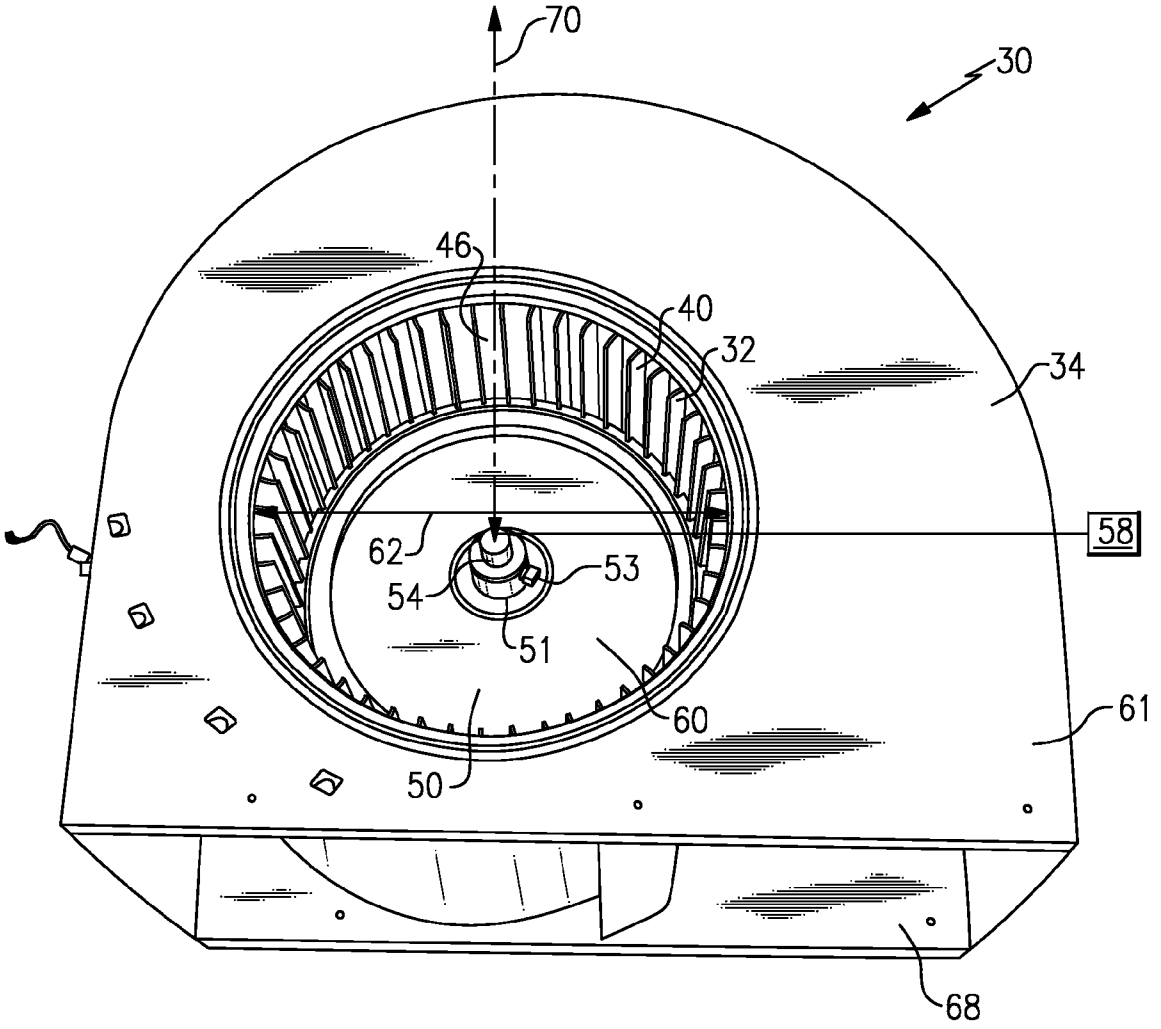


FIG.3

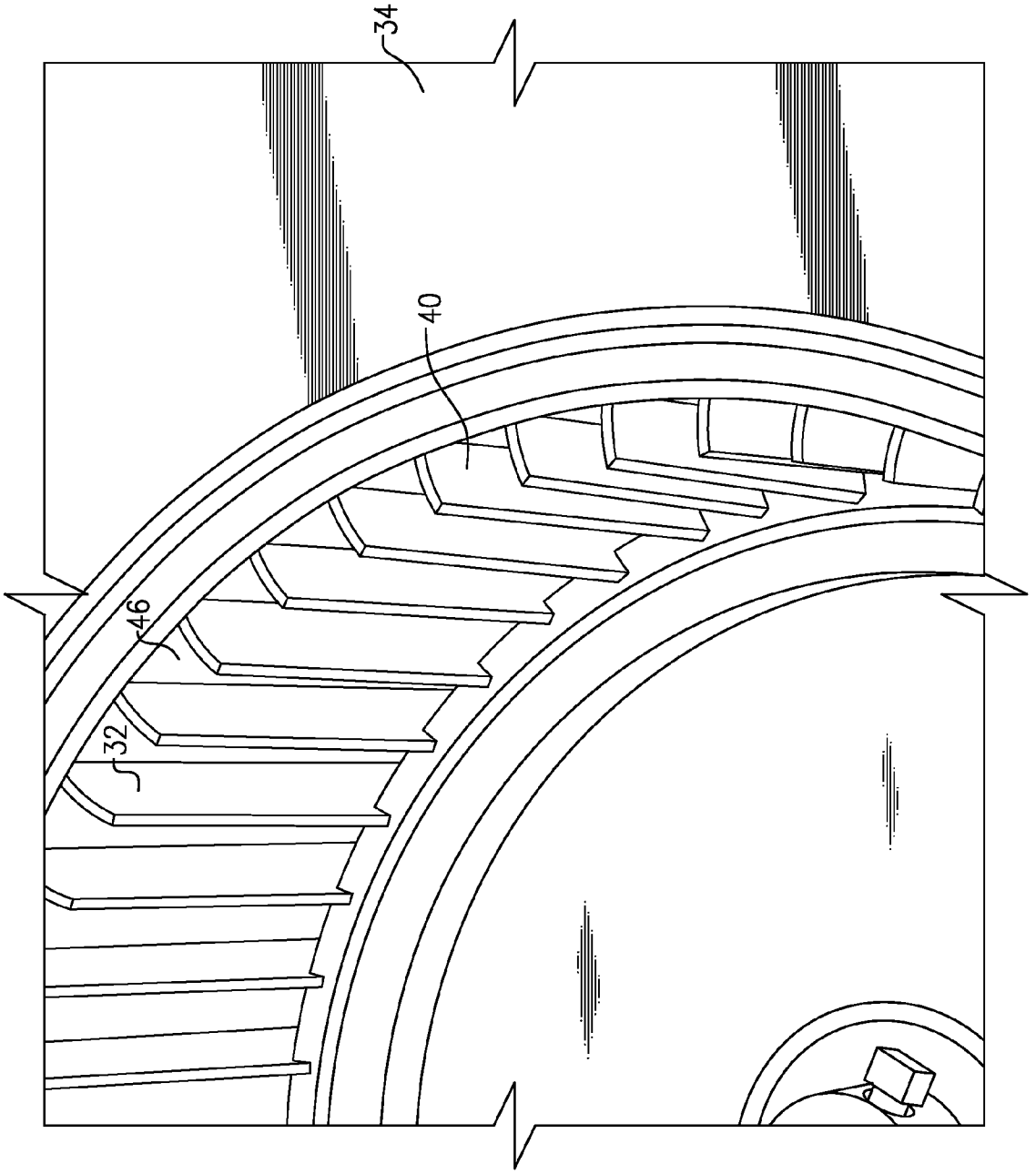


FIG.4

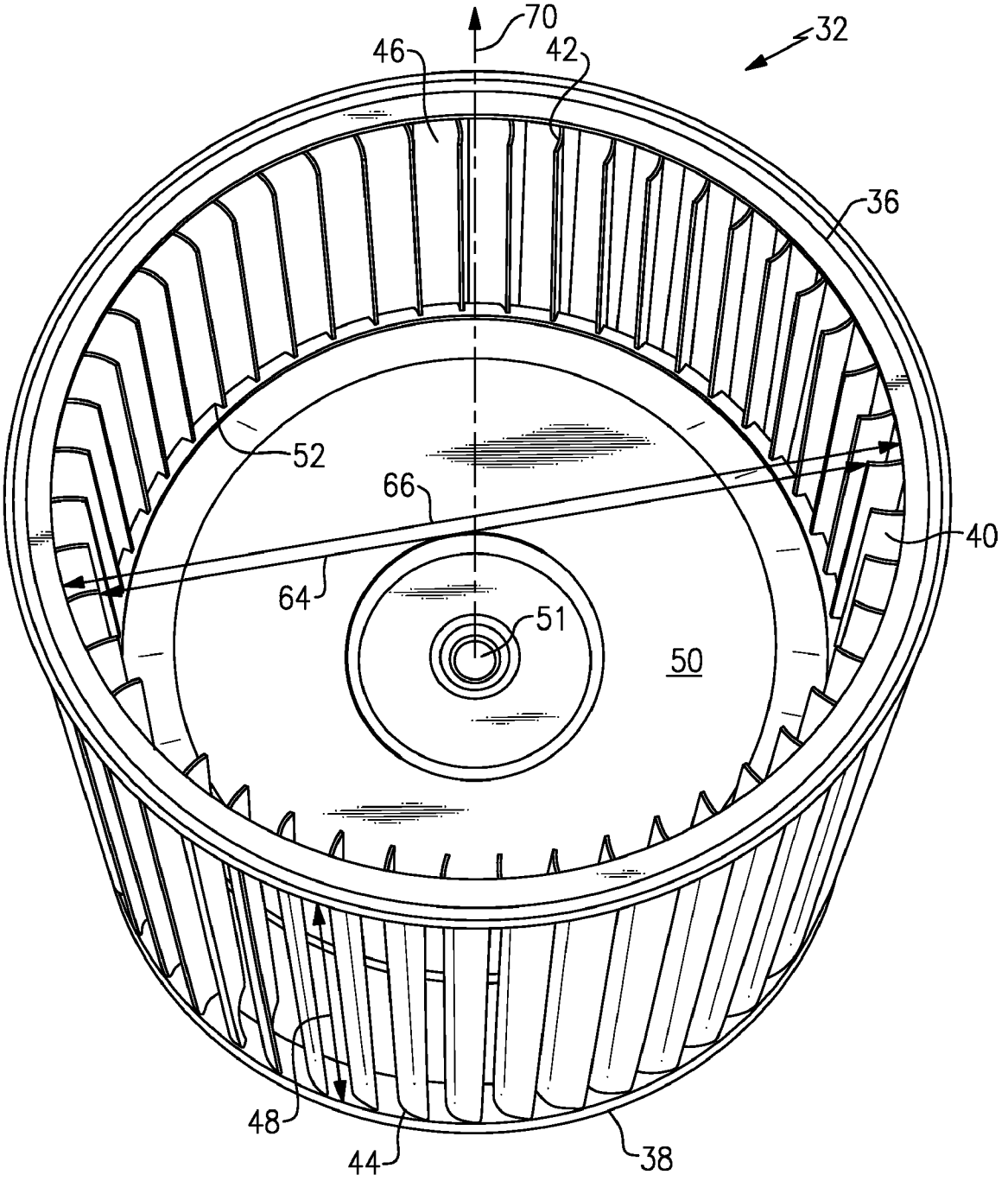


FIG.5

INLET ORIFICE OF BLOWER FAN OF FAN COIL UNIT

REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Provisional Application No. 61/039,513 filed Mar. 26, 2008.

BACKGROUND OF THE INVENTION

[0002] This invention relates generally to a blower fan of a fan coil unit including a housing having an inlet orifice with a diameter that is substantially equal to an inner diameter of an end ring of a fan wheel received in the housing.

[0003] A fan coil unit includes a blower fan and a coil. Refrigerant flows through the coil, and the blower fan draws air over the coil. Heat is exchanged between the air drawn over the coil and the refrigerant flowing through the coil.

[0004] One example blower fan includes a fan wheel located in a housing. The fan wheel includes a plurality of blades that extend between two end rings and that define an inner diameter and an outer diameter of the fan wheel. The housing includes an inlet orifice having an orifice diameter, and air is drawn into the housing through the inlet orifice. In one example, the diameter of the inlet orifice is approximately equal to the inner diameter of fan wheel. Therefore, the housing covers the ends of the blades, hindering the flow of the air entering the blades.

[0005] Another example blower fan includes a fan wheel including a plurality of blades that extend between an end ring and an endplate. The end ring has an inner diameter that defines a central opening. The endplate includes a hub that receives a shaft. The endplate is only defined by the outer diameter and does not have an inner diameter that defines a central opening once the shaft is received in the hub.

SUMMARY OF THE INVENTION

[0006] A blower fan of a fan coil unit includes a fan wheel including a first end ring, a second end ring, and a plurality of blades that extend between the first end ring and the second end ring. The plurality of blades define a wheel inner diameter, and each of the first end ring and the second end ring define an end ring inner diameter. The blower fan also includes a housing including an inlet orifice having an orifice diameter. The fan wheel is located within the housing. The orifice diameter is substantially equal to the end ring inner diameter and greater than the wheel inner diameter.

[0007] Another aspect provides a fan coil unit including a coil through which refrigerant flows and a blower fan that draws air over the coil. The blower fan includes a first end ring, a second end ring, and a plurality of blades that extend between the first end ring and the second end ring. The plurality of blades define a wheel inner diameter, and each of the first end ring and the second end ring define an end ring inner diameter. The blower fan also includes a housing including an inlet orifice having an orifice diameter. The fan wheel is located within the housing. The orifice diameter is substantially equal to the end ring inner diameter and greater than the wheel inner diameter.

[0008] Another aspect provides a refrigeration system including a compressor for compressing a refrigerant, a condenser for cooling the refrigerant, an expansion device for expanding the refrigerant, and a fan coil unit including an evaporator coil and a blower fan. The refrigerant flows through the evaporator coil, and the blower fan draws air over the evaporator coil to reject heat to the refrigerant. The blower fan includes a first end ring, a second end ring, and a plurality of blades that extend between the first end ring and the second end ring. The plurality of blades define a wheel inner diameter, and each of the first end ring and the second end ring define an end ring inner diameter. The blower fan also includes a housing including an inlet orifice having an orifice diameter. The fan wheel is located within the housing. The orifice diameter is substantially equal to the end ring inner diameter and greater than the wheel inner diameter.

[0009] These and other features of the present invention will be best understood from the following specification and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The various features and advantages of the invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows:

[0011] FIG. **1**A illustrates a refrigeration system operating in a cooling cycle including a fan coil unit;

[0012] FIG. **1**B illustrates a refrigeration system operating in a heating cycle including the fan coil unit;

[0013] FIG. **2** illustrates an example fan coil unit;

[0014] FIG. **3** illustrates a perspective view of a blower fan of the fan coil unit including a housing and a fan wheel;

[0015] FIG. **4** illustrates a perspective view of an enlarged view of a portion of the blower fan of FIG. **3**; and

[0016] FIG. **5** illustrates a perspective view of the fan wheel of the blower fan.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] FIG. **1**A illustrates a refrigeration system **20** operating in a cooling mode. Refrigerant flows through the closed circuit refrigeration system **20**. The refrigeration system **20** includes a fan coil unit **21** located inside **17** a building and an outdoor unit **23** located outside **15** the building. The inside **17** of the building and the outside **15** of the building can be separated by a wall **19**.

[0018] Refrigerant exits a compressor **22** in the outdoor unit **23** at a high pressure and a high enthalpy. A reversing valve **25** directs the refrigerant through a first heat exchanger **24**, which operates as a condenser. In the first heat exchanger **24**, the refrigerant flows through a coil **26** and rejects heat to air that is drawn over the coil **26** by a fan **29**. In one example, the fan **29** is a propeller fan. In the first heat exchanger **24**, the refrigerant is condensed into a liquid that exits the first heat exchanger **24** at a low enthalpy and a high pressure.

[0019] The refrigerant bypasses an outdoor expansion device **26***b* (described below) and travels to the fan coil unit **21** through tubing **37**. In the fan coil unit **21**, the cooled refrigerant then passes through an indoor expansion device **26***a*, expanding the refrigerant to a low pressure. After expansion, the refrigerant flows through a second heat exchanger **28**, which operates as an evaporator. A blower fan **30** draws air through the second heat exchanger **28** and over a coil **27**. The refrigerant flowing through the coil **27** accepts heat from air, exiting the second heat exchanger **28** at a high enthalpy and a low pressure.

[0020] The refrigerant then flows back to the outdoor unit **23** through tubing **39**. The refrigerant can flow through an

accumulator **31**, which regulates the amount of refrigerant flowing through the refrigeration system **20**. The refrigerant then flows to the compressor **22**, completing the cycle.

[0021] FIG. **1**B illustrates the refrigeration system **20** operating in a heating mode. Refrigerant exits the compressor **22** in the outdoor unit **23** at a high pressure and a high enthalpy. The reversing valve **25** directs the refrigerant to the fan coil unit **21** through the tubing **39**.

[0022] In the fan coil unit **21**, the refrigerant flows through the second heat exchanger **28**, which operates as a condenser. A blower fan **30** draws air through the second heat exchanger **28** and over the coil **27**. In the second heat exchanger **28**, the refrigerant flows through the coil **27** and rejects heat to air and is condensed into a liquid, exiting the second heat exchanger **28** at a low enthalpy and a high pressure. The refrigerant exits the coil **27** and bypasses the indoor expansion device **26***a*.

[0023] The refrigerant exits the fan coil unit **21** and flows through the tubing **37** towards the outdoor unit **23**, where the refrigerant is expanded to a low pressure in the outdoor expansion device **26***b*. After expansion, the refrigerant flows through the first heat exchanger **24**, which operates as an evaporator. In the first heat exchanger **24**, the refrigerant flows through the coil **26** and accepts heat from air that is drawn over the coil **26** by the fan **29**, exiting the first heat exchanger **24** at a high enthalpy and a low pressure. The refrigerant can flow through the accumulator **31**. The refrigerant then flows to the compressor **22**, completing the cycle.

[0024] FIG. **2** illustrates the fan coil unit **21**. The fan coil unit **21** includes a housing **41** that contains the blower fan **30** that draws the air over the coil **26**. A motor **58** rotates the blower fan **30** about an axis of rotation **70**. Air enters the blower fan **30** through an inlet orifice **60** and exits the blower fan **30** through an outlet **68**.

[0025] As shown in FIGS. **3** and **4**, the blower fan **30** includes a fan wheel **32** and a housing **34**. In one example, the housing **34** is metal. The fan wheel **32** rotates about the axis of rotation **70**. As further shown in FIG. **5**, the fan wheel **32** includes a first end ring **36** and a second end ring **38**. The end rings **36** and **38** are substantially the same size and shape. In one example, the end rings **36** and **38** are substantially circular in shape. The end rings **36** and **38** define an end ring inner diameter **66**.

[0026] The fan wheel **32** also includes a plurality of blades **40** each having a first end **42** and a second end **44**. The plurality of blades **40** are equally spaced and define a space **46** between each of the plurality of blades **40**. The plurality of blades **40** are substantially parallel to each other and substantially perpendicular to the end rings **36** and **38**. The plurality of blades **40** define a wheel inner diameter **64**.

[0027] The ends **42** and **44** of the blades **40** are each connected to a base portion (not shown), and each of the end rings **36** and **38** are attached to one of the base portions. In one example, the end rings **36** and **38** are attached to the base portions by crimping. In one example, the fan wheel **32** is substantially cylindrical in shape. A cross-section of each of the plurality of blades **40** taken substantially perpendicularly to a length **48** of the blades **40** is substantially arc-shaped.

[0028] A wheel disc **50** is attached to the plurality of blades **40** at a location **52** along the length **48** of the blades **40** that is substantially equidistant from each of the ends **42** and **44**. The wheel disc **50** includes a hub **51** that receives a shaft **54** of the motor **58**, and a setup screw **53** mounts the wheel disc **50** to the shaft **54**. As the motor **58** rotates the shaft **54**, the fan wheel **32** rotates about the axis of rotation **70** to draw air into the fan wheel **32**.

[0029] The housing **34** includes the inlet orifice **60** and the outlet **68**. In one example, the inlet orifice **60** is substantially circular and has an orifice diameter **62**. The fan wheel **32** is installed in the housing **34** such that the axis of rotation **70** of the fan wheel **32** is substantially centered within the inlet orifice **60**. In one example, the housing **34** includes a planar surface **61**, and the inlet orifice **60** is defined in the plane of the planar surface **61**.

[0030] As the fan wheel **32** rotates about the axis of rotation **70**, air is drawn into the inlet orifice **60** of the housing **34** and through the spaces **46** between the blades **40** of the fan wheel **32**. The air is directed in an outwardly direction relative to the axis of rotation **70** of the fan wheel **32** and through the outlet **68** of the housing **34**. The blower fan **30** draws air over the coil **27**, the air exchanging heat with the refrigerant flowing through the coil **27**.

[0031] As stated above, the second heat exchanger **28** can be an evaporator or a condenser. If the second heat exchanger **28** is an evaporator, the air rejects heat to the refrigerant flowing through the coil **27**. If the second heat exchanger **28** is a condenser, the air accepts heat from the refrigerant flowing through the coil **27**.

[0032] The size and shape of the inlet orifice **60** affects the flow of air into the fan wheel **32**, and therefore efficiency. The orifice diameter **62** of the inlet orifice **60** of the housing **34** is approximately equal to or greater than the end ring inner diameter **66** of the end rings **36** and **38** of the fan wheel **32**. The orifice diameter **62** of the inlet orifice **60** is therefore greater than the wheel inner diameter **64** (defined by the innermost portion of the blades **40**), and the ends **42** and **44** of the blades **40** are partially exposed by the housing **34**. In another example, the ends **42** and **44** of the blades **40** are entirely exposed by the housing **34**. The air can be directly drawn into the fan wheel **32**, and the rotation of the fan wheel **32** helps the air evenly flow over the fan wheel **32**. The air is not required to make abrupt turns from the inlet orifice **60** to blade regions near the ends **42** and **44** of the blades **40**, which could impede the flow in the region near the ends **42** and **44** of the blades **40**.

[0033] In prior fan wheels, the orifice diameter of the inlet orifice is approximately equal the wheel inner diameter defined by the innermost portion of the blades. Therefore, a portion of the housing covers the ends of the blades, and this portion prevents the direct passage of air into the fan wheel. The air must make an abrupt turn around this portion of the housing to enter the fan wheel, reducing efficiency.

[0034] The size and shape of the inlet orifice **60** of the housing **34** is optimized to affect the flow of air drawn into the fan wheel **32** and improve the efficiency of the blower fan **30**. By optimized, it is meant that the orifice diameter **62** of the inlet orifice **60** of the blower fan **30** is enlarged such that the orifice diameter **62** is substantially equal to the end ring inner diameter **66** of the end rings **36** and **38**, partially exposing the ends **42** and **44** of the plurality of blades **40**. Additionally, in one example, the inlet orifice **60** can be substantially circular to correspond to the shape of the fan wheel **32**.

[0035] In one example, for a **42** size fan coil unit, enlarging the orifice diameter **62** of the inlet orifice **60** such that the orifice diameter **62** is approximately equal to the inner diameter **66** of the end rings **36** and **38** reduces the power of the blower fan **30** by approximately 6% at the same operation point (same airflow and same external static pressure) as a blower fan of the prior art, saving costs. The aerodynamic flow of the blower fan **30** reduces the watts consumption of the blower fan **30**, reducing the cost of the outdoor unit **23**. The size of the blower fan **30** could also be reduced.

[0036] The foregoing description is only exemplary of the principles of the invention. Many modifications and variations of the present invention are possible in light of the above

teachings. The preferred embodiments of this invention have been disclosed, however, so that one of ordinary skill in the art would recognize that certain modifications would come within the scope of this invention. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. For that reason the following claims should be studied to determine the true scope and content of this invention.

What is claimed is:

1. A blower fan of a fan coil unit, the blower fan comprising:

a fan wheel including a first end ring, a second end ring, and a plurality of blades that extend between the first end ring and the second end ring, wherein the plurality of blades define a wheel inner diameter and each of the first end ring and the second end ring define an end ring inner diameter; and

a housing including an inlet orifice having an orifice diameter, wherein the fan wheel is located within the housing and the orifice diameter is substantially equal to the end ring inner diameter and greater than the wheel inner diameter.

2. The blower fan as recited in claim **1** wherein each of the plurality of blades has a length, and a cross-section of each of the plurality of blades taken substantially perpendicularly to the length is substantially arc-shaped.

3. The blower fan as recited in claim **1** wherein a space is defined between each of the plurality of blades, and each of the spaces is approximately equal.

4. The blower fan as recited in claim **1** further including a wheel disc attached to each of the plurality of blades at a location that is substantially equidistant from a first end and an opposing second end of the plurality of blades.

5. The blower fan as recited in claim **4** wherein the wheel disc includes a hub that receives a shaft of a motor, and the motor rotates the shaft to rotate the fan wheel about an axis of rotation.

6. The blower fan as recited in claim **1** wherein a first end and an opposing second end of each of the plurality of blades is partially exposed by the inlet orifice and uncovered by the housing.

7. The blower fan as recited in claim **1** wherein the fan wheel draws air over a coil of a heat exchanger and into the inlet orifice of the housing and discharges the air through an outlet of the housing.

8. The blower fan as recited in claim **1** wherein the plurality of blades are substantially parallel.

9. The blower fan as recited in claim **1** wherein the fan wheel is substantially cylindrical.

10. A fan coil unit comprising:

a coil, wherein refrigerant flows through the coil; and

a blower fan that draws air over the coil to exchange heat with the refrigerant flowing through the coil, wherein the blower fan includes a fan wheel including a first end ring, a second end ring, and a plurality of blades that extend between the first end ring and the second end ring, wherein the plurality of blades define a wheel inner diameter and each of the first end ring and the second end ring define an end ring inner diameter, and the blower fan includes a housing including an inlet orifice having an orifice diameter and an outlet, wherein the fan wheel is located within the housing to draw the air over the coil and into the inlet orifice and discharge the air through the outlet, and the orifice diameter is substantially equal to the end ring inner diameter and greater than the wheel inner diameter.

11. The fan coil unit as recited in claim **10** wherein each of the plurality of blades has a length, and a cross-section of each of the plurality of blades taken substantially perpendicularly to the length is substantially arc-shaped.

12. The fan coil unit as recited in claim **10** wherein a space is defined between each of the plurality of blades, and each of the spaces is approximately equal.

13. The fan coil unit as recited in claim **10** further including a wheel disc attached to each of the plurality of blades at a location that is substantially equidistant from the first end and the opposing second end of the plurality of blades.

14. The fan coil unit as recited in claim **13** wherein the wheel disc includes a hub that receives a shaft of a motor, and the motor rotates the shaft to rotate the fan wheel about an axis of rotation.

15. The fan coil unit as recited in claim **10** wherein a first end and an opposing second end of each of the plurality of blades is partially exposed by the inlet orifice and uncovered by the housing.

16. The fan coil unit as recited in claim **10** wherein the plurality of blades are substantially parallel.

17. The fan coil unit as recited in claim **10** wherein the fan wheel is substantially cylindrical.

18. A refrigeration system comprising:

a compressor for compressing a refrigerant;

a condenser for cooling the refrigerant;

an expansion device for expanding the refrigerant; and

a fan coil unit including an evaporator coil and a blower fan, wherein the refrigerant flows through the evaporator coil and the blower fan draws air over the evaporator coil to reject heat to the refrigerant,

wherein the blower fan includes a fan wheel including a first end ring, a second end ring, and a plurality of blades that extend between the first end ring and the second end ring, the plurality of blades define a wheel inner diameter and each of the first end ring and the second end ring define an end ring inner diameter, and the blower fan includes a housing including an inlet orifice having an orifice diameter and an outlet, and

wherein the fan wheel is located within the housing to draw the air over the evaporator coil and into the inlet orifice and discharge the air through the outlet, and the orifice diameter is substantially equal to the end ring inner diameter and greater than the wheel inner diameter.

* * * * *