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(71) Applicant: **FANERGIES LLC** [US/US]; 127 East Riverside Drive #131, Austin, TX 78704 (US).

(72) Inventor: **SCHULER, Berhnard, L.**; 127 East Riverside Drive #131, Austin, Texas 78704 (US).

(74) Agent: **BURR, Matthew, E.**; Mwr Legal, 620 Congress Avenue, Ste. 320, Austin, TX 78701 (US).

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(54) **Title**: APPARATUS AND METHODS FOR ELECTRICITY GENERATION FROM EXHAUST OF CONDENSER OF HVAC SYSTEM

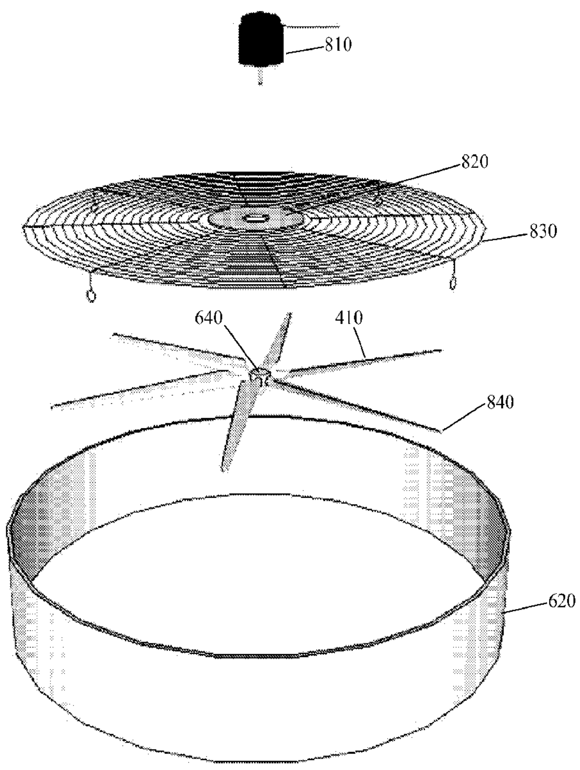

Fig. 8

(57) **Abstract**: A low RPM permanent magnet generator mounted over the exhaust port of a HVAC condenser provides a direct drive generator that allows low cogging and low startup resistance to effectively produce electricity at low wind speeds.

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Apparatus and Methods for Electricity Generation from Exhaust of Condenser of HVAC System

By
Bernhard L. Schuler
127 East Riverside Drive #131
Austin, Texas 78704
USA

Prepared by
Matthew E. Burr
Registration No. 37,591
Customer No. 47900

MOSTER WYNNE & RESSLER, PC
620 Congress Avenue, Suite 320
Austin, Texas 78701
(512) 320-0601
mburr@mosterwynne.com

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Apparatus and Methods for Electricity Generation from Exhaust of Condenser of HVAC System

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present disclosure is related to, claims priority from and the benefit of United States provisional application entitled “Apparatus and Methods for Power Generation from Exhaust of Condenser of Central Air System” by the same inventor, serial no. 61/654,621, filed June 1, 2012, the disclosure of which is incorporated herein by reference. The present disclosure is also related to United States provisional application serial no. 61/804,525, filed March 22, 2013, having the same title and inventor, the disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] This disclosure relates generally to turbine generators and more particularly to a turbine connected to a Heating, Ventilation, and Air Conditioning (“HVAC”) condenser exhaust outlet.

BACKGROUND

[0003] The present generator design improves the electricity output, given the constant volume of moving fluid, gas, air or wind produced by the exhaust of a HVAC condenser. HVAC systems use condensers to move hot or cold air out of a building. During this process, the condenser produces an exhaust gas with a typical wind speed of 15-25 mph.

SUMMARY

[0004] The present methods and apparatus harness wind energy by mounting the wind turbine horizontally over the exhaust of the condenser without impacting the operation of the HVAC condenser. A generator of the present disclosure produces electricity at a rate that is proportional to the diameter of the condenser exhaust, usually between 100-500 watts/hour. The wattage output is proportional to the force of the exhaust that activates the generator.

[0005] More generally, the present disclosure describes an energy recovery system. A conduit, such as the frame of the present disclosure, with a width, a first end and a second end, is configured so that the first end of the conduit receives a gas flow transmitted by a gas flow channel of a gas flow source, such as a HVAC exhaust, and the conduit is configured to transmit the received gas flow from the first end toward the second end of the conduit. The gas flow channel has a diameter.

[0006] A blade assembly having a diameter is coupled to the conduit and the blade assembly is configured to be moved with relatively low torque of less than or equal to 0.5 Newton-meters starting torque when the received gas flow is transmitted from the first end of the conduit. The conduit width is greater than the blade assembly diameter so that a portion of the gas flow transmitted by the gas flow channel can bypass the blade assembly to limit back pressure on the gas flow source. The blade assembly diameter is greater than the gas flow channel diameter.

[0007] An electrical generator is coupled to the blade assembly. The electrical generator is configured to generate electricity when the blade assembly moves.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a more complete understanding of the present disclosure, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

[0009] Figure 1 is an isometric side view illustration of a condenser unit having a turbine generator of the present disclosure attached the exhaust thereof.

[0010] Figure 2 is an isometric top view illustration of the condenser unit of Fig. 1 having a turbine generator of the present disclosure attached the exhaust thereof.

[0011] Figure 3 is a top view illustration of the condenser unit of Fig. 1 having a turbine generator of the present disclosure attached the exhaust thereof.

[0012] Figure 4 is top view isometric illustration of a turbine blade of a generator of the present disclosure.

[0013] Figure 5 is side view isometric illustration of a turbine blade of a generator of the present disclosure.

[0014] Figure 6 is a top view illustration of a frame and blade assembly of the present disclosure placed on the exhaust of a condenser unit.

[0015] Figure 7 is a side view isometric illustration of a turbine generator assembly of the present disclosure.

[0016] Figure 8 is an exploded side view illustration of a turbine generator assembly of the present disclosure.

[0017] Figure 9A is a top view illustration of an exemplary embodiment of a blade assembly of the present disclosure.

[0018] Figure 9B is an isometric side view illustration of an exemplary embodiment of a blade assembly of Fig. 9A.

[0019] Figure 10 is an isometric top view illustration of an exemplary embodiment of a blade assembly hub of the present disclosure.

DETAILED DESCRIPTION

[0020] Before describing the drawings, it may be helpful to define some selected components and features of the present apparatus.

[0021] Generator: a low RPM, alternating current (AC) permanent magnet generator. The generator, preferably, is a direct drive generator that provides low cogging and low startup resistance to effectively start producing electricity at low, less powerful exhaust speeds. Although alternative embodiments having a non-direct drive generator, that is, a generator with gears or brushes would be functional, a gearless, brushless direct drive generator is preferred. A preferred exemplary embodiment of the generator provides:

[0022] 100 - 500 watts/hour rated continuous power; contingent on size of the condenser exhaust;

[0023] 24v or 48v rated voltage;

[0024] Less than or equal to 1000 rated RPMs;

[0025] Less than or equal to 0.5 Newton-meters (Nm) rated starting torque; and

[0026] -30 C - 180 C working temperature

[0027] Electromagnetic braking system

[0028] **Blade Design (with hub 640):** The blade length is relatively short compared to other wind turbines with the same output, the blades are designed with a higher arc angle than is found with similar generators to maximize torque and get as many RPMs to the generator. A preferred exemplary embodiment provides blades having the following specifications:

[0029] Six blade high torque design

[0030] Blade thickness is 0.0625 of an inch made from a light weight material

[0031] Blade shape is that of a 90 degree arc angle from a cylinder with a two inch radius

[0032] 3.14 inch width at the widest section of the blade

[0033] 0.5 inch width at top and bottom of blade

[0034] Blade length is contingent on the diameter of the condenser exhaust. Blade diameter is one inch larger that the diameter of the condenser exhaust. Blade length is important to achieving the power generation performance because the wind speed at the outer edge of the exhaust is more powerful than on the inner edge.

[0035] Six blades are connected to a hub 640 with a diameter of 3.25 inches (preferably). The relatively small diameter of the hub 640 allows for more blade coverage over the source area.

[0036] Frame – The frame acts as a funnel and collects wind that would otherwise disperse away from the condenser. This exhaust gas is directed over the generator blades. In preferred embodiments, the diameter of the frame is approximately 1.0 inch larger than the diameter of the condenser exhaust. The frame is 0.5 inches larger than the blade diameter.

[0037] Wire Guard – The present generator design is covered by a wire guard which does not impede the flow of exhaust and does not impact the flow of air through the condenser unit. The wire guard also serves as a means to protect anyone from injury by the spinning turbine blades.

[0038] Tests of a generator of the present disclosure yield the following results:

[0039] Test Results – Turbine generator assembly with rated potential of 300 watts/hour

[0040] Test #1

[0041] 24 volts

[0042] 550 RPMs

[0043] 305 watts/hour

[0044] Test #2

[0045] 48 volts

[0046] 550 RPMs

[0047] 305 watts/hour

[0048] Turning now to the drawings, Figure 1 is an isometric side view illustration of a condenser unit having an exemplary embodiment of a turbine generator of the present disclosure attached the exhaust thereof. Generator assembly 110 is mounted over the exhaust of condenser unit 120. Wire guard 830 is mounted on top of frame 620 and generator 810 is mounted to rotatable blades 410 (see Fig. 4) which are suspended under wire guard 830 and housed in frame 620.

[0049] Figure 2 is an isometric top view illustration of the air conditioning unit of Fig. 1 having a turbine generator of the present disclosure attached the exhaust thereof. Blades housed in assembly 110 rotate from exhaust escaping condenser 120 and produce energy with generator 810.

[0050] Figure 3 is a top view illustration of the condenser unit of Fig. 1 having an exemplary embodiment of turbine generator 810 of the present disclosure attached the exhaust thereof. Exhaust air from condenser 120 is channeled by frame 620 to impel the rotation of blades housed in frame 620.

[0051] Figure 4 is top view isometric illustration of an exemplary embodiment of a turbine blade of a generator of the present disclosure. The length of the blade 410, line d-d, is selected based on the diameter of the condenser exhaust. The blade length is longer than the radius of the condenser exhaust, preferably in the range of by 0.5 to 1.0 inch. The perimeter of blade 410 roughly describes a scalene triangle of edges d-d, b-c, c-a, having the widest section bisected by line c-c. The triangle shape is cropped by edge b-b at the tip closest to line c-c and edge b’ - b’ at the opposite tip. The portion from line c-c to tip b-b is one third the length of line d-d. The portion from line c-c to tip b’-b’ is two thirds the length of blade 410. In a preferred embodiment, the length of line c-c is 3.14 inches, the length of edge b-b is 0.5 inches and the width e of blade 410 is 0.0625 inches. Blade 410 length d-d is contingent on the diameter of the condenser exhaust port. The blade 410 length d-d is in the range of 0.5 to 1.0 inch larger than the condenser exhaust port diameter, preferably.

[0052] Figure 5 is side view isometric illustration of an exemplary embodiment of a turbine blade of a generator of the present disclosure. The thickness e-e of blade 410 is 0.0625 inches. Blade 410 is formed to curve 90 degree from the x-axis with a curvature radius f of 2 inches.

[0053] Figure 6 is a top view illustration of an exemplary embodiment of a frame and blade assembly of the present disclosure placed on the exhaust of a condenser unit. In a preferred embodiment, 3.25 inch diameter hub 640 is mounted over the exhaust of an HVAC condenser unit. Blades 610 are mounted to hub 640 and extended some distance, such as 0.5 inch, for example, longer than the diameter of condenser exhaust 630. Frame 620 is disposed around blades 410 and directs blowing exhaust gas over blades 410. Preferably, the diameter of frame 620 is one inch larger than the diameter of the gas flow channel diameter of condenser exhaust 630.

[0054] Figure 7 is a top and side view isometric illustration of an exemplary embodiment of a turbine generator assembly of the present disclosure.

[0055] Figure 8 is an exploded side view illustration of an exemplary embodiment of a turbine generator assembly of the present disclosure. Low revolutions per minute (RPM) permanent magnet generator 810 is mounted to generator mounting block 820, supported by wire guard 830. Blade and hub assembly 840, comprised of blades 410 and hub 640, is connected to generator 810 and disposed within frame 620. Wire guard 830 is mounted on the top of frame 620.

[0056] Figure 9A is a top view of an exemplary embodiment of a blade assembly of the present disclosure. Blades 410 are attached to hub 640 with fasteners at fastener locations 910.

[0057] Figure 9B is a side view of an exemplary embodiment of a blade assembly of Fig. 9A. The curved topography of blades 410 is apparent.

[0058] Figure 10 is an isometric side view of an exemplary embodiment of a blade hub of the present disclosure. Fastener locations 910 are used to attach blades 410 to hub 640. Mounting hole 920 is used to attach generator 810 to hub 640 and ensure that generator 810 is centered on hub 640.

[0059] Features and advantages of various specific embodiments of the power recovery system described herein include but are not limited to:

[0060] (1) Blade curvature - curved blades create an airfoil which makes the blades turn even at low exhaust gas velocities, for improved power output from the generator.

[0061] (2) Low start-up torque design - blade rotation in low exhaust gas speeds allows power recovery from relatively low volume or low speed HVAC exhaust.

[0062] (3) Light weight blades - do not restrict HVAC condenser exhaust.

[0063] (4) The present apparatus harnesses an underutilized, ubiquitous, energy source.

[0064] (5) The present apparatus obtains power recovery in a range that includes but is not limited to 100 watt to 500 watt output. The power obtained by the present apparatus is, of course, contingent on the size of HVAC condenser to which the apparatus is mounted. The present apparatus contemplates a variety of preferred sizes to fit standard and non-standard

HVAC exhaust sizes. The present apparatus is easily customized to fit on non-standard HVAC exhausts.

[0065] (6) Wire guard - provides protection from operator and does not restrict HVAC condenser exhaust.

[0066] (7) Small hub 640 diameter (3.25 inches, for example) - allows for improved blade coverage over source area (exhaust area).

[0067] (8) Electromagnetic braking system (on generator) - preferred embodiments of the generator of the system provide an electromagnetic braking system which maintains consistent voltage output in variable wind speeds. Consistent output is advantageous for connection of the electricity produced by the generator.

[0068] (9) Connectivity - Although grid connection is contemplated as a primary application of the present apparatus, off grid uses, such as battery storage, may also find utility.

[0069] (10) Components of the apparatus are waterproof and have non-corrosion ratings.

[0070] (11) Operational temperature range is -30c to 180c which allows for use in extreme climate areas.

[0071] (12) Easy 4 bolt installation to most HVAC condensers.

[0072] Many modifications and other embodiments of the power recovery system described herein will come to mind to one skilled in the art to which this disclosure pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the disclosure is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

What is claimed is:

1. An energy recovery system, comprising:

a conduit having a width, a first end and a second end, wherein the first end of the conduit is configured to receive a gas flow transmitted by a gas flow channel of a gas flow source and wherein the conduit is configured to transmit the received gas flow from the first end thereof toward the second end thereof, wherein the gas flow channel has a diameter;

a blade assembly coupled to the conduit and having a diameter, wherein the blade assembly is configured to be moved with relatively low torque of less than or equal to 0.5 Newton-meters starting torque when the received gas flow is transmitted from the first end of the conduit, wherein the conduit width is greater than the blade assembly diameter so that a portion of the gas flow transmitted by the gas flow channel can bypass the blade assembly to limit back pressure on the gas flow source, and further wherein the blade assembly diameter is greater than the gas flow channel diameter; and an electrical generator coupled to the blade assembly, the electrical generator being configured to generate electricity when the blade assembly moves, wherein the generator generates electricity from blades moving with relatively low starting torque less than or equal to 0.5 Newton-meters.

2. The system of claim 1, wherein the blade assembly comprises a plurality of blades mounted to a hub, wherein each of the blades has a curved cross-sectional shape.

3. The system of claim 2, wherein the each of the blades comprises curvature equal to 90 degree arc angle from a cylinder with a two inch radius.

4. The system of claim 2, wherein the curved blades produce an airfoil.

5. The system of claim 1, wherein the generator is an alternating current electricity generator comprising a permanent magnet.

6. The system of claim 1, wherein the generator produces in the range of 100 watts to 500 watts.

7. The system of claim 1, wherein the generator comprises an electromagnetic braking system.

8. The system of claim 1, wherein the conduit further comprises a wire guard to which the blade assembly and the generator are attached.

9. The system of Claim 1, wherein the generator is connected to a power grid.

10. The system of claim 1, wherein the generator is not connected to a power grid.

11. The system of claim 10, wherein the generator output charges a battery.

12. The system of claim 1, wherein the blade assembly comprises a hub to which blades are attached.

13. The system of claim 12, wherein the hub comprises a diameter of 3.25 inches.

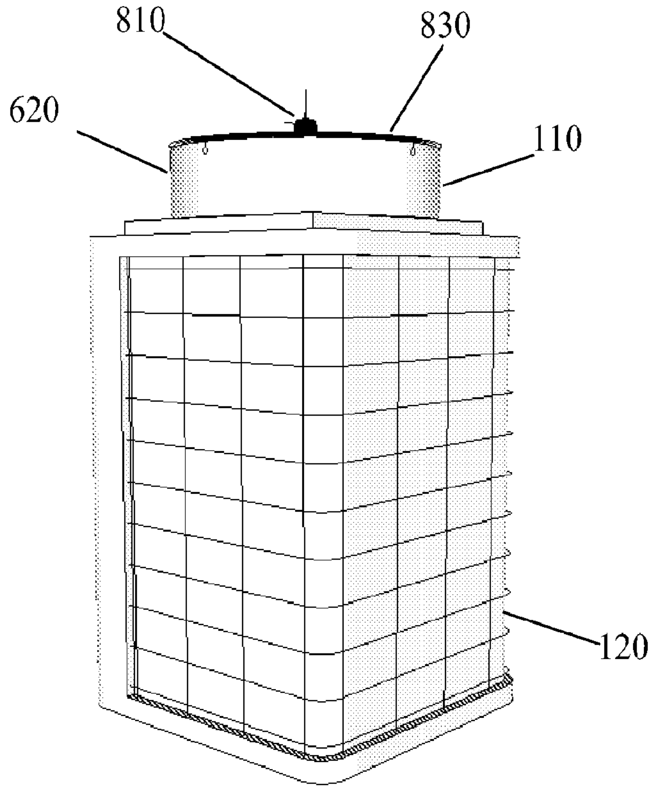

Fig. 1

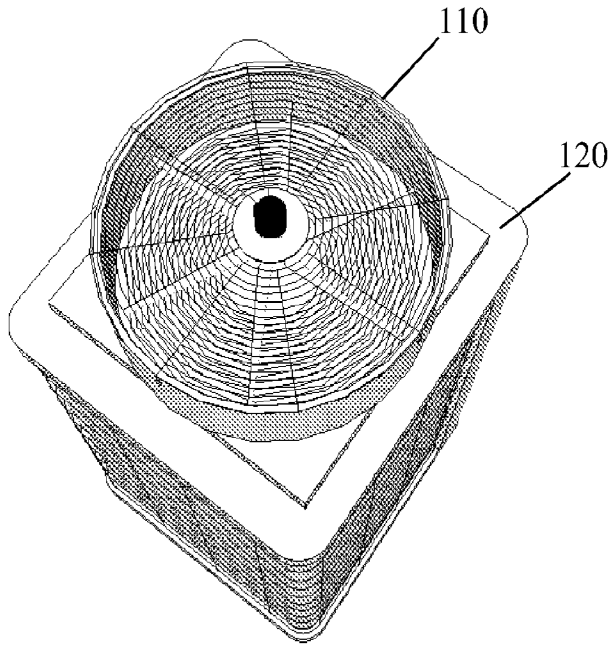

Fig. 2

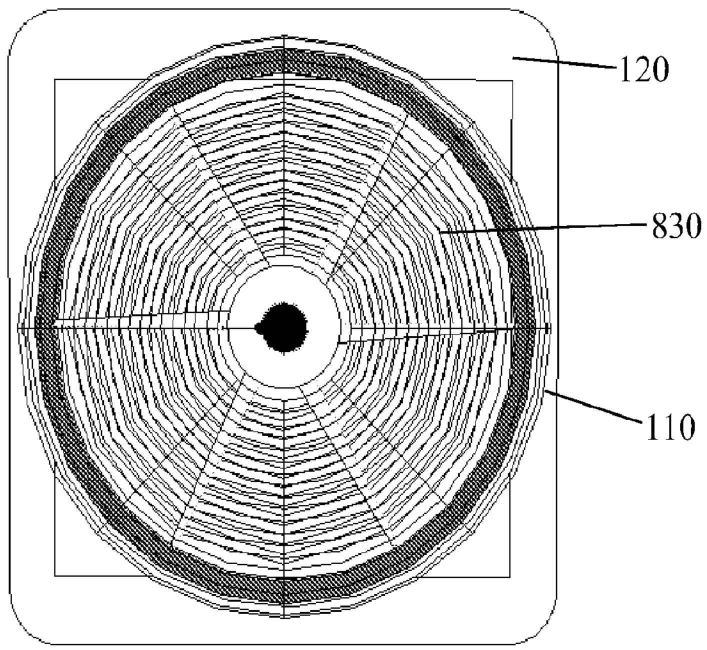

Fig. 3

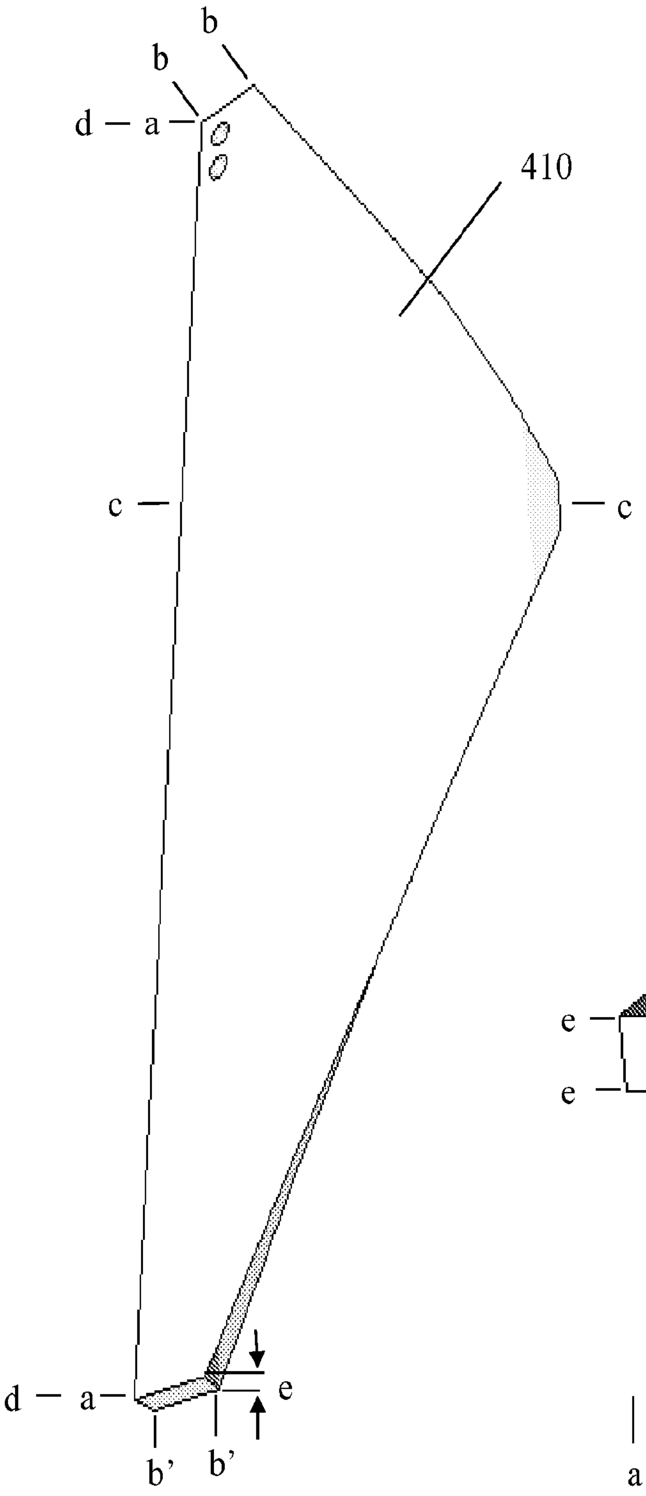

Fig. 4

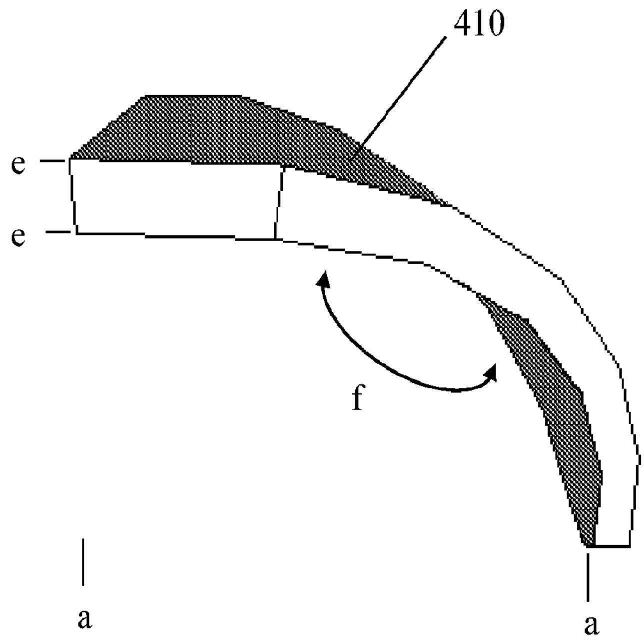

Fig. 5

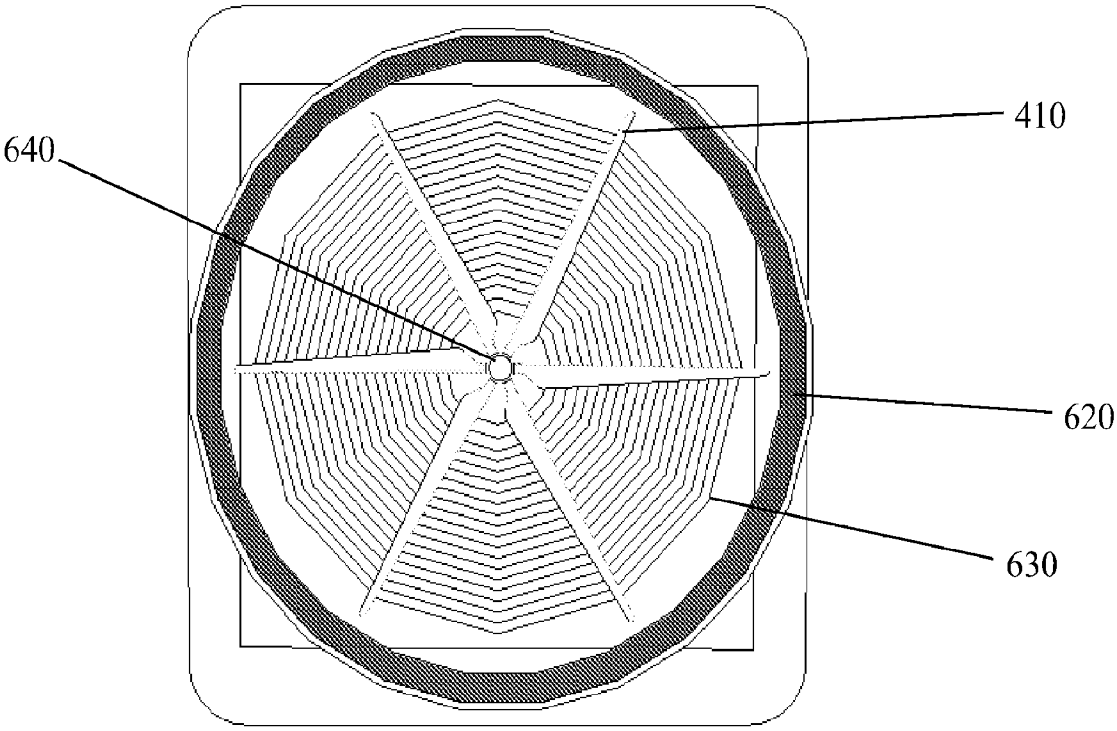

Fig. 6

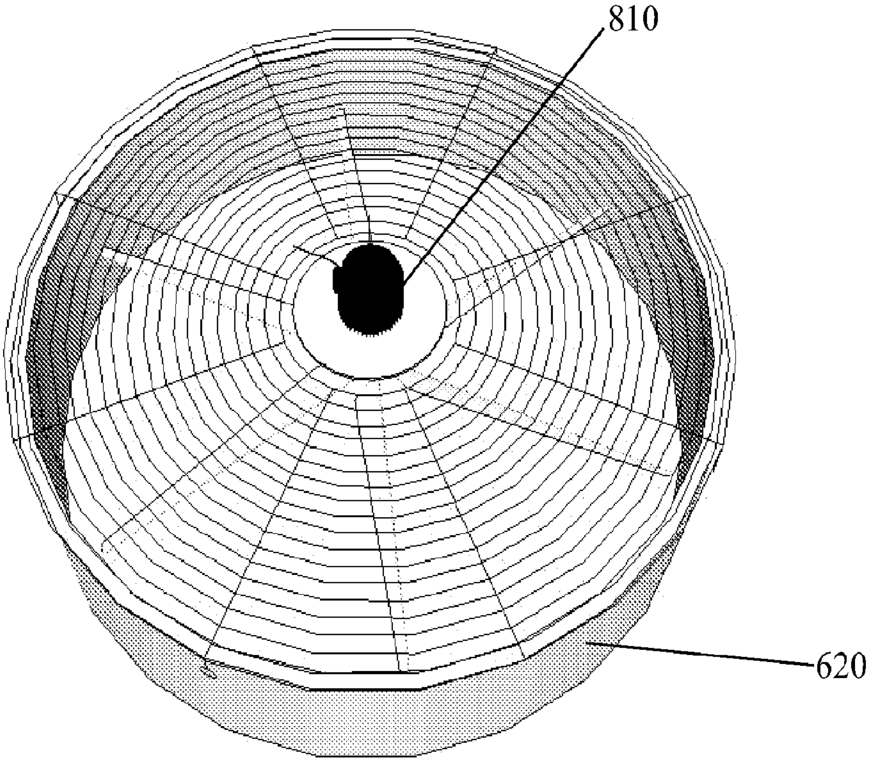

Fig. 7

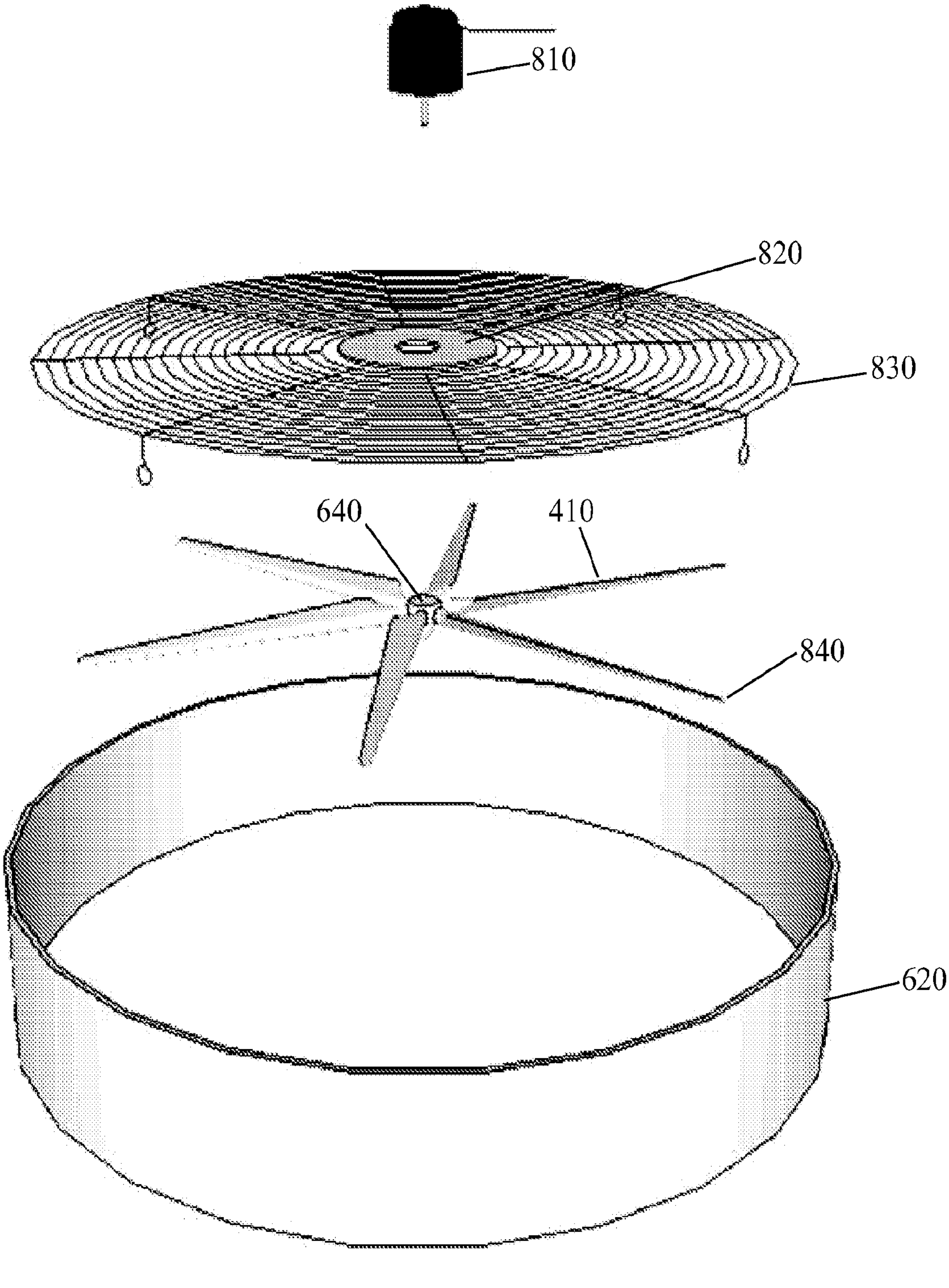

Fig. 8

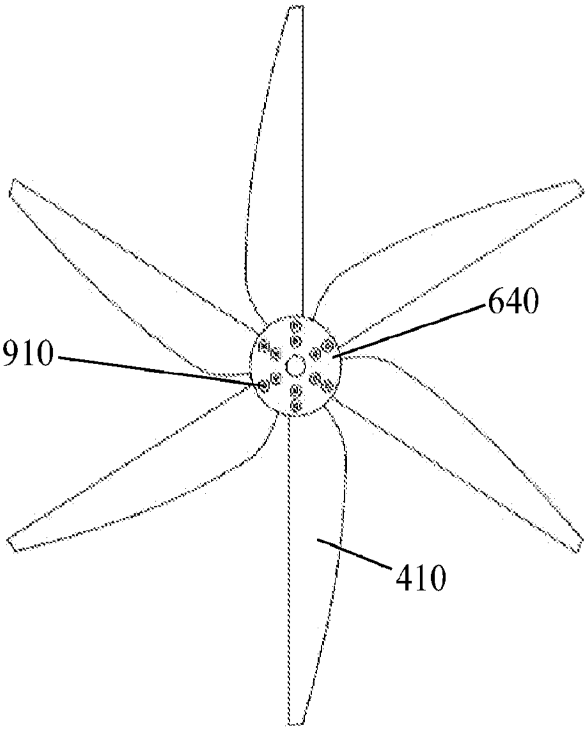

Fig. 9A

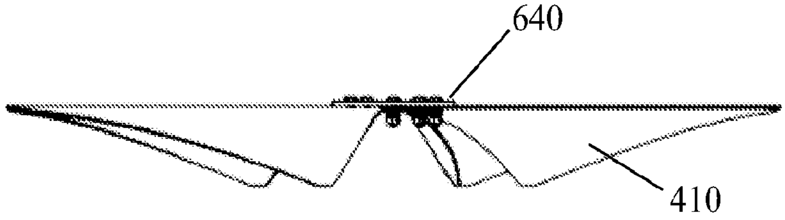

Fig. 9B

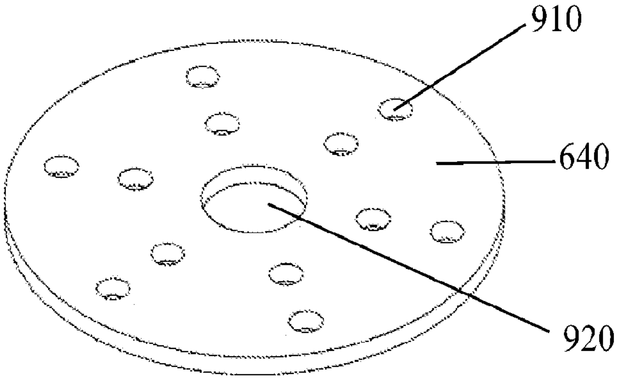

Fig. 10