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(54) **WIND TURBINE WITH FRICTION DRIVE POWER TAKE OFF ON OUTER RIM**

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(57) **ABSTRACT**

A wind turbine has multiple blades (**10**) that are mounted on a shaft (**19**) with a ring around a circumference of the blades. There are tires (**18**) that are arranged to be in contact or out of contact with the ring. The tires draw generators when the tires are in contact with the ring and the ring is rotating. A controller monitors the wind conditions and controls the turbine to produce electricity or other-energy output or to shut down if the wind falls below a predetermined level.

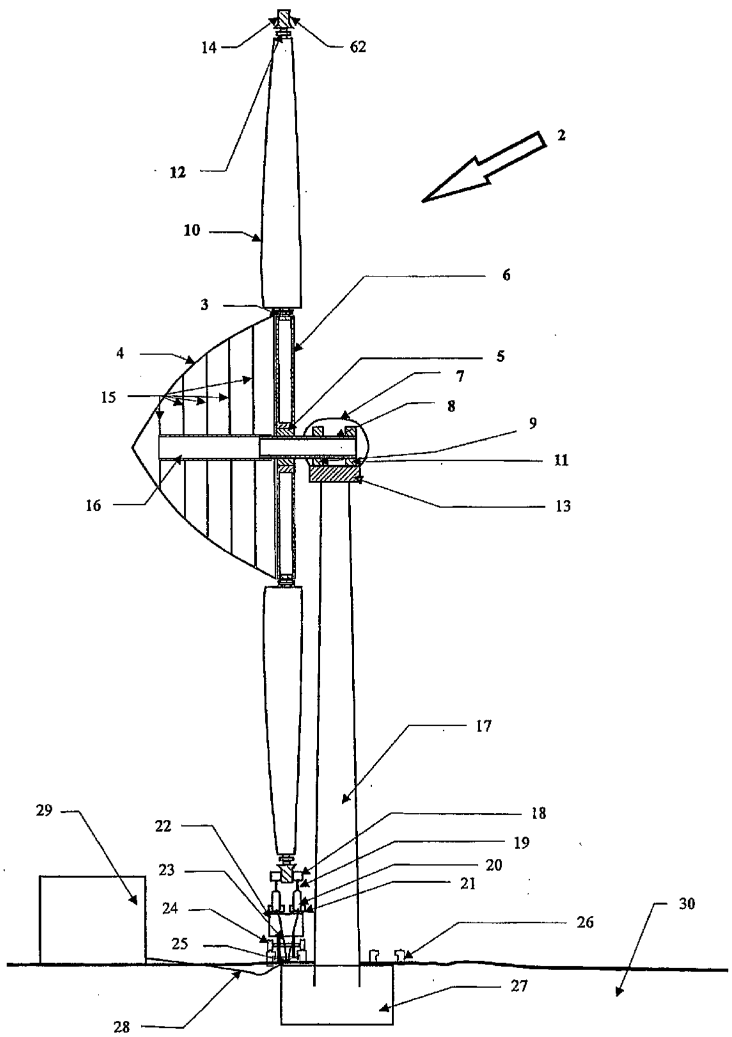

FIGURE 1

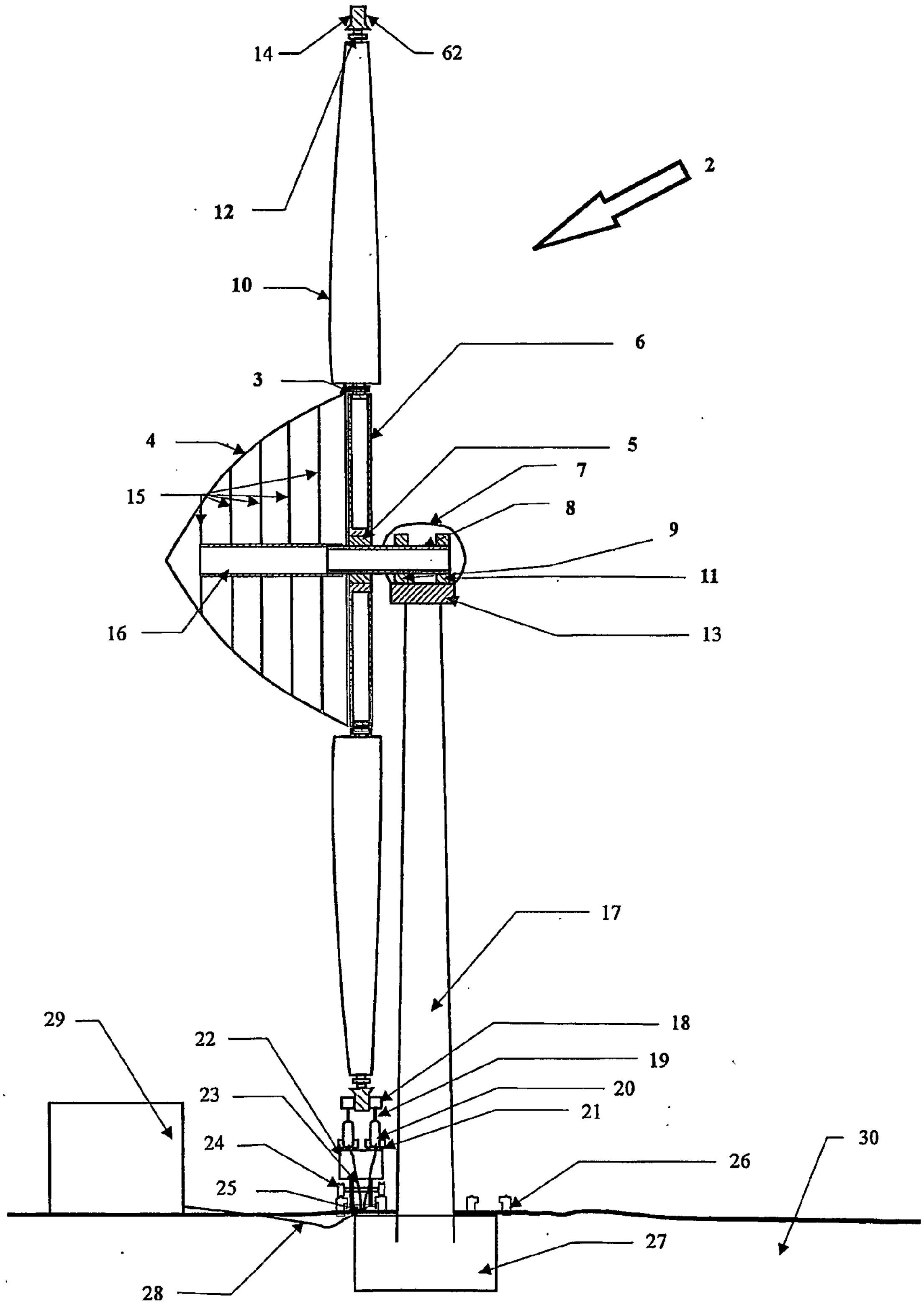
14
62
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FIGURE 2

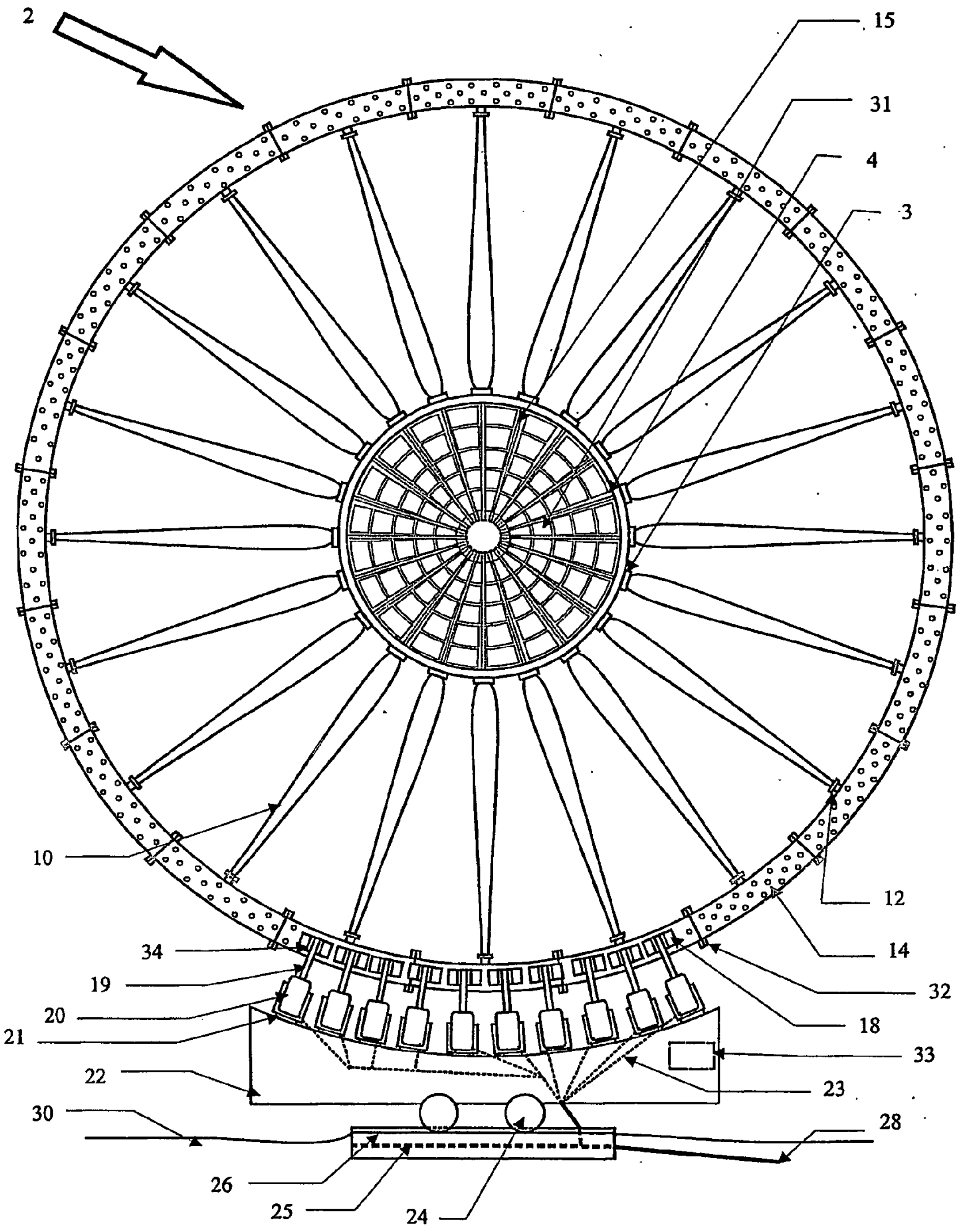


FIGURE 3

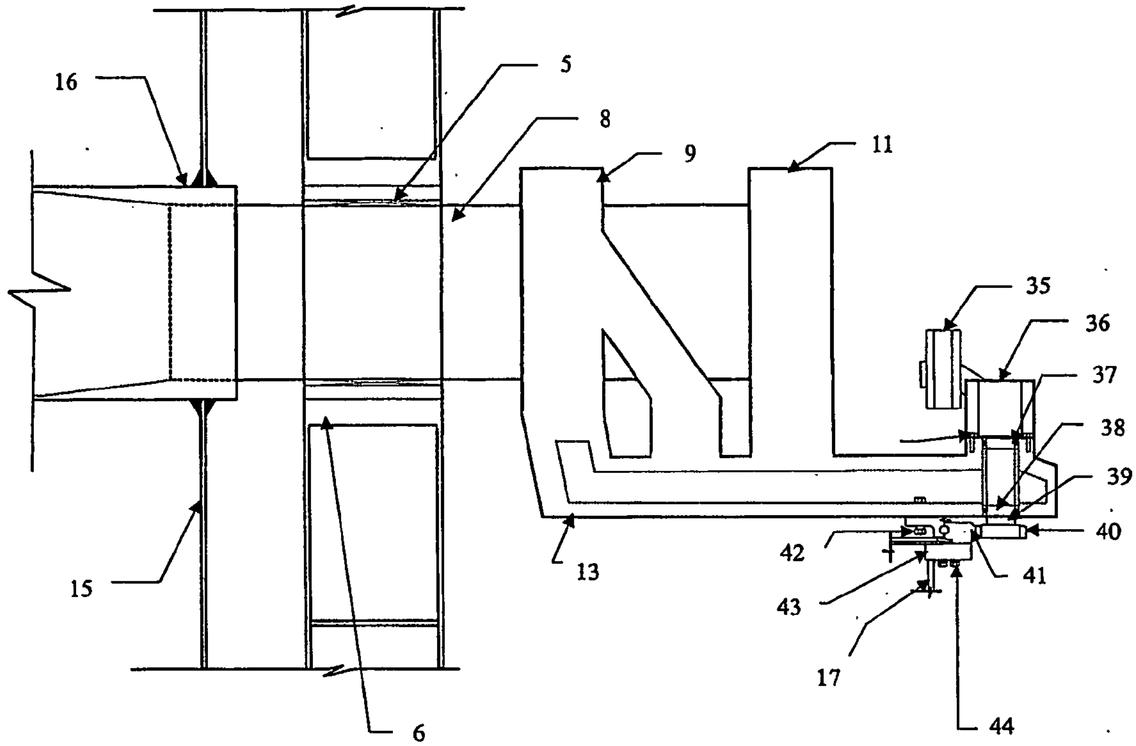


FIGURE 4B

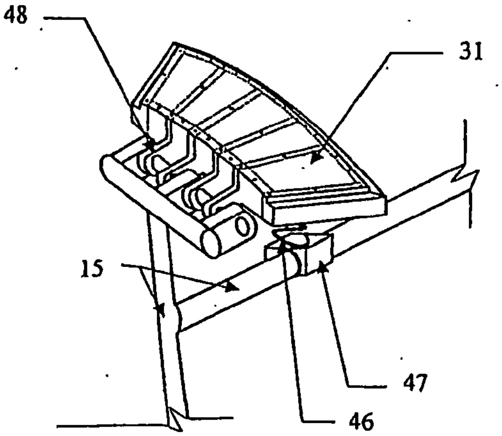


FIGURE 4A

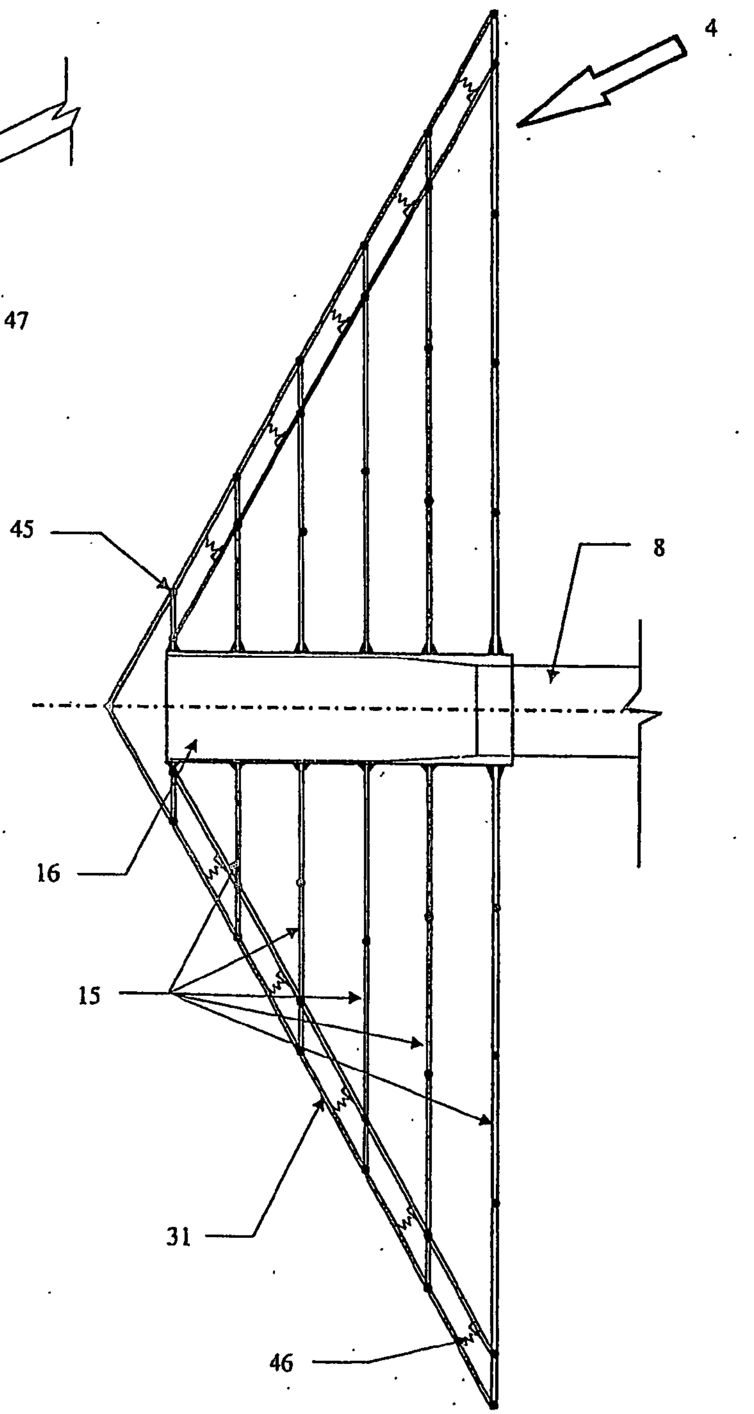


FIGURE 5B

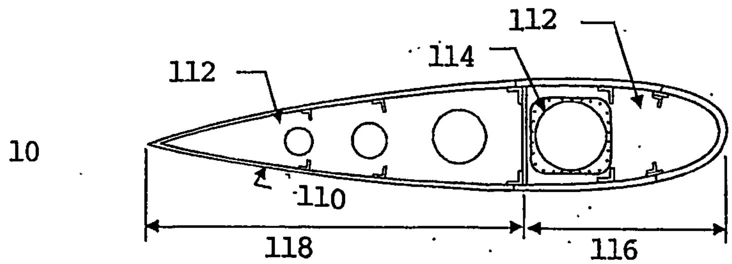


FIGURE 5A

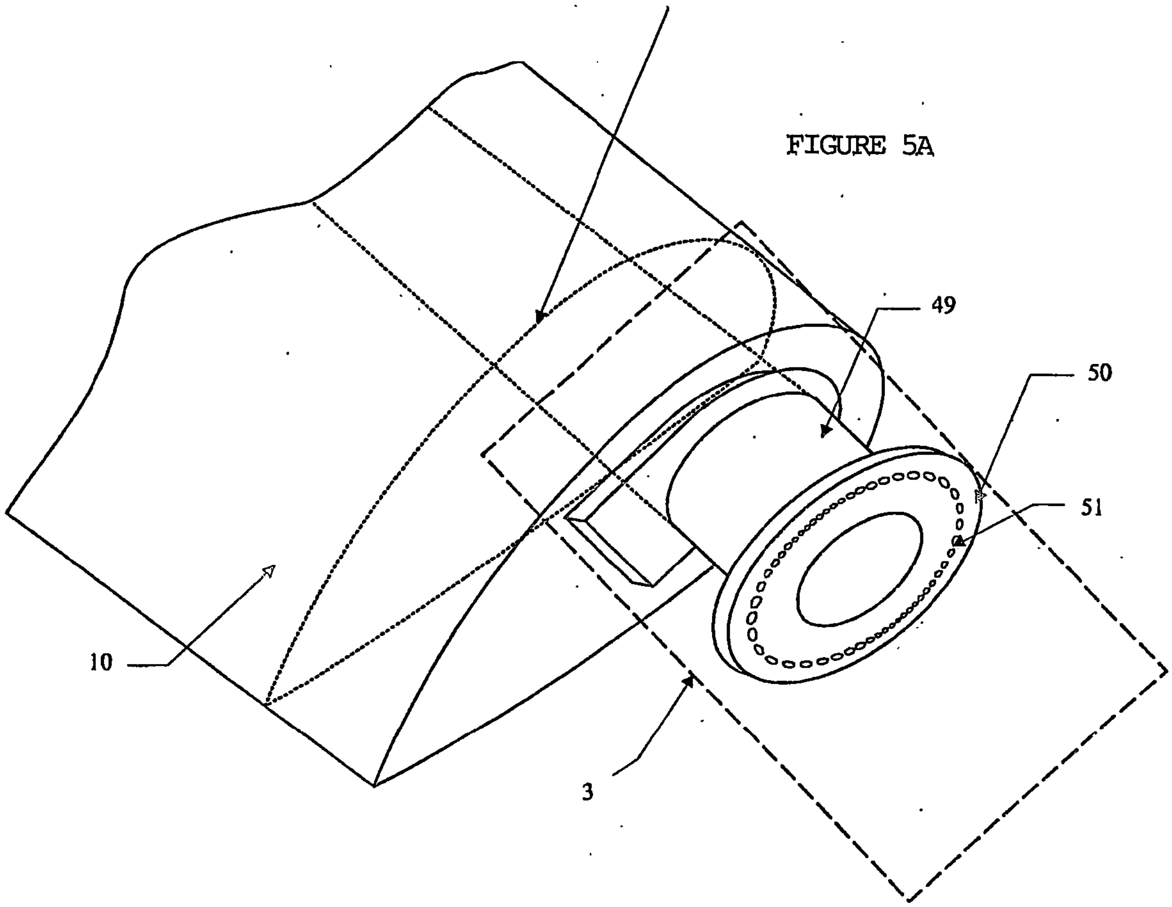


FIGURE 6

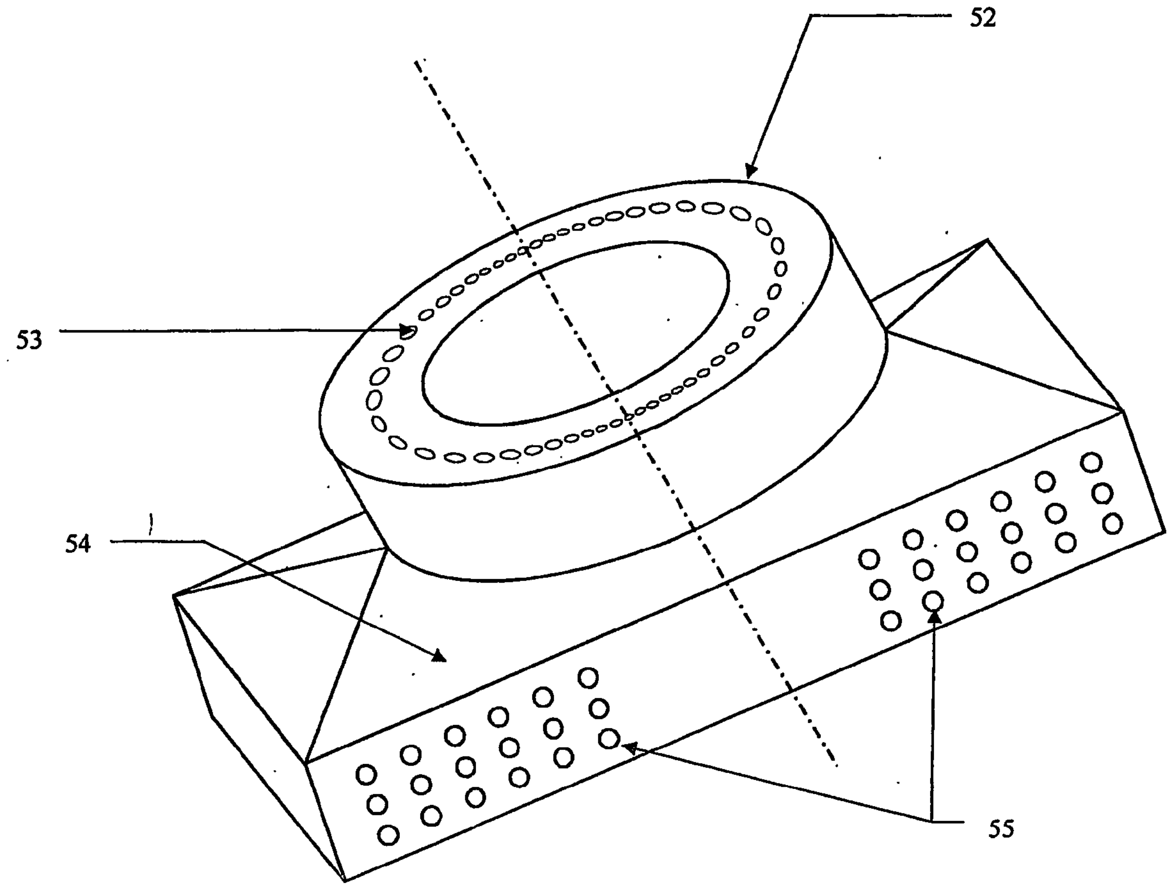


FIGURE 7

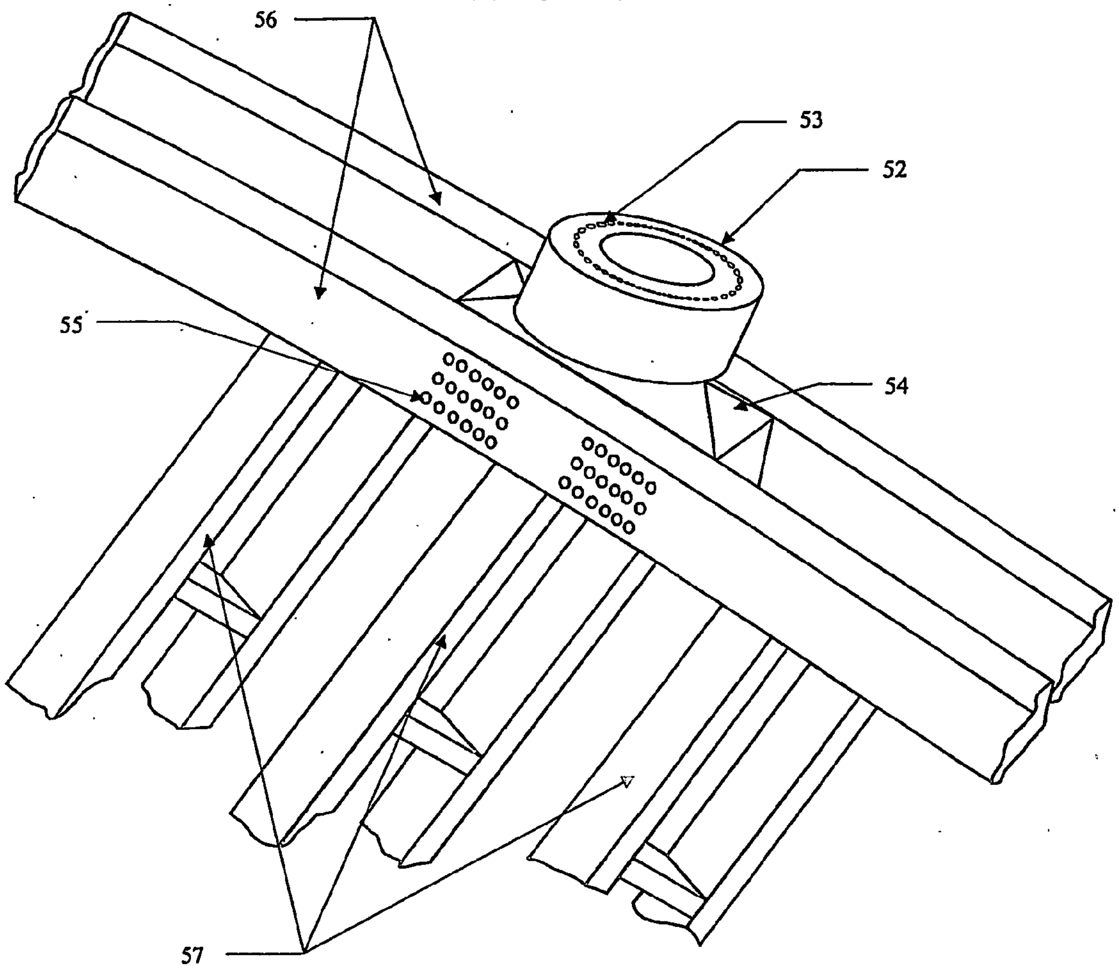


FIGURE 8A

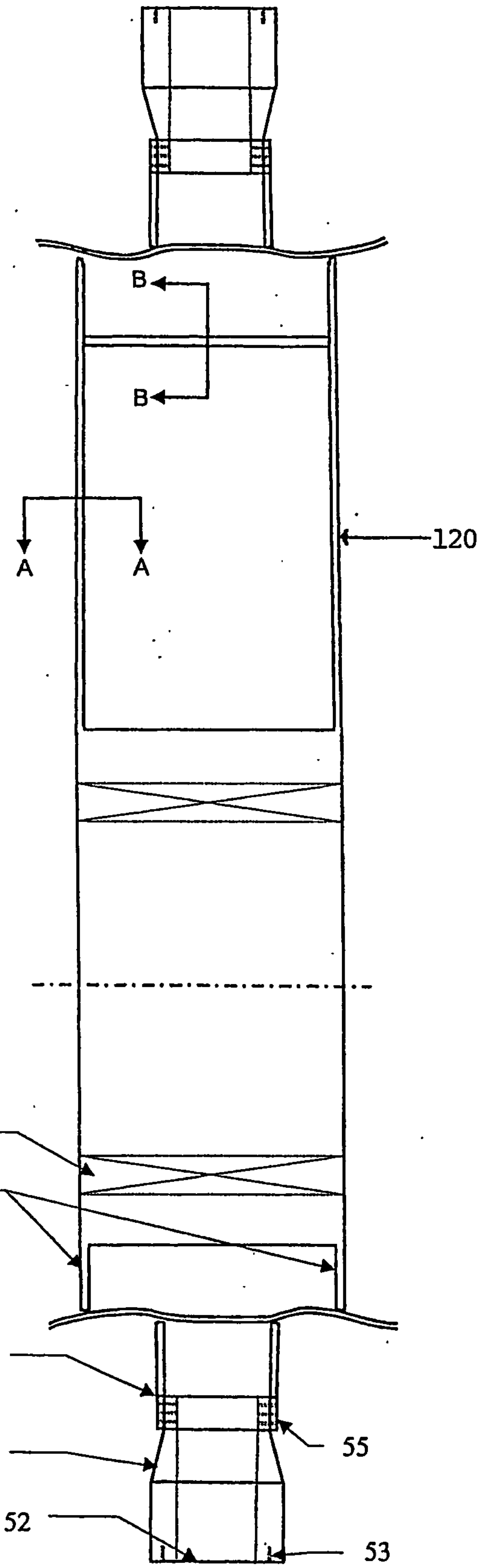


FIGURE 8B

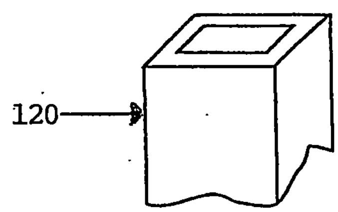


FIGURE 8C

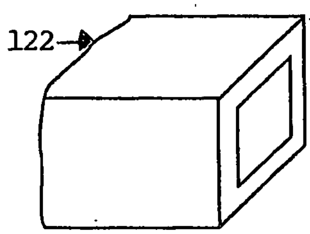
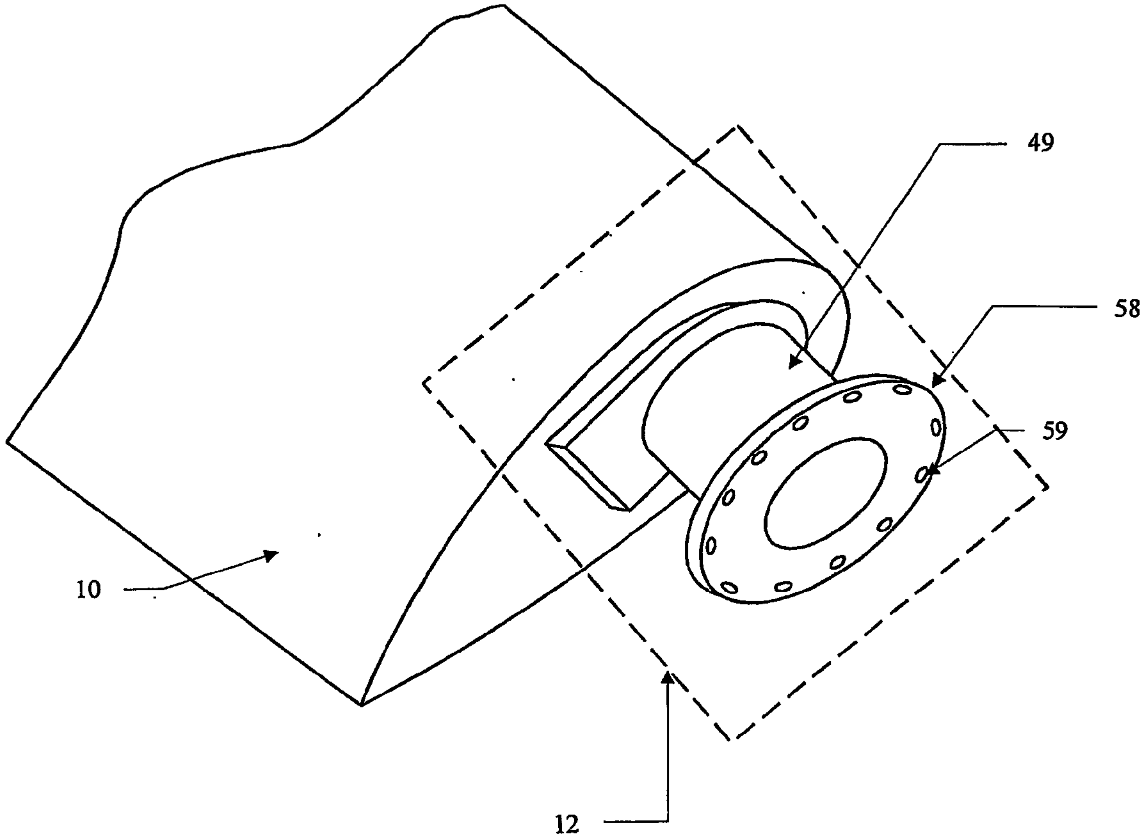


FIGURE 9



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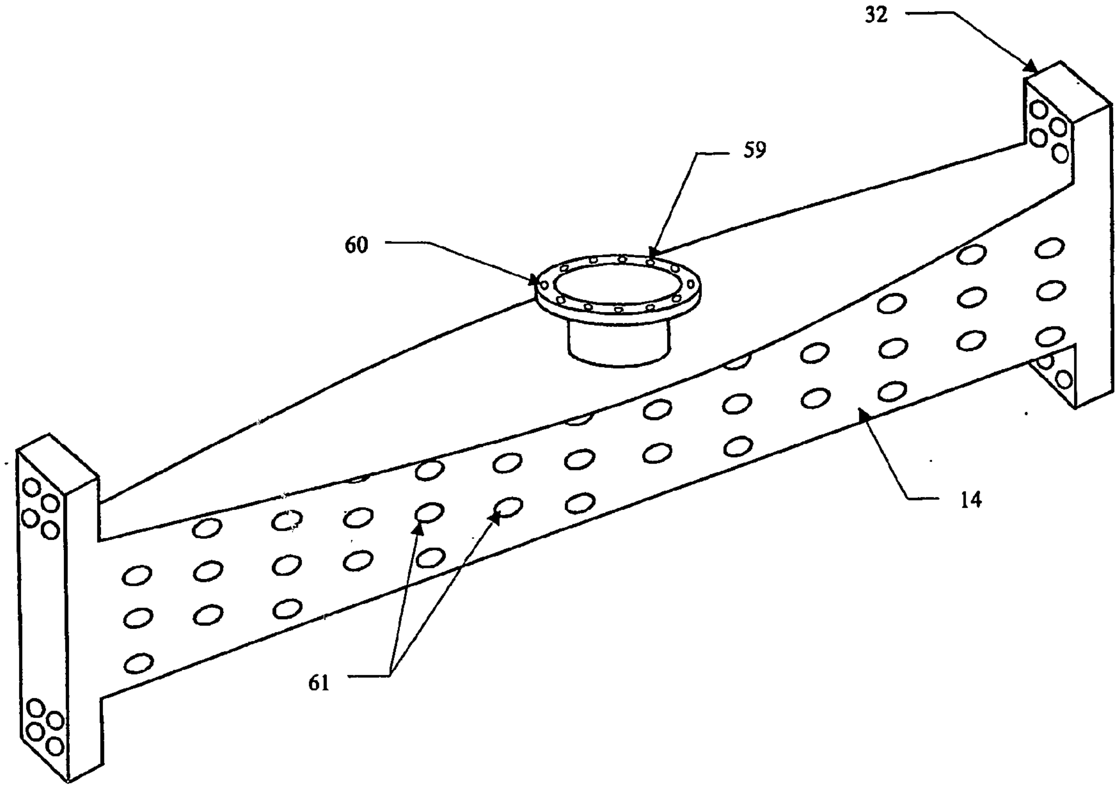

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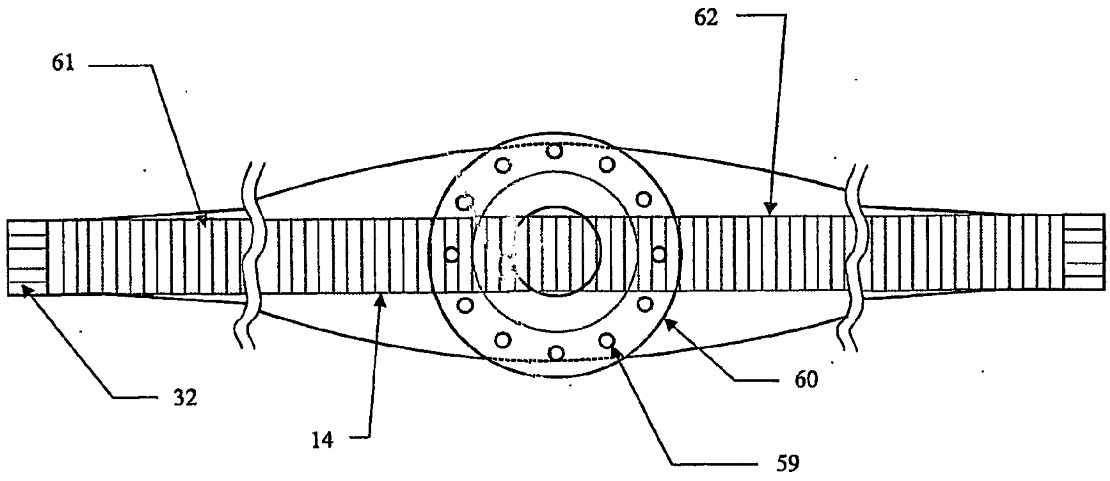

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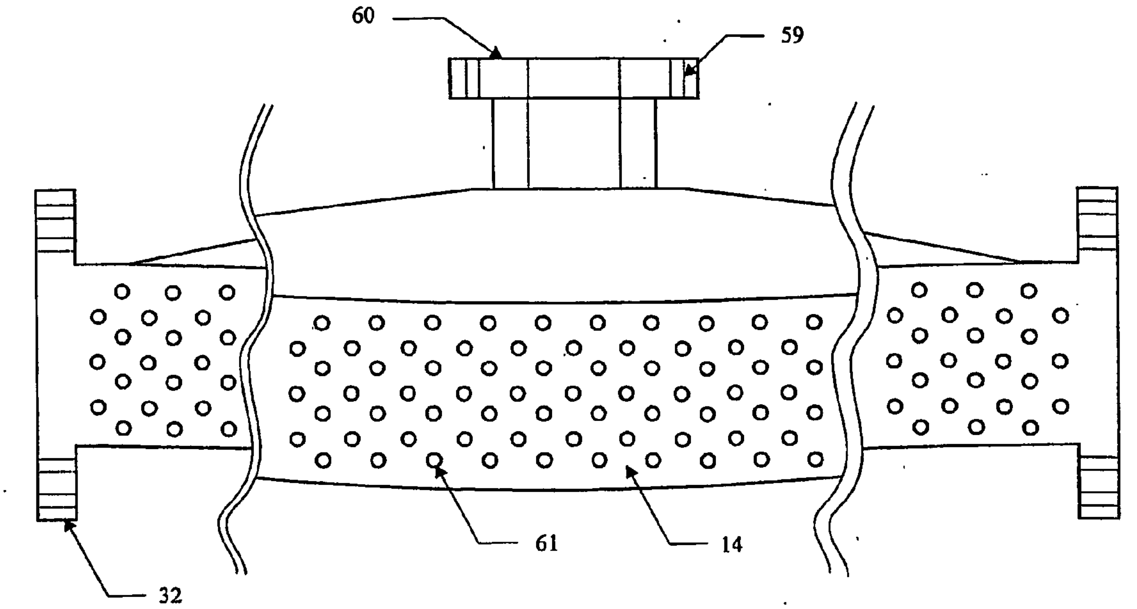

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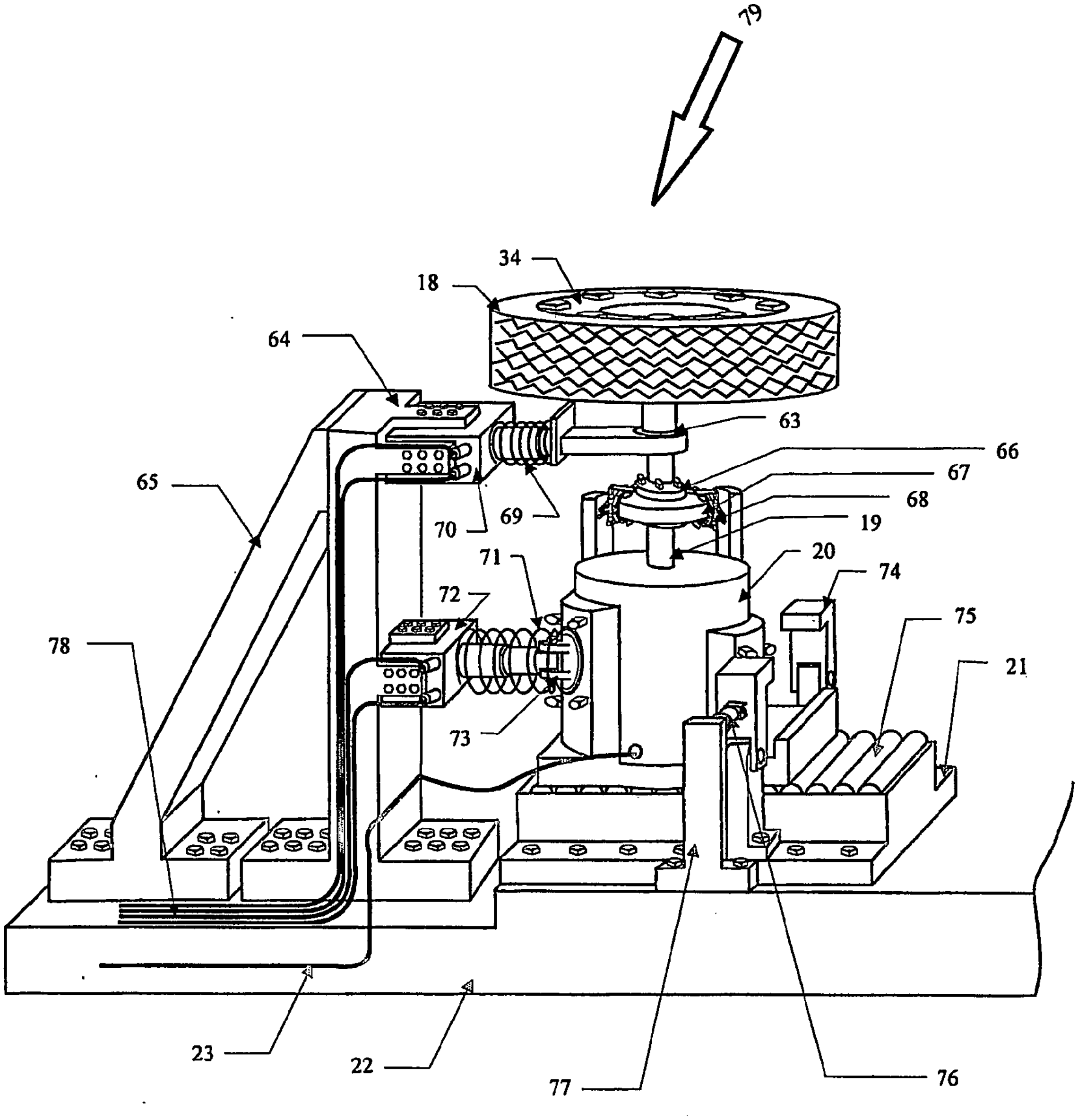
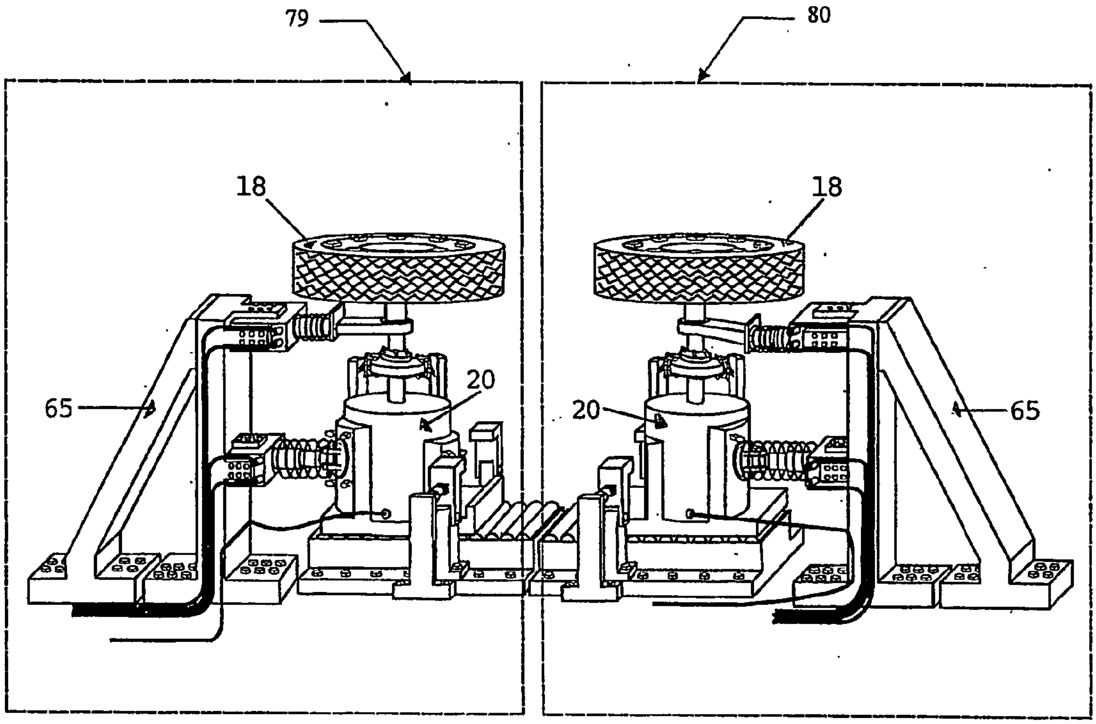


FIGURE 14



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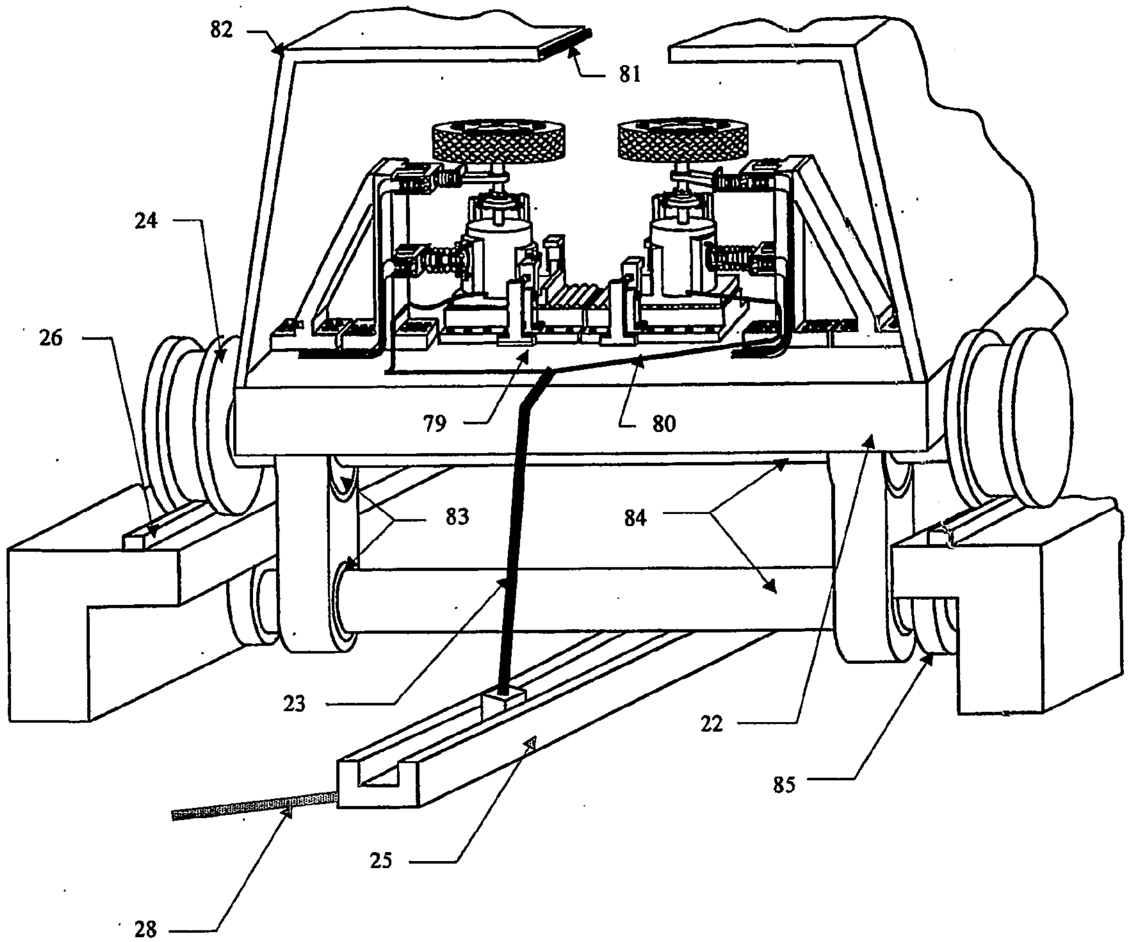

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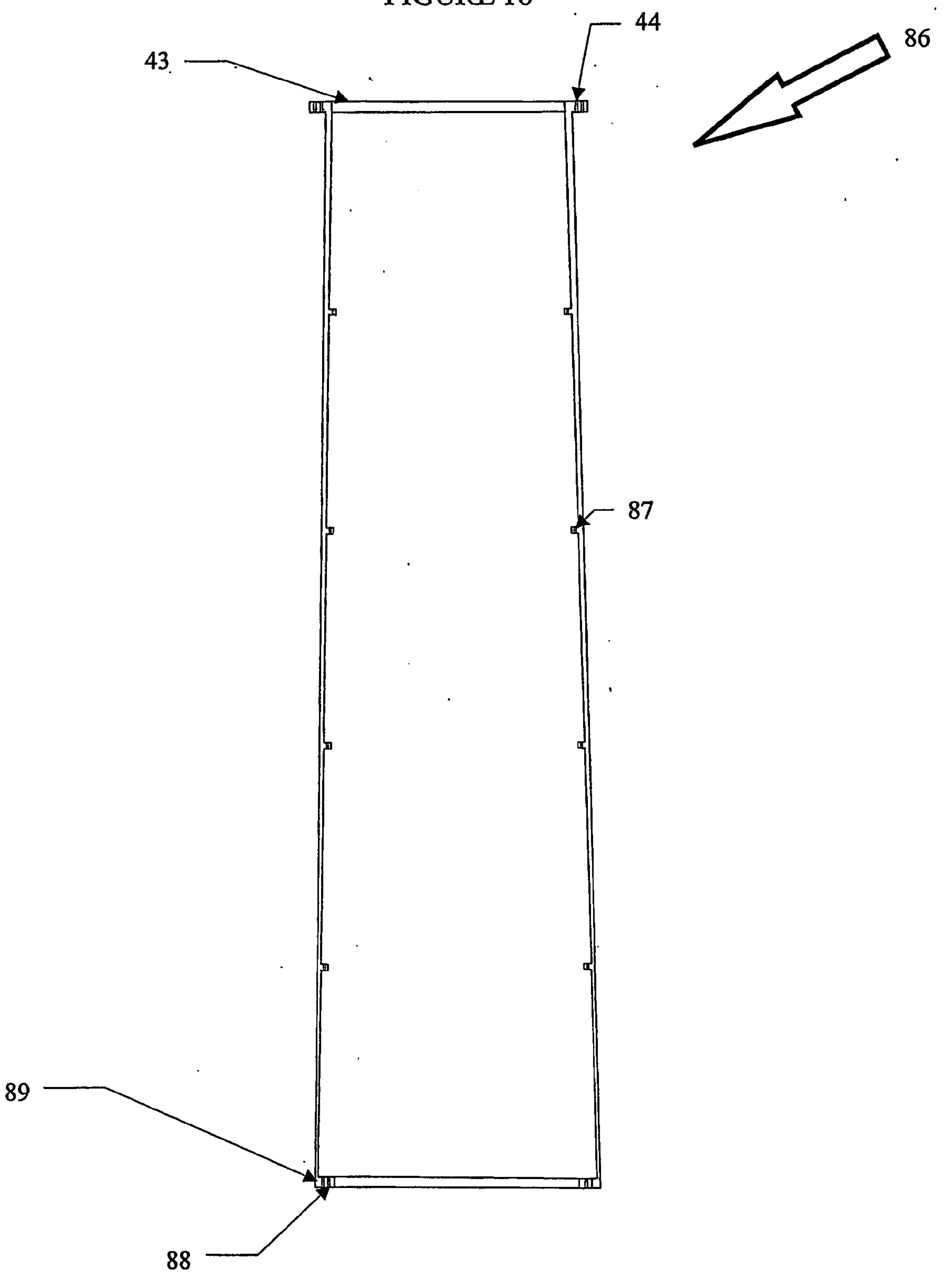
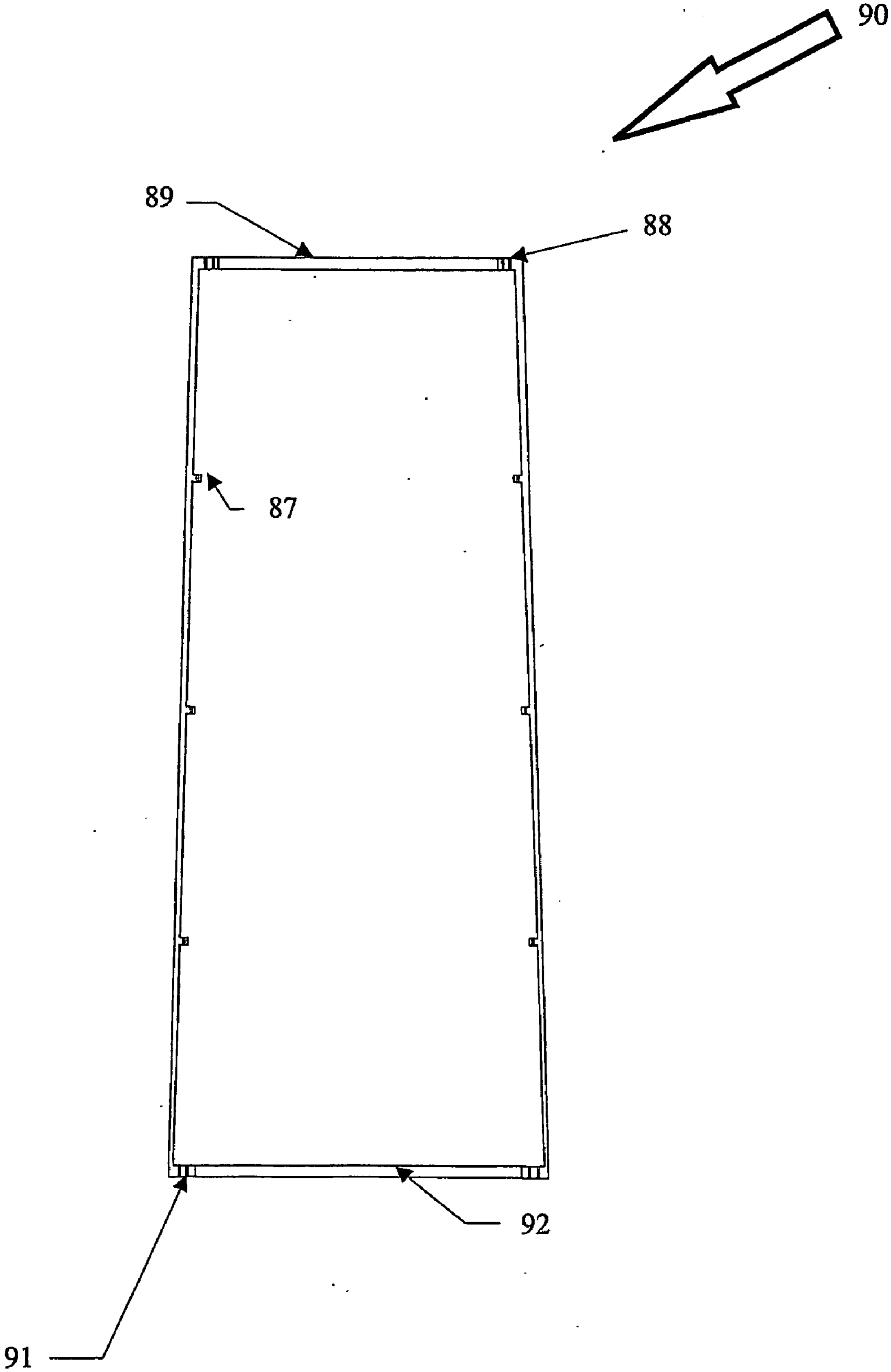


FIGURE 17



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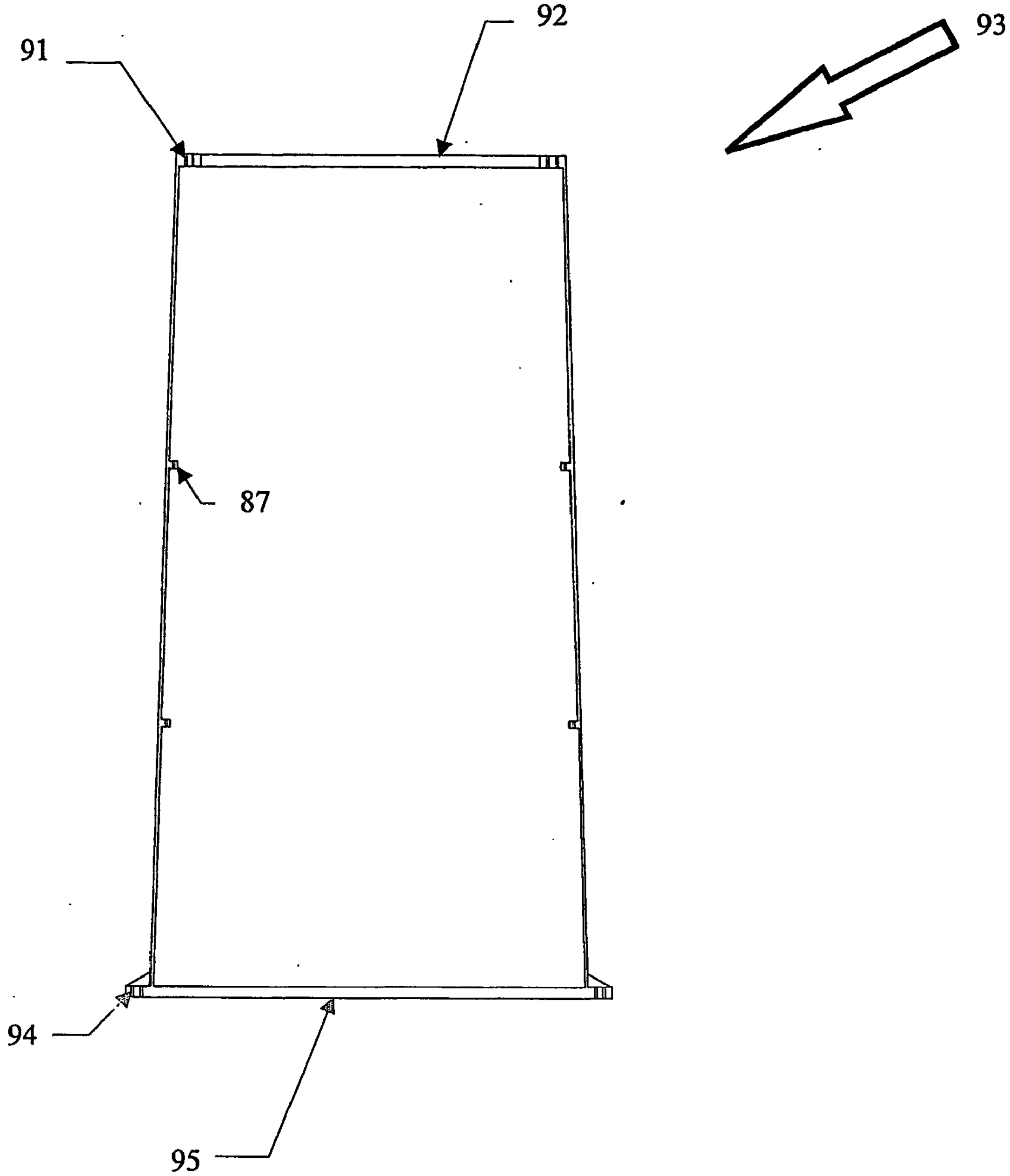


FIGURE 19

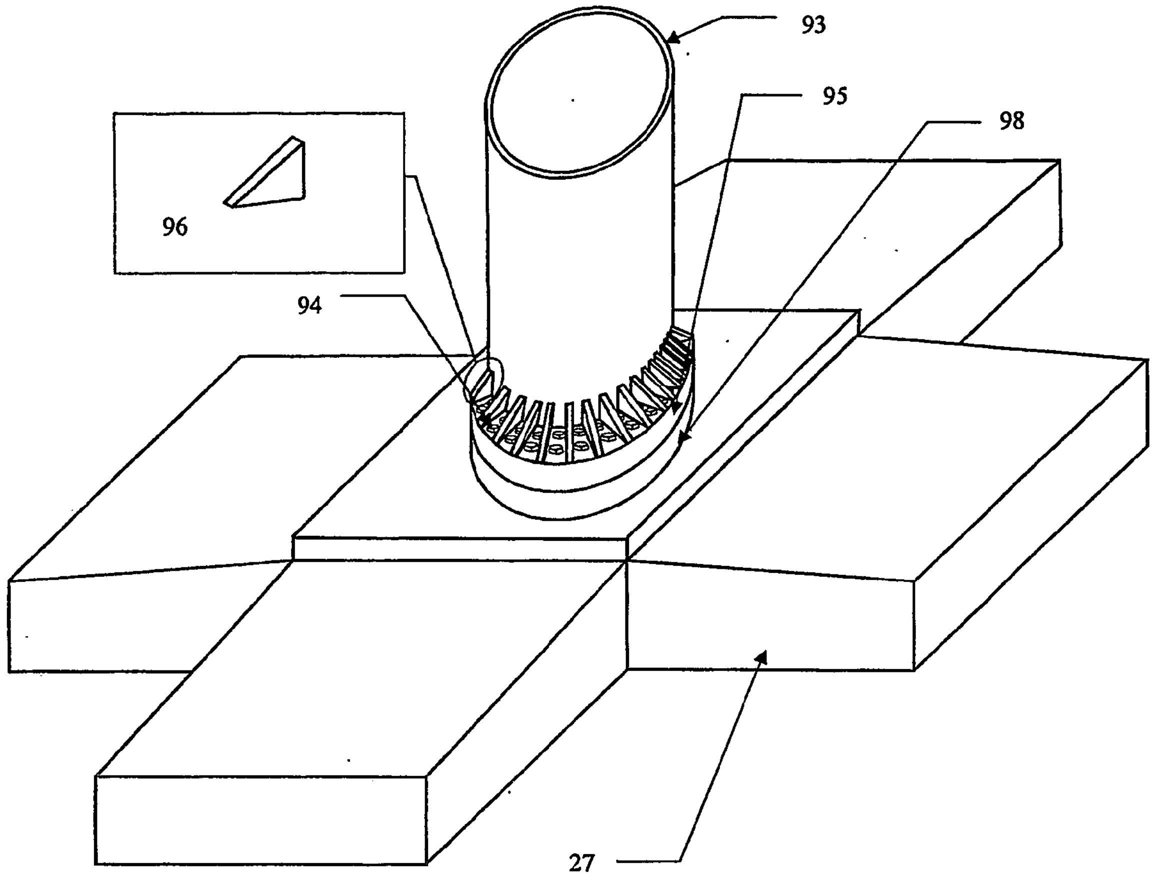


FIGURE 20

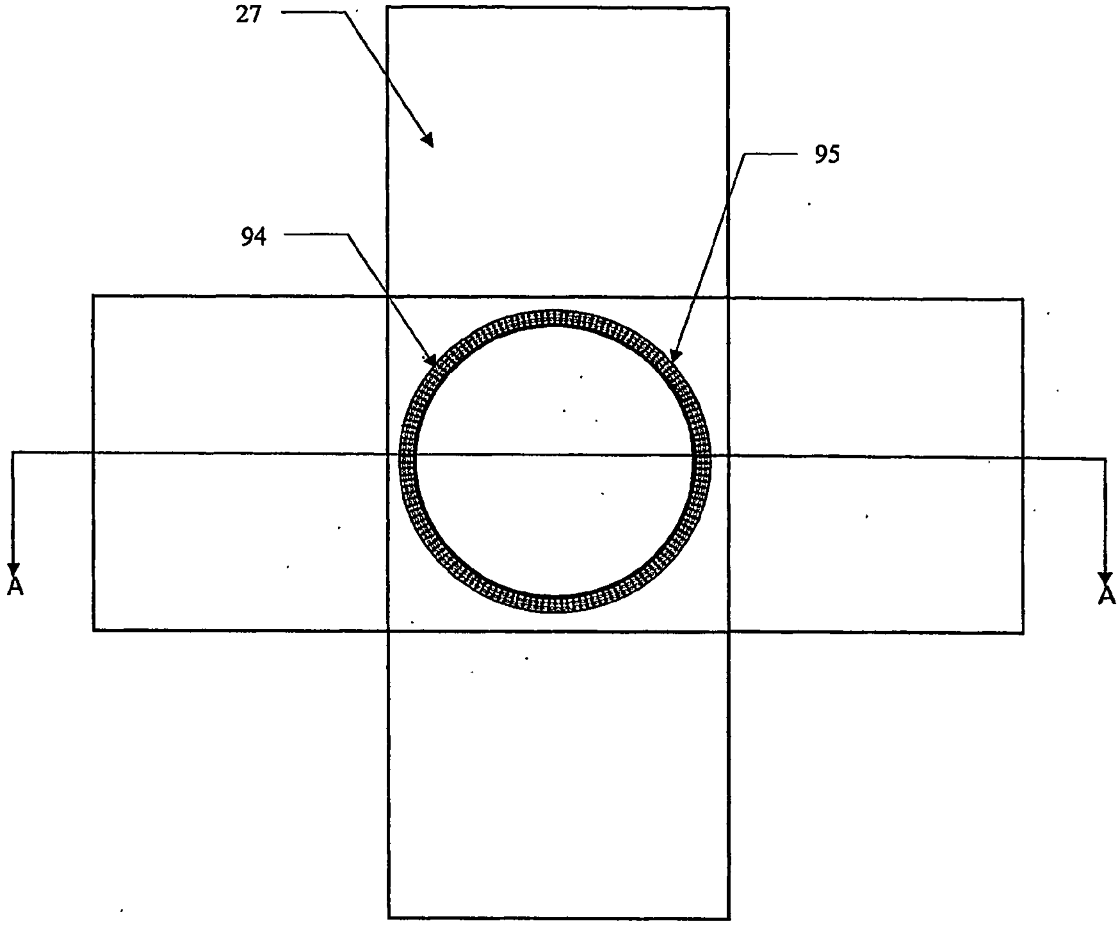


FIGURE 21

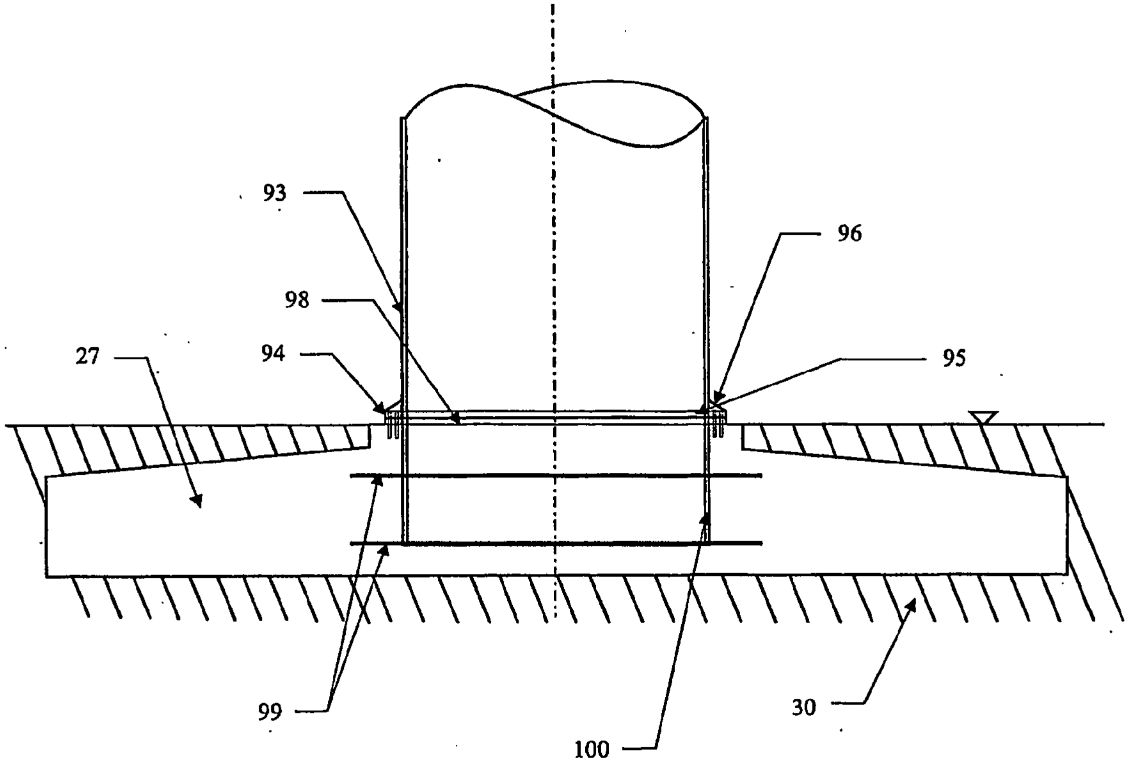


FIGURE 22

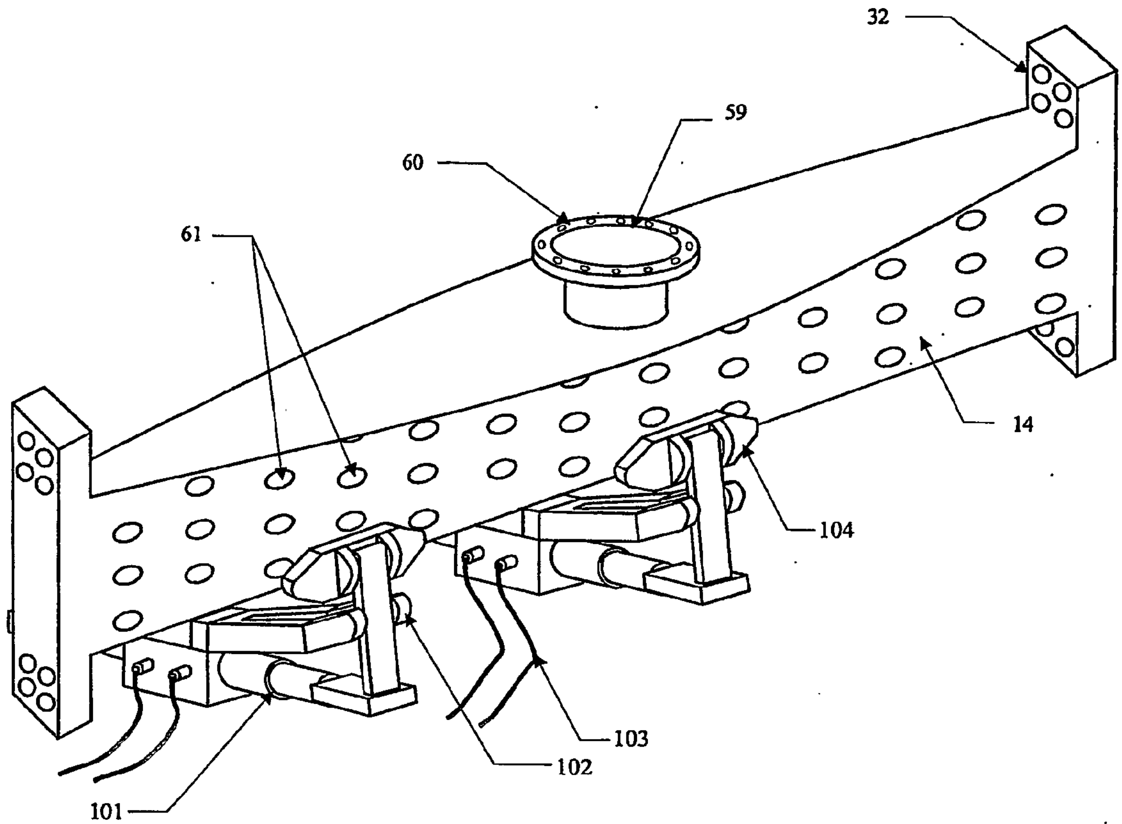


FIGURE 23

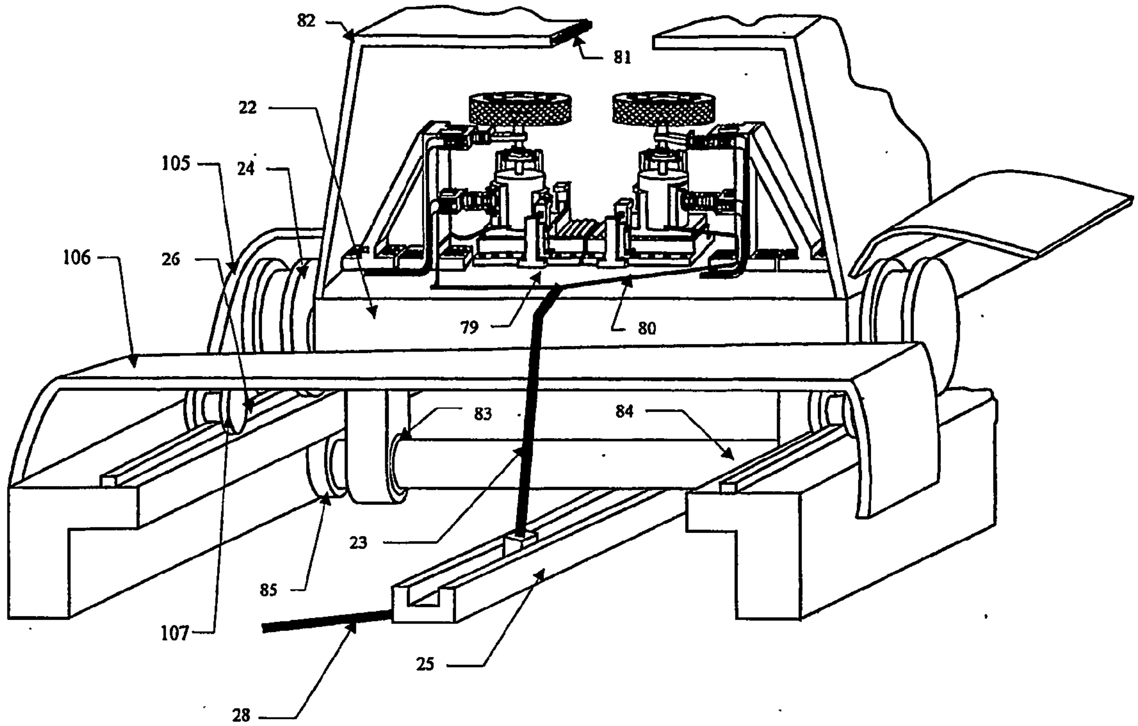
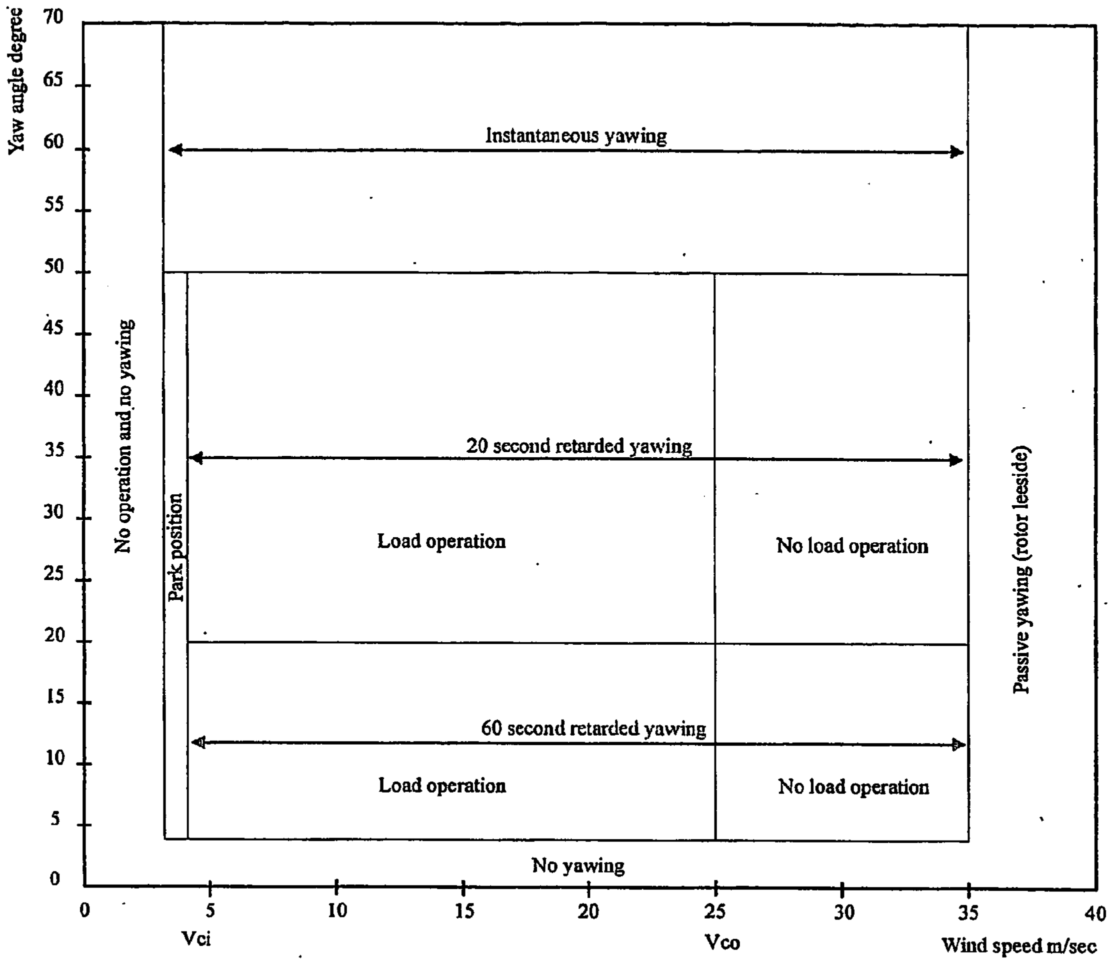


FIGURE 24


Yaw angle degree
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Instantaneous yawing
No operation and no yawing
Park position
20 second retarded yawing
Load operation
No load operation
60 second retarded yawing
Load operation
No load operation
Passive yawing (rotor leeside)
No yawing
0
5
10
15
20
25
30
35
40
Vci
Vco
Wind speed m/sec

WIND TURBINE WITH FRICTION DRIVE POWER TAKE OFF ON OUTER RIM

BACKGROUND OF THE INVENTION

[0001] 1. Field of Invention

[0002] This invention relates to a wind turbine and method of operation thereof for producing energy and, more particularly, to a wind turbine having multi-blades (for example eight to twenty), and a ring around the circumference thereof, the ring driving energy producing equipment. The blades are shaped with airfoils to produce maximum power coefficient.

[0003] 2. Description of the Prior Art

[0004] Wind turbines, including windmills, are known and are used to power energy production equipment including generators, compressors or pumps, as well as other devices. It is known to have the wind turbine connected to a shaft and the rotational energy in the shaft is then used to drive the energy producing equipment. Windmills or wind turbines have gearboxes to transfer the energy from the blades through the shaft to energy producing equipment. Some wind turbine manufactures are using a large diameter direct drive generator connected directly to the shaft and running at low rotational speed. Wind turbines with large rated electrical output require (<3 MW) large gearboxes and generators. This can result in heavy and costly power transmission and energy production equipment. It is known to use wind turbines to produce electrical energy. Fixed and variable speed wind turbines are used to produce electricity with the same frequency as the grid. Fixed and variable speed wind turbines have certain advantages and disadvantages. Variable speed wind turbines have advantages of reducing the dynamic loads on the power transmission systems and have higher power coefficients than fixed speed wind turbines. Variable speed wind turbine use several methods and systems to obtain the same frequency as the grid system of an electrical utility. These systems are more costly than those used in fixed speed wind turbines. Variable speed operation will allow the wind turbine to start producing electricity at lower wind speeds and hence collect more energy. With variable speed wind turbines, there is a difficulty of producing electricity with the same frequency as the grid because the wind velocity constantly changes and therefore the speed of rotation of the blades of the wind turbine varies. With constant speed wind turbines, the frequency of the electricity produced can match the frequency of the grid, but difficulty arises in maintaining a constant speed with variable wind conditions. Further, electrical energy cannot be produced by any wind turbine during periods when the wind is not blowing or is not blowing at a sufficient velocity to rotate the rotor of the wind turbine.

[0005] Wind power is renewable and is a green energy source that is highly desirable as it does not pollute.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide a wind turbine that can be controlled to operate energy producing equipment at variable speed rate of speed. It is further object of the present invention to provide a wind turbine without using a step up gearbox.

[0007] A wind turbine for producing energy has a rotor on a shaft. The rotor supports a plurality of blades and is rotatably mounted on the shaft. The blades each have a tip, there being a plurality or tips on the turbine. The tips are connected to support a ring that extends around a circumference formed by the tips. The ring rotates with the blades, the ring having a front and rear surface with rotators mounted to removably contact the ring on the front and rear surfaces. Each of the rotators is connected to energy producing equipment. The rotators rotate with the ring when the ring rotates, thereby driving the energy producing equipment. The turbine is controlled by a controller.

[0008] A wind turbine for producing energy has a rotor on a stationary shaft. The rotor supports a plurality of blades shaped with airfoil sections and is rotatably mounted on the stationary shaft via a hub and a bearing. The blades each have an outer tip, there being a plurality of outer tips on the wind turbine. The tips are connected to a ring that extends around a circumference formed by the tips. The ring has front and rear surface and rotators are mounted to removably contact the ring on the front and rear surfaces. Each of the rotators is connected to energy producing equipment. When the ring rotates and the rotators are in contact with the ring, the rotators also rotate, thereby driving the energy producing equipment.

[0009] Preferably, the energy producing equipment is selected from the group of a generator, a compressor and a pump.

[0010] Still more preferably, the rotators are mounted on a cart with rails having its center of rotation at the center of the tower base circle. The cart being rotatable to move with the wind turbine either toward or away from the wind.

[0011] A method of operating a wind turbine for producing energy, said turbine having a rotor on a shaft, said rotor supporting a plurality of blades and being rotatably mounted on said shaft, said blades each having a tip, there being a plurality of tips on said turbine, said tips being connected to support a ring that extends around said tips, said ring rotating with said blades, said ring having a front and rear surface with rotators mounted to removably contact said ring on said front and rear surfaces, each of said rotators being connected to energy producing equipment, said rotators rotating with said ring when said ring rotates, said turbine being controlled by a controller, said method comprising operating said turbine by continuously monitoring wind conditions, adjusting yaw, blade orientation and pressure and number of rotators against said ring or removal of rotators from said ring to produce power output whenever said wind conditions are sufficient.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] **FIG. 1** is a partial sectional side view of a wind turbine;

[0013] **FIG. 2** is a front view of a wind turbine;

[0014] **FIG. 3** is an enlarged view of a nacelle and bed plate;

[0015] **FIG. 4A** is a side view of a stationary cone;

[0016] **FIG. 4B** is an enlarged partial perspective view of a spring loaded gate;

[0017] **FIG. 5A** is blade connection to a hub;

[0018] **FIG. 5B** is a partial schematic sectional view of a glade;

[0019] **FIG. 6** is a perspective view of a hub-blade connection;

[0020] **FIG. 7** is partial perspective view of spokes and said hub-blade connection;

[0021] **FIG. 8A** is a partial perspective view of side view of the hub;

[0022] **FIG. 8B** is a partial perspective view along with lines A-A of **FIG. 8A**;

[0023] **FIG. 8C** is a partial perspective view along the lines B-B of **FIG. 8A**;

[0024] **FIG. 9** is a partial perspective view of a blade-ring connection;

[0025] **FIG. 10** is a perspective view of a ring section;

[0026] **FIG. 11** is a top view of the ring section and part of a ring;

[0027] **FIG. 12** is a side view of the ring section;

[0028] **FIG. 13** is a perspective view of a tire connected to a shaft of a generator;

[0029] **FIG. 14** is a perspective view of two opposing tires and generator;

[0030] **FIG. 15** is a partial perspective view of a power production equipment cart;

[0031] **FIG. 16** is a side view of a first section of a tower;

[0032] **FIG. 17** is a side view of a second section of the tower;

[0033] **FIG. 18** is a side view of a third section of the tower;

[0034] **FIG. 19** is a partial perspective view of the third section of the tower on a foundation;

[0035] **FIG. 20** is a top view of the tower and foundation shown in **FIG. 19**;

[0036] **FIG. 21** is a partial sectional side view of the tower and foundation

[0037] **FIG. 22** is a partial perspective view of a ring section with a brake system mounted thereon;

[0038] **FIG. 23** is an enlarged partial perspective view a rail cover layout; and

[0039] **FIG. 24** is a graph of the operation of the yaw system.

DESCRIPTION OF A PREFERRED EMBODIMENT

[0040] In **FIGS. 1 and 2**, a turbine **2** has a rotor with a hub **6** and a plurality of blades **10** extending outward from a root **3** to a tip **12**. Preferably, the wind turbine has eight to twenty blades. Connected to and supported by each of the tips **12** is a ring with a front surface **14** and a back surface **62**. Rotators **18** are located and mounted to be removably placed into contact with the front surface **14** and back surface **62** as the ring **1** rotates. The rotators each have a shaft **19** which is connected to energy producing equipment **20**. The rotators are preferably tires mounted on a rim **34**. The tires are preferably made of rubber. Steel or metal wheels can also be used as rotators. The energy producing equipment includes generators, compressors, pumps and the like. When the energy producing equipment is a generator, the rotation of the wind turbine **2** will cause the front surface **14** and back surface **62** of the ring to rotate. The tires will also rotate when they are in contact with the ring **1**, thereby driving the generators. Preferably, each tire is connected to a separate generator. Also preferably, every rotator, shaft and generator on the front surface **14** of the ring **1** has a corresponding rotator, shaft and generator on the back surface **62**. The corresponding rotator is preferably mounted and controlled to removably contact the back surface simultaneously with the front surface rotator so that when a rotator is in contact with the ring on the back surface, the corresponding rotator on the front surface will also be in contact with the ring. Similarly, when a rotator on the front surface is moved out of contact with the ring, the corresponding rotator on the back surface will also be moved out of contact with the ring. The corresponding rotator is always located directly behind the rotator on the front surface. In this way, the pressure on the ring from front and back is equalized at all times so that the ring is not unbalanced by force exerted by the rotators **18**. The rotator **18**, shaft **19** and energy producing equipment **20** of each mechanism are mounted on a moving base **21**. All the mechanisms are mounted on a cart **22** having steel wheels **24** allowing the cart **22** to travel on a rail **26** when required to turn the turbine **2** toward or from a direction of the wind. A hydraulic supply **33** will provide the necessary hydraulic pressure to move the mechanisms. The electrical current produced by the turbine is transmitted by the generator cables **23** to the transformer **29** via a slip ring **25** and a main electrical cable **28**.

[0041] In **FIGS. 1 and 2**, it can be seen that the blades **10** are connected to the hub **6** and the hub **6** is mounted on a stationary shaft **8** via a bearing **5**. A stationary cone **4** is mounted on a front side of the stationary shaft **8**. The stationary cone **4** is fixed to the stationary shaft **8** by spokes **15** and a hollow shaft **16**. The cone is equipped with spring loaded gates **31**, which start allowing air to pass through the cone **4** at high wind speeds.

[0042] The stationary shaft **8** is fixed on a bedplate **13** by a front mounting **9** and a rear mounting **11**. The bedplate **13** is mounted on a tower **17**, which is fixed to a foundation **27**. The foundation **27** is constructed into the ground **30**.

[0043] In **FIG. 3**, an electrical motor **35** will be used to power a yaw mechanism. The motor **35** will drive a gear reducer **36** with a shaft **39**, two locating bearings **37**, **38** and a pinion **40**. The pinion **40** will drive a slew bearing **41** mounted to the bedplate **13** by bolts **42** and to a tower flange **43** by bolts **44**. The tower flange **43** is welded to the tower **17**.

[0044] **FIG. 4A** shows an enlarged side view of the cone **4**. A hollow shaft **16** is fixed to the stationary shaft **8** and provides the necessary support for the radial spokes **15** and outer spokes **45**. A spring loaded gate **31** (as shown in detail in **FIG. 4B**) has a spring **46** and a hinge **48** keeping the gate closed at low wind speeds. The gate will start to open under high wind speed allowing air to pass through the cone. The spring **46** is mounted on a base **47** supported by the radial spokes **15** of the cone.

[0045] **FIG. 5A** is a perspective view showing the blade to hub connection **3**. The blade **10** has a supporting shaft **49** which extends from the root of the blade to the tip (not shown in **FIG. 5A**). The blade root flange **50** is welded to the support shaft **49** having bolt holes **51**. This design is for a stall regulated operation, which does not require a pitch mechanism. The blades **10** can be mounted on a slew bearing and have an electrical motor and a gear reducer (similar to the mechanism shown in **FIG. 3** for the yaw drive) to provide a pitching mechanism for the blades **10**.

[0046] In **FIG. 5B**, there is shown a schematic sectional view of the blade **10**. It can be seen that the blade **10** has an air foil shape with an outer wall **110**, ribs **112** and a blade shaft **114**. The blade **10** has a D-shaped spar section **116** and a trailing edge section **118**.

[0047] **FIG. 6** is a perspective view showing the hub blade connection **54**. The blade root flange **50** from **FIG. 5A** (not shown in **FIG. 6**) is mounted on a hub blade mounting flange **52**. The hub blade mounting flange **52** (shown in **FIG. 5A**, but not shown in **FIG. 6**) has bolt holes **53** facing the blade root flange bolt holes **51**.

[0048] **FIGS. 7, 8A**, **8**B and **8**C show the hub blade connection **54** connected to hub rings **56** via mounting bolts **55**. The hub rings **56** are connected to a center of the hub **6** by spokes **57**.

[0049] **FIGS. 8B and 8C** show a partial perspective view of a side wall **120** of the hub **6** and a cross member **122**.

[0050] **FIG. 9** shows a blade to ring connection **12**. The blade **10** has a supporting shaft **49** which extends from the root of the blade to the tip (not shown in **FIG. 9**). The blade tip flange **58** is welded to the blade support shaft **49** having bolt holes **59**. **FIG. 9** shows an opposite end of the blade **10** from the end shown in **FIG. 5A**.

[0051] **FIGS. 10, 11** and **12** show the front face of the ring section **14** and back face of the ring section **62**, the ring section has a blade mounting flange **60** with bolt holes **59** facing the bolt holes of the blade tip flange **59**. Each ring section is connected to the adjacent ring section by a mounting **32**. Ring sections have holes **61** to reduce the weight. Each ring section **14** has a curvature (**FIG. 12**) so that the ring sections can form a circle (see **FIG. 2**). The portions of the ring sections that the tires contact are flat.

[0052] **FIG. 13** shows a perspective view of a front tire-generator mechanism **79** consisting of a rotator **18** (preferably a tire) mounted on a rim **34** which is connected to a shaft **19** that drives the power generation equipment **20**, which in this Figure is an electrical generator. A brake disc **67** is mounted on the shaft **19** by a flange **66**. Brake calipers **68** are located around the brake disc **67** (first brake option). A power generating equipment mounting **73** is fitted with rolling elements **75**, which are fixed to a mounting base **21**. A spring **69** is mounted around a hydraulic cylinder **70**, which is connected to the shaft **19** and mounted on support structure **64**. Another spring **71** is mounted around a hydraulic cylinder **72**, which is connected to the power generation equipment mount **73** and mounted on the support structure **64**. The springs **69, 71** will provide the required pressure to connect the rotator **18** to the front face ring **14** to transmit the required power. The hydraulic cylinders **70**, **72** provide the required force to disconnect the rotator **18** from the front face ring **14**. A lock **74** locks the power generating equipment mounting **73** into place when the rotator **18** is fully disconnected from the front face ring **14**, relieving the two hydraulic cylinders **70**, **72**. A small hydraulic cylinder **76** actuates the lock **74**. The hydraulic cylinder **76** is mounted on a support structure **77**. The two hydraulic cylinders **70**, **72** are supplied by hydraulic pressure by hydraulic lines **78** connected to the hydraulic supply **33**. The hydraulic cylinders **70**, **72** are mounted on a support structure **64**, which is supported by an angled structural member **65**, to provide the required stiffness. An electrical cable **23** is used to connect the power generation equipment **20** (generator in this case) to the slip ring **25**. The whole mechanism is mounted on the cart **22**.

[0053] **FIGS. 14 and 15** show the front tire-generator mechanism **79** and a back tire-generator mechanism **80**, which are mounted on the cart **22**. The mechanisms **79, 80** are identical to one another and are mirror images of one another. An electrical cable **23** connects the power generation equipment **20** (generator in this case) to the slip ring **25**, which is connected to the transformer **29** by an electrical cable **28**. The cart **22** has a cover **82** protecting the equipment from the environment and a brush **81** scraping the front face ring **14** (not shown in **FIGS. 14 and 15**) and the back face ring **62**. The cart **22** is mounted on a steel wheels **24**, the wheels being connected to a shaft **84** having a bearing **83**. Inner steel retention wheels **85** are used to prevent the cart **22** from tipping to the sides. The steel wheels **24** are rotate on the rail **26**.

[0054] **FIG. 16** shows a first tower section **86** having a top first section tower flange **43** that is fitted with bolts holes **44**. Several service station supports **87** are located on the inside of the first tower section **86**. The first tower section **87** is constructed from hollow steel and is fitted at the bottom with a flange **89** having bolt holes **88** to connect it to the next tower section.

[0055] **FIG. 17** shows a second tower section **90**. A top flange **89** is fitted with bolts holes **88** to connect the section to the first tower section **86** (not shown in **FIG. 17**). Several service station supports **87** are located on the inside of the second tower section **90**. The second tower section is constructed from hollow steel and is fitted at the bottom with a flange **92** having bolts holes **91** to connect it to the next tower section.

[0056] **FIG. 18** shows the third tower section **93**. A top flange **92** is fitted with bolts holes **91**. Several service station supports **87** are located on the inside of the third tower section **93**. The third tower section **93** is constructed of hollow steel and is fitted with a flange **95** having bolts holes **94** to connect it to the foundation flange **98** (see **FIG. 19**).

[0057] **FIGS. 19, 20**, and **21** show the third tower section **93** connected to the foundation flange **98** having steel support triangles **96** to prevent bending of the third tower section **93**. The foundation steel flange **98** is connected to a steel shaft **100** and steel rings **99** embedded into the reinforced concrete foundation **27**.

[0058] **FIG. 22** is shows the second option for the brake system by fitting calipers **104** actuated by a hydraulic cylinder **101** having a hinged mechanism **102** at the front ring side **14** and the back ring side **62** (not shown) to provide the required braking power to stop the wind turbine **2** from rotating. Hydraulic cylinders **101** are supplied with hydraulic fluid through hydraulic supply lines **103**, which are connected to the hydraulic supply **33**.

[0059] **FIG. 23** shows a rail cover **106** mounted on small wheels **107**. The small wheels **107** move on the rail **26** with the cart **22** to keep the rail **26** protected from the outside environment. A steel wheel cover **105** protects the steel cart wheels **24** from the outside environment. The steel wheel cover **105** can move up and down to allow access to service the cart steel wheels **24**. The same reference numerals are used in **FIG. 23** as those used in **FIG. 15** to refer to those components that are identical.

Operation and Controls

[0060] The wind turbine of the present invention has the capacity to collect and transmit power in the range of 50 kilowatts to 7.5 megawatts and has a low capital cost when compared to conventional power wind turbines rated in the same range. The wind turbine will rotate with relatively low rpm when compared to conventional wind turbines (rpm will depend on the number of blades, when using 20 blades the rotational speed is between 1 and 5 rpm). This low rotational speed will provide long service time for the rotating parts requiring less maintenance, produce less noise than conventional wind turbines, and the turbine has better control characteristics than conventional designs. The wind turbine of the present invention can be designed to compress air and to store that compressed air for use during peak hours for the electrical system. The number of compressors used depends on the power delivered by the wind turbine and the capacity of each compressor. Compressed air can be stored in underground storage pipes, tanks, caverns or in the body of the wind turbine tower. Heat exchangers can be used to extract the heat from the compressed air storage and re-provide the same heat for the compressed air later for the regeneration process.

[0061] The wind turbine of the present invention can be used to drive an air-water engine consisting of several cylinders. Air-water systems have been previously described. A Pelton wheel is preferably used with the air-water system to produce electricity as described in U.S. Pat. Nos. 6,672,054 and 6,718,761.

[0062] A single rotator can be designed to drive different types of energy production equipment. For example, a rotator could be alternatively connected to a pump, compressor and generator with a controller to control which type of energy producing equipment is being driven at any particular time. The wind turbine can be constructed to be strong enough to have the rotators contact one surface of the ring only. Also, the ring can be designed with projection and indentations thereon corresponding to projections and indentations on the rotators. The ring could also be designed in separate parts with the front surface located on a separate component from the back surface.

A control system for the wind turbine is as follows:

[0063] Operational sequence system.

[0064] The system will receive external signals according to the operating conditions, above all the wind conditions and operator's intentions, which will determine the set values for the control system.

[0065] Objectives of the operational sequence system are as follows:

[0066] 1—Ensure fully automatic operation.

[0067] 2—Recognize hazards and activate the corresponding safety systems.

[0068] 3—Meet special requirements of the operator.

[0069] Supervisory systems controls.

[0070] The system will take into consideration the following:

[0071] 1—Yaw motion.

[0072] 2—Speed and power output.

[0073] 3—Mode of operation.

The control system will take into consideration the following:

[0074] 1—Wind Measurement System:

[0075] Operational sequence and yawing requires measuring the wind speed and direction.

[0076] Electrical motor-driven yawing system is proposed for the multi blade wind turbine, which requires information about wind direction.

[0077] Operational sequence requires the wind speed information in order to switch between different modes of operation.

[0078] Measuring of the wind speed could be preformed indirectly by means of the electrical output. The rotor itself is the only representative wind measuring instrument of a turbine.

[0079] 2—Yaw Control:

[0080] The wind measuring system provides a mean value of the wind direction over a period of ten seconds. This value is compared with the instantaneous azimuth position of the nacelle every two seconds. If the deviation remains below 3 degrees, the yaw system will not be activated. If the determined yaw angle is above this value, the time for correction is determined by a pre-programmed function. An operating diagram for the yaw is shown in **FIG. 24**.

[0081] If the yaw angle is small (0 to 20 degrees), yawing is carried out within 60 seconds.

[0082] If the yaw angle is 20 to 50 degrees, yawing is carried out within 20 seconds.

[0083] If the yaw angle is large (exceeds 50 degrees), yawing is carried out immediately.

[0084] The rotor yaw speed is low and to be determined after taking into consideration the gyroscopic moments. Since the yaw speed is the same for small and large yaw movements of the turbine, large movements will take much longer to complete than small movements. For small movements, the commencement of yawing is delayed as the wind may change direction within the delay period. For large movements (exceeding 50 degrees), the yaw movement commences immediately.

[0085] 3—Power and Speed Control by Rotor Blade Pitching when using a Blade Pitching Mechanism:

[0086] The objective is to obtain a stable operating point by the following means:

[0087] a—Controlling the blade pitch, which will control the rotor's primary energy.

[0088] b—Control of the generator voltage and reactive power.

[0089] c—Loading and unloading of the generators.

[0090] Extremely brief fluctuations of less than few seconds are reduced by the rotor blades, friction ring, and actuating elements mass inertia. Combined speed and power control system is proposed for the control of the Multi Blade wind turbine.

[0091] 4—Mechanical Drive Train:

[0092] The inertia of the rotating masses including:

[0093] a—The Rotor.

[0094] b—The Friction ring.

[0095] c—The Rotator and shaft

[0096] d—The Generator Rotor.

[0097] The stiffnesses, the damping behavior, and vibration behavior are different than those of a conventional wind turbine as the power transmission system is unconventional using a friction drive and multi-generator system.

[0098] 5—Full and Partial Load Operation:

[0099] In full load operation the pitch control is active (when using a pitch mechanism), so that rotational speed and power can be adjusted to the nominal values. The speed controller can be provided with a degree of insensitivity to reduce the number of pitching processes.

[0100] When not using a pitch mechanism, the blades will be stall regulated. Hence, the angle of the blades will be high enough at high wind speeds to ensure stall to reduce the loads on the blades.

[0101] At partial load, control of the power output and rotor speed is carried out by variation of the generator torque and loading and unloading of the Tire-Generator mechanisms (if the mechanisms is not in contact with the friction ring all the time).

[0102] Using the MPPT (Maximum Point Power Tracking) process approach to control the rotor speed achieving the optimal rotor power coefficient. This is achieved by determining the set point for the power maximum by incremental speed variation, in the form of a scanning process.

[0103] Control System Actions:

[0104] 1—Acquisition of the input data necessary for operational sequence as wind speed and wind direction.

[0105] 2—Automatic operational sequence, with manual operation for special cases.

[0106] 3—Activation of the safety and emergency systems taldng into consideration shutdown of the rotor even with out electric control system.

[0107] 4—Adaptation to operation on the grid.

[0108] Operational Cycle:

[0109] Operational cycle includes the following:

[0110] System check at stand still: checking of the operational status of the most important systems. The rotor is arrested by the parking brake and pitch angle (when pitch mechanism is used). If no faults are indicated in the system check, the turbine is ready for further progress in the operational cycle.

[0111] Yawing: if the system check is positive, the yaw system is activated, the rotor still being parked. The turbine is yawed to the wind direction (turbine yawing includes moving the Rotor head and the Tire-Generator Mechanism Cart at the same time) and it is checked whether the wind speed is within the operating range of 4 to 25 m/sec.

[0112] Start up: pitching of the rotor blades into the starting position (when using a pitching mechanism), subsequently the mechanical rotor brake is released. The rotor stars to turn and accelerates up to the synchronization speed of the generator, corresponding to 90% of the nominal speed. Start loading of the Tire-Generator Mechanism (Tire-Generator mechanisms may be in contact with the friction ring all the time or may be loaded as the wind speed increase). The blade pitch angle is controlled according to a preset speed increase (when using a pitch mechanism).

[0113] Normal operation: if the generator's connection to the grid has been established the power output into the grid begins (cut-in wind speed). The turbine operates at partial load if the wind is below rated value. Under these conditions the pitch angle is set to a predetermined value (when using a pitch mechanism), which is the angle of the best compromise close to the optimum in the rotor power characteristics (variable blade pitch operation under partial load may be required). When operating at full load, the blade pitch is then controlled such that the rated power is not exceeded. When using a stall regulation as the state of pitch mechanism, the blades will stall to avoid overrating the wind turbine and this will ensure that the rated power is not exceeded.

[0114] Shut-down: if the wind speed drops below the cut-out wind speed or if loaded operation is to be interrupted, the rotor will be brought to the standstill. During the shutdown process the rotor blades are pitched in order to achieve a defined speed decrease (when using a pitch mechanism). The generators are taken off the grid, within the range of 92% to 90% of the rated speed. Rotor standstill is achieved by setting the speed set-point value to zero. The rotor blades pitch to an angle of approximately 80 degrees (when using a pitch mechanism). This brakes the rotor aerodynamically to a low idling speed. Complete standstill is achieved by applying the mechanical brake. When using stall to regulate the blades, the turbine is yawed out of the wind direction. This will reduce the rotor speed to idling speed. Complete standstill is achieved by applying the mechanical brake.

[0115] The method of operating the wind turbine to produce energy can vary. The turbine is preferably operated as a variable speed turbine and the controller is used to control the operation of the turbine in light of the wind conditions. The controller preferably continually monitors the wind conditions and when the conditions are sufficient to generate energy from the wind turbine, the controller automatically adjusts the yaw, orients the blades and when the blades are rotating at sufficient rpm, places the appropriate number of rotators with the appropriate pressure against the ring. In stronger wind conditions, the controller will place more rotators against the ring and in weaker wind conditions, the controller will remove some or all of the rotators from the ring. When wind conditions are not sufficient to generate energy, the controller will shut the turbine down by applying a mechanical brake to the turbine to stop the blades from rotating and also orienting the blades and adjusting the yaw of the turbine to reduce the effect of the wind. As the wind conditions improve, the controller will again release the brake, adjust the yaw and orient the blades to cause the blades to rotate at sufficient speed to generate energy. The controller will then place the rotators in varying numbers against the ring and remove rotators as required as the wind conditions continue to vary. The process will be repeated as the turbine continues to operate.

[0116] Numerous variations can be made to the invention within the scope of the attached claims. For example, the front and rear surfaces of the ring can have a plurality or alternating ridges and indentations thereon corresponding to alternating indentations and ridges on said rotators. The wind turbine has a controller that automatically controls the operation of the turbine.

We claim:

1. A wind turbine for producing energy comprises a rotor on a shaft, said rotor supporting a plurality of blades and being rotatably mounted on said shaft, said blades each having a tip, there being a plurality of tips on said turbine, said tips being connected to support a ring that extends around a circumference formed by said tips, said ring rotating with said blades, said ring having a front and rear surface with rotators mounted to removably contact said ring on said front and rear surfaces, each of said rotators being connected to energy producing equipment, said rotators rotating with said ring when said ring rotates, thereby driving said energy producing equipment, said turbine being controlled by a controller.

2. A wind turbine as claimed in claim 1 wherein said controller is connected to continuously monitor wind conditions and to control a yaw of the turbine, orientation of the blades, number of rotators in contact with said ring in response to changing wind conditions.

3. A wind turbine as claimed in any one of claims **1** or **2** wherein said turbine is a variable speed turbine.

4. A wind turbine as claimed in claim 1 wherein there are brakes that can be operated to stop or slow down a speed of rotation of said turbine.

5. A wind turbine as claimed in claim 1 wherein the number of blades ranges from substantially eight to substantially twenty.

6. A wind turbine as claimed in claim 1 wherein said rotators are at least one of tires, tires made of rubber, steel wheels and metal wheels.

7. A wind turbine as claimed in claim 1 wherein said front and rear surfaces have a plurality of projections and indentations thereon corresponding to indentations and projections respectively on said rotators.

8. A wind turbine as claimed in claim 7 wherein said tires are mounted to power a generator that produces electricity.

9. A wind turbine as claimed in claim 7 wherein said ridges and indentations on said rotators are mounted to drive a generator.

10. A wind turbine as claimed in claim 1 wherein the blades are constructed so that a longitudinal orientation of said blades can be adjusted to control a speed of rotation with varying wind conditions.

11. A wind turbine as claimed in claim 1 wherein said shaft is supported by a tower.

12. A wind turbine as claimed in claim 1 wherein said wind turbine is mounted on a turntable so that said turbine can be oriented in response to changes in wind direction.

13. A wind turbine as claimed in claim 12 wherein said turntable has wheels thereon.

14. A wind turbine as claimed in claim 13 wherein there is a rail mounted on a base and said wheels ride on said rail.

15. A wind turbine as claimed in claim 1 wherein said blades have an air foil construction.

16. A wind turbine as claimed in claim 14 wherein there are guides to guide said wheels on said rail.

17. A wind turbine as claimed in claim 16 wherein there are retention means to maintain said wheels on said rail.

18. A wind turbine as claimed in claim 14 wherein there are guides and retention means connected to said wheels beneath said rail to hold said wheels on said rail and prevent said wheels from running off said rails.

19. A wind turbine as claimed in claim 1 wherein said energy producing equipment is one or more selected from the group of generators, compressors and pumps.

20. A wind turbine as claimed in claim 11 wherein said blades, rotor, shaft, tower, rotators and energy producing equipment are mounted on a turntable to enable said turbine to be oriented to respond to changes in wind direction.

21. A method of operating a wind turbine based on conditions of said wind, said turbine having a rotor on a shaft, said rotor supporting a plurality of blades and being rotatably mounted on said shaft, said blade each having a tip, there being a plurality of tips on said turbine, said tips being connected to support a ring that extends around a circumference formed by said tips, said ring having a front and rear surface with rotators mounted to removably contact said ring on said front and rear surfaces, each of said rotators being connected to energy producing equipment, said rotators rotating with said ring when said ring rotates, thereby driving said energy producing equipment, said turbine having a controller, said method comprising operating said turbine to have said controller monitor wind conditions, said controller:

(a) when said wind conditions are sufficient to generate energy from said wind turbine;

(b) adjusting the yaw, orienting the blades, placing rotators in varying numbers against said ring or removing rotators from said ring to have said turbine generate energy; and

(c) when said wind conditions are not sufficient to generate energy, operating said turbine to stop said blades from rotating.

22. A method of operating a wind turbine for producing energy, said turbine having a rotor on a shaft, said rotor supporting a plurality of blades and being rotatably mounted on said shaft, said blades each having a tip, there being a plurality of tips on said turbine, said tips being connected to support a ring that extends around said tips, said ring rotating with said blades, said ring having a front and rear surface with rotators mounted to removably contact said ring on said front and rear surfaces, each of said rotators being connected to energy producing equipment, said rotators rotating with said ring when said ring rotates, said turbine being controlled by a controller, said method comprising operating said turbine by continuously monitoring wind conditions, adjusting yaw, blade orientation and pressure and number of rotators against said ring or removal of rotators from said ring to produce power output whenever said wind conditions are sufficient.

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