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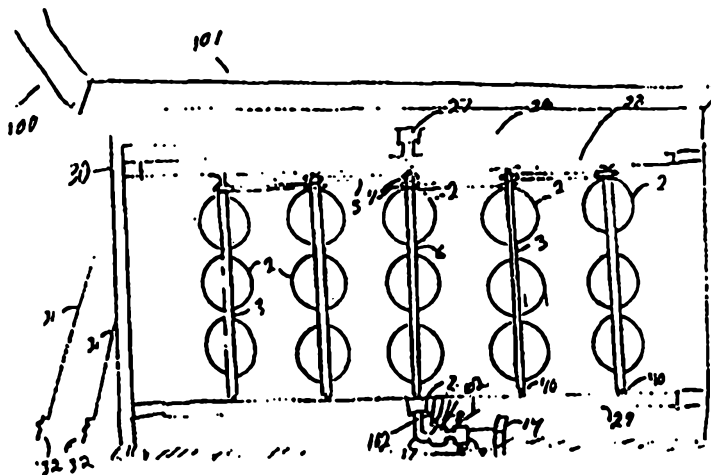
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<p>(21) International Application Number: PCT/US00/01133 (22) International Filing Date: 15 January 2000 (15.01.00)</p> <p>(30) Priority Data: 60/117,056 25 January 1999 (25.01.99) US 60/141,524 25 June 1999 (25.06.99) US 60/155,587 24 September 1999 (24.09.99) US 09/482,038 13 January 2000 (13.01.00) US</p> <p>(71)(72) Applicant and Inventor: RICKER, Jonathan, C. [US/US]; 11 Maple Avenue, Shrewsbury, MA 01545 (US).</p>	<p>(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>	

(54) Title: MULTIAXIS TURBINE

(57) Abstract

Multiaxis turbine with an external upper covering (101), a tower structure with a plurality of vertical elongated members (30) connected to each other with supporting horizontal elongated members (26), and a plurality of smaller blades (2) on a rotation member (6) connected to a tower structure with a plurality of rotation members (6). A preferred embodiment includes impact impellers connected to the rotation member (6) creating a swept area with a height to a diameter ratio of greater than four. A preferred embodiment includes the impact impellers connected to the rotation member (6) creating a swept area with a height to diameter ratio of greater than ten.

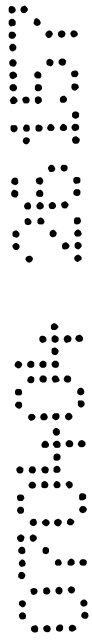
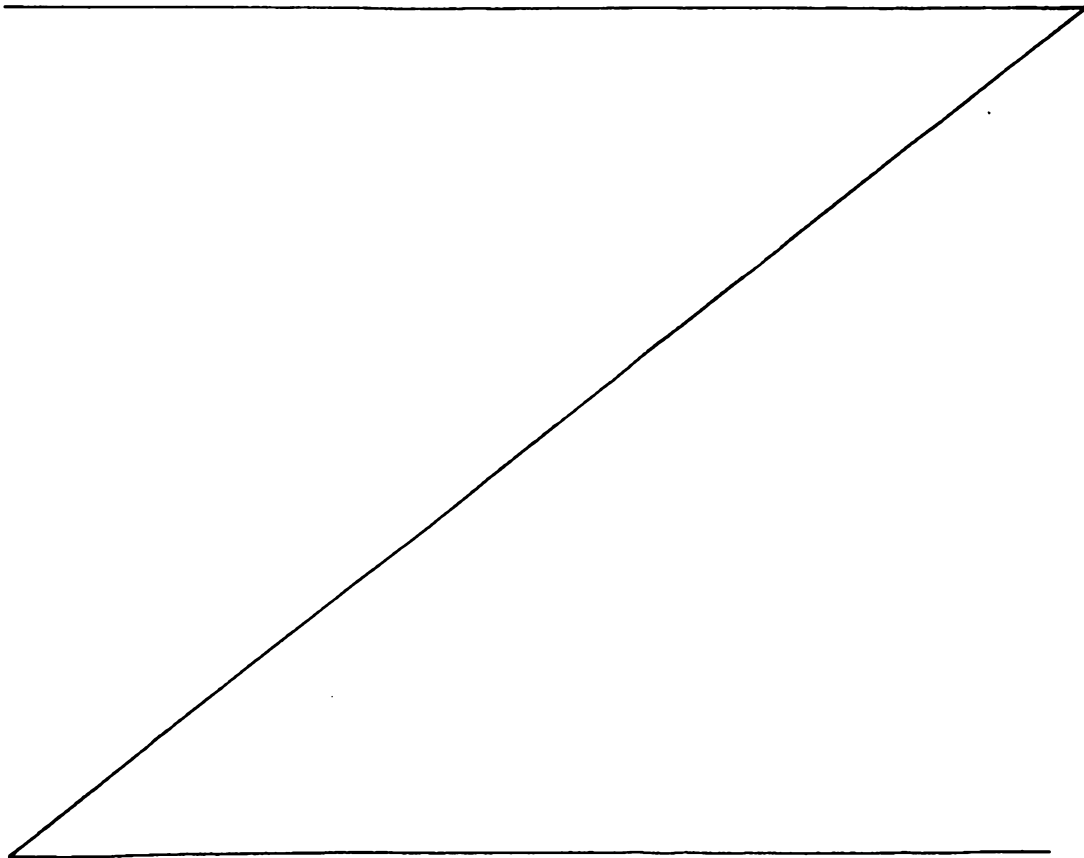


Multiaxis Turbine

Background of the Invention

This invention relates generally to the field of wind energy, and more particularly to vertical axis turbines and turbines with more than one axis or shaft.

Wind turbines utilize a rotor for converting the energy of the air stream into rotary mechanical power as a power conversion device from the wind. Wind machines can take advantage of a free and inexhaustible power source of mechanical power for various purposes including driving an electrical generator. Most wind turbines are the horizontal-axis wind turbine (HAWT). However, many wind turbines are known as vertical-axis turbines (VAWT). The blades of a VAWT are arranged vertically. VAWTs have design advantages including the generator being on the ground level for easier maintenance and avoiding the need to change the blade direction every time the wind changes direction. The most related wind turbines to the invention are the vertical axis turbines VAWT'



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including turbines using Darrieus related technology. Darrieus technology invented by D.J.M. Darrieus comprise of curved blades connected at two points along a rotatable tower. When the turbine rotates, the centrifugal forces are reduced with the blades already bulging outward in a shape known as troposkein before the rotor started spinning. The troposkein shape is similar to the shape a rope would take if it was spun around an axis. As a result, the troposkein shape minimizes stresses due to centrifugal forces. U.S. Patent number 1,835,018 has a more detailed information of the Darrieus turbine invented by D.J.M. Darrieus.

In generating large amounts of power, conventional turbines had large rotors in order to generate a sufficient amount of energy in order to make it worthwhile for having a generator in order to produce electricity. Unfortunately, the large rotors are expensive because the stress on the rotors increase dramatically as the diameter increases. Conventional turbines had to increase the diameter of the blades in order to capture more energy by increasing the area of moving air which are impacting on the blades. This increase in the diameter of blades for producing substantial power can increase the cost of other items in the turbine other than the blades. Large blades which have not been properly produced can create structural stress and fatigue problems for the gearbox, tower, and the system that turns the generator toward the optimal wind direction. In the past, wind turbines were supported by a single tower and guy wires in many cases leading to many vibration and frequency related problems. The blades of vertical axis turbines were large and could be limited in the design and the materials used. For example aluminum extrusion and fiberglass pultrusion were used in the two most serious commercial applications of vertical axis turbines. Due to the large size of the fiberglass blades, the strength was limited in order to bend the blade at the place of installation.

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The aluminum blades could not form a true troposkein shape. The blades had to be made of significant length and the available extrusion equipment is not available. The patents of both serious commercial prior applications of vertical axis technology are described in "Vertical Axis Wind Turbine" Patent number 4,449,053 and "Vertical Axis Wind Turbine with Pultruded Blades" in Patent number 5,499,904. However, the fatigue factor in blades using those materials suffered from structural stress caused by cyclical loads on vertical blades. The lift forces push the blades back and forth as they rotate. The more popular horizontal wind turbines are not subject to this cyclical stress occurring many thousand of times per day. The construction and installation was complex and costly.

The vertical blades in prior technology could not place the rotor high enough above the ground in order to avoid a turbulence leading to long term structural problems.

In other prior technology, the swept area of the turbine had an aspect ratio of less than four due to construction limitations. The aspect ratio, the swept area height to diameter, is preferred to be high for better efficiency. This occurs when a tall and thin rotor maintains a large swept area and a high RPM. As a result, the moment of inertia is reduced and less energy is spent on its own motion.

In prior blade technology, two or more blades per shaft section was used in order to achieve proper blade balance. The designing of one blade per shaft section was expensive and had imbalance problem in past turbines. A German Company attempted a horizontal one bladed turbine. However, it was not seriously commercialized.

Summary of the Invention

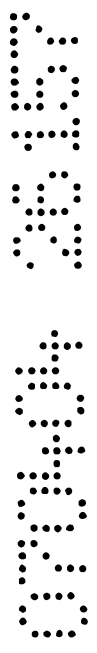
It is an object of the present invention to substantially overcome or at least ameliorate one or more of the aforementioned deficiencies of the prior art, or to at least provide the consumer with a useful or commercial choice.

Other objects and advantages of the present invention will become apparent from the following descriptions, taken in connection with the accompanying drawings, wherein, by way of illustration and example, an embodiment of the present invention is disclosed.

According to a first aspect of the present invention there is provided a multiaxis turbine comprising a tower structure supported on the ground. The tower structure comprises a plurality of vertical elongated structural members connected by a plurality of horizontal elongated structural members, the tower structure forming a box-like structure with at least two active sides. There are a plurality of vertical shafts located coextensively with the active sides of the tower structure, each shaft carrying a plurality of blades adapted to be rotated by the wind, so that the shafts are rotated by the wind, wherein each shaft is supported by a plurality of the horizontal structural members coupled to the shaft at spaced locations along the shaft, with one support location proximate the top of each shaft, one support location proximate the bottom of each shaft, and at least one support location intermediate the top and bottom support locations. There are also one or more electric generators located proximate the ground. Each shaft is connected to a generator, to generate electricity from the wind energy.

In such first aspect of the present invention, each shaft preferably comprises a plurality of shaft sections. Each shaft section preferably supports only one, or a pair of blades. Each shaft section is preferably supported at both ends by the tower structure. Preferably, the swept area of each shaft has a height to diameter ratio greater than four, and even more preferably, the swept area of each shaft has a height to diameter ratio of at least ten. The blades preferably have no twist or taper.

In such first aspect, the invention preferably further comprises a shaft bearing between the shaft and the tower horizontal structural member at each support location. Such first aspect of the invention preferably still further comprises a vibration



absorbing means between each bearing and the horizontal structural member. The vibration absorbing means preferably comprises a sleeve between each bearing and the horizontal structural member, in which the sleeve is not bonded to the bearing.

Such first aspect of the invention preferably further comprises control means to optimize the number of activated generators depending upon the wind velocity. Such first aspect of the invention preferably also further comprises means for coupling a plurality of shafts to a generator. Preferably, the means for coupling comprises a timing belt. The first aspect of the invention preferably still further comprises means for increasing air flow velocity proximate the blades, a roof member covering the tower to protect the shafts and blades from the elements, and springs between the tower and the ground.

According to a second aspect of the present invention there is provided a multi-axis turbine comprising a tower structure supported on the ground and comprising a plurality of vertical elongated structural members connected by a plurality of horizontal elongated structural members, the tower structure forming a box-like structure with at least two active sides. There are a plurality of shafts located coextensively with the active sides of the tower structure, each shaft carrying a plurality of blades adapted to be rotated by the wind, so that the shafts are rotated by the wind, wherein the swept area of each shaft has a height to diameter ratio of at least ten, wherein each shaft is supported by a plurality of the horizontal structural members coupled to the shaft at spaced locations along the shaft, with one support location proximate the top of each shaft, one support location proximate the bottom of each shaft, and at least one support location intermediate the top and bottom support locations, and wherein each support location comprises a shaft bearing and a vibration absorbing means between the bearing and the horizontal structural member, to decrease transmission of vibration between the shafts to the support structure. There are also one or more electric generators located proximate the ground, and means for connecting each shaft to a generator, to generate electricity from the wind energy.

The multi-axis turbine may comprise an external upper covering or roof, a tower structure comprising a plurality of vertical elongated members connected to each other with supporting horizontal elongated members like a large lattice tower section, and a plurality of smaller blades. The blades may be connected to a shaft or



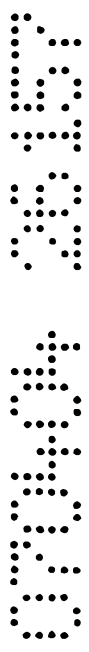
any other rotation means which is connected to a tower structure with a plurality of shafts. The blades or any form of impact impellers may be connected to the shaft or any rotation means creating an aspect ratio or a swept area with a height to diameter ratio of greater than four. Each shaft is preferably connected to a generator near the ground. The structure support for the blades or impact impellers and shafts or rotation means are preferably not individually supported in itself. The tower structure preferably supports the shafts collectively. The turbine may comprise vibration absorbing means or bushings between the bearings or moving parts and the support structure. The plurality of small blades with a simple design of no twist and taper are preferably connected to a plurality of generators with each generator connected to each shaft or rotation means of the turbine's plurality of shafts or rotation means. A blade or impact impeller at each section of the rotation means are preferably placed at different positions or angles along the axis for reducing torque ripple.

The multiaxis turbine described in the preceding paragraph was developed in order to simplify the cost of the blades by reducing their size and avoiding larger blades which require an expensive construction cost. Using many smaller blades is a more cost-effective approach than using a large and complex one toward a given power generation unit. The multiaxis turbine (MAT) has a different approach of positioning the blades for gathering the mechanical power and directing it toward the generator for producing electricity. The MAT also allows for repositioning other parts of wind turbines in order to reduce the complexity of constructing a wind turbine and reducing the impact of vibrations normally associated with wind turbines. The MAT comprises several axes each with a plurality of small vertical axis blades on each axis or shaft. The axes transfer its mechanical energy captured by the small blades preferably by belt and pulley system to an axis or shaft connected to the generator or a gearing device which in turn is connected to the generator. An advantage of the design is to reduce the cost of producing the turbine systems by allowing cheaper material using an inexpensive vibration protection with reinforcement of the structure or material for protecting the structure. The shape preferably of an airfoil can be added to the structure in order to increase the air velocity approaching the turbine which would result in greater power output. A roof comprising of any cost effective means including cheap plastic may be placed above the wind turbine structure



including any VAT system. The roof on this four legged tower structure may be curved into a shape which would increase the air velocity approaching a wind turbine unit preferably a MAT. Less vibrations and better protection would allow the use of cheaper material in the wind system. We can use cheap wooden and less treated elongated structures which is also easier to construct. We would also have the ability to use cheaper materials for other parts like the turbines and bearings as examples. An advantage of the roof is to prevent excess wear and tear from the rain and snow from falling onto the turbine system and causing rapid deterioration including warping and rotting.

The structure could be like a four legged table unlike a one legged table of other wind turbines. This is similar to the concept behind the lighter but stronger Rolm tower. Therefore it requires less material for the required stability. Although, the four legged tower would bring additional stability, the use of an off the shelf bushing of concentric sleeves with rubber, polyurethane or other isolator, absorber and/or damper securely bonded between them would isolate or dampen the vibrations of the moving blades from the steel structure. The bushings would preferably be placed between the shaft and bearings. The sleeve structure is designed to take up torsional movements as well as axial and radial loads. The design of not having one central blade area allows this "divide and conquer" approach of isolating the vibrations to occur in a cost-effective manner. The belting connecting the generator would isolate vibrations in the electrical area. More importantly, the less vibrations and a stronger tower structure would add years to the life of the turbine at a lower cost. At the same time, there would be a less troublesome belt and pulley system for the MAT or multiaxis turbine. The connection of the mini towers of the MAT would allow a structural reinforcement of the MAT and



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therefore allowing cheaper tower material.

The novel features which are considered characteristic for the invention are set forth in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of the specific embodiments when read and understood in connection with the accompanying drawings.

The drawings constitute a part of this specification and include exemplary embodiments to the invention, which may be embodied in various forms. It is to be understood that in some instances various aspects of the invention may be shown exaggerated or enlarged to facilitate an understanding of the invention.

Brief Description of the Drawings

FIG. 1 is the front view of the invention's Preferred Embodiment.

FIG. 2 is the side view of the invention's Preferred Embodiment.

FIG. 3 is a description of the preferred furling control system.

FIG. 4 is a fragmentary sectional view near the top area of the Preferred Embodiment.

FIG. 5 is a fragmentary sectional view near the generator

FIG 6 shows an alternative detail of the footprint version using savonius turbines

FIG 7 shows an alternative version of a Savonius turbine.

FIG.8 shows a structural sketch of the turbine and a top view of the Savonius blades.

FIG. 9 shows the use of two bearings with damper, absorber, or isolator for preventing misalignment

FIG. 10 shows the use of one bearing with vibration reducer.

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FIG. 11 and 12 shows vibration reducers between the blade and shaft.

FIG. 13 shows a side and top cut of the vibration reducer as well as a vibration reducer.

FIG. 14 shows a version a MAT using Darrieus blades.

FIG.15 shows an example of a two Darrieus blades on one section of a rotor shaft.

FIG.16 shows an example of one Darrieus blade per rotor shaft section.

FIG. 17 shows an example of four rotor shaft sections with two Darrieus blades per shaft section.

FIG.18 shows an example of four rotor sections with one Darrieus blade per shaft section.

FIG.19 show an alternative version of the frame structure.

FIG.20 shows a plurality of blades on one shaft inside a lattice tower.

FIG.21 shows an alternative version of the shaft mounting every 20 feet.

FIG.22 shows a version of the blade joints.

FIG. 23 is a front view of the blade joint.

FIG. 24 is a side view of the blade joint.

FIG. 25 is an illustration of the cage roof weather protection washer.

FIG.26 shows a side view of the bearing protection structure.

FIG.27 shows a front view of the bearing protection structure.

Detailed Description of the Preferred Embodiments

Detailed descriptions of the preferred embodiment are provided herein. It is to be understood, however, that the present invention may be embodied in various forms. Therefore, specific details disclosed herein are not to be

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interpreted as limiting, but rather as a basis for the claims and as a representative basis for teaching one skilled in the art to employ the present invention in virtually any appropriately detailed system, structure or manner.

In the preferred embodiment, a Multiaxis Turbine comprising a roof or an external upper covering (not shown) has a tower structure using a plurality of elongated member or steel square tubing 1104. The said members are connected to each other with supporting horizontal members or steel tubing 1104. The square tubing or horizontal elongated members are connected to the rotation means or shafts with a bearing. A plurality or several impact impellers also referred to as blades are connected to the shaft. The several blades are collectively are creating a swept area with a height greater than four times the diameter. The swept area the blades collectively along each shaft in the preferred embodiment has an aspect ratio or height to diameter ratio of about ten. Therefore, the blades provide a high aspect ratio. The tower structure allows the swept area per shaft to be very high. Each blade or impact impeller can be small and simple with no twist or taper. It also provides for individual generators for each shaft. Refer now to FIG.1 and FIG. 2, which are overall drawing of a preferred embodiment of the invention. A MAT 1 or virtual axes turbine is the preferred embodiment of the invention which incorporates interconnected blades 2 preferably vertical axis turbines like the Darrieus or Savonius version for the gathering of mechanical energy on impact as the blades 2 rotate. The blades can be replaceable and non durable unlike in other wind turbines. The loss of blades in damaging winds would not have a serious or an effect on the overall structure of the wind turbine. Rotor shaft 3 are connected to blades 2. As the blades 2 gather energy from the rotation, rotor shaft 3 rotate as a result. This transfer of

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mechanical energy continues toward other items connected to rotor shaft 3 as illustrated with pulley 4 or sheave connected with rotor shaft 3. Elongated structure 28 is connected to Pulley 4 which continues to carry this energy to belting 5. Elongated structure 29 is also connected with rotor shaft 3 by means 40. This linking interconnection continues to main shaft 6 which also preferably has blades 2 for gathering of mechanical energy. Main shaft 6 is also connected with elongated structure 28 which is further connected to bearing 27. Support elongated structure 26 above main shaft 6 area is connected to elongated structure 28 with bearing 27. With bearing 7 connected to elongated structure 26, the MAT can pivot into an optimal wind direction. Support elongated structure 26 is connected in a cantilevered manner to elongated structure 30 which is further supported to guy wire 31 and guy wire anchor 32. Main shaft 6 is preferably supported by bottom bearing 7 as main shaft 6 is connected to shaft speed increaser 8 and eventually to generator 9. The shaft speed increaser 8 increases the rotation of the main shaft 6 for the purpose of converting the mechanical energy into electrical energy by generator 9. The generator 9 output is controlled by control unit 14. In referring to FIG.2, as an overall side version of the preferred embodiment, the preferred directional vane means 10 is shown as a means of facing the MAT in an optimal wind direction. Furling system 11 is shown to block the wind like a normal household window shade in order to prevent excessive and damaging output by the generator. Referring to FIG. 3, the preferred Control unit 14 determines the optimal amount of wind blockage for the MAT by using a furling control shaft speed decreaser unit 15 preferably using a pulley and cable connected to a furling motor 18 for turning furling system pulley 12 which is connected to cable 13 and shade 19. Furling

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motor 18 also turns furling unit pulley 21 and furling unit cable 22 for determining the optimal shade 25 level for furling unit generator 24 or other electric power producing device like an alternator which is determined by the power output gathered by blades 23. Preferably, a normally open relay or diode at 12 volts would turn on furling motor 18 in the direction of lowering shade 19 and shade 25. A normally closed relay or diode at 10 volts would turn on the furling motor 18 in the direction of raising shade 19 and shade 25 when the relay or diode is opened at a rating below 10 volts. Variations of this description

could include a furling power generating unit 24 registering as a proportional output to the MAT generator 9 whereas any excessive output rating of generator 9 would turn on the furling motor 18 in the direction of lowering shade 19 and shade 25. When a similar means of registering output shows generator 9 as having an output below its rated output, then the furling motor 18 would turn in the direction of raising the shade. The gearing ratio for the speed decreasing unit 15 would be directly proportional to the height of the VAT and the height of the furling control unit 14. In other words, if the height of the VAT was 21 feet tall and the height of the furling control unit 14 was 3 feet tall, the speed decreasing ratio would be 7 to 1. For example, for every seven inches which the shade 19 is raised (or lowered), shade 25 is raised (or lowered) one inch. The percentage of power output of the furling unit generator 24 in comparison to the power output of generator 9 must be the same percentage of the wind exposed area not influenced by any shade 19 in the furling control unit 14 in comparison to the wind exposed area of the MAT

not influenced by any shade 25. Referring to FIG. 4, lightning protection 16 is placed on an elongated structure 26 connected to bearing 27 which is connected to elongated

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structure 28 further connected to pulley 4. Main shaft 6 is connected to pulley 4. In FIG. 5, an alternative version is shown. Pulley 4, belting 5, main shaft 6, speed increaser 8, and generator 9 are shown with a bevel gear 17.

In FIG. 1, 101 is a roof protecting the MAT. The roof could be aerodynamically curved like roof section 100, which can be detached from the MAT and the portion of the roof directly over it. The detachment allows a cheaper built roof section structure which would not be subject to the vibrations of the spinning turbines. In FIG 2, vane 10 could be plywood in a stationary version for added structural support with plywood on the roof 101. The vane (wall) 10 would be parallel to the prevailing wind. Preferably, wall 10 would be shorter than the structure area where the prevailing wind would travel. Heat removal ventilators could be used which could create a vacuum effect along the shaft of turbines for the purpose of accelerating airflow. Adding baffle walls along the side of the MAT or to the roof as a form of windspeed accelerator could be added.

Fins 102 could be added to the generator 9 and gearbox 8 as a heat sink which would allow cooling from the natural airflow of the wind which would result in the ability to produce higher kilowatt output than rated output. The increased ventilation would be possible due to the increased weather protection with the invention. A structure to augment airflow could be also be placed around a gearbox and generator for faster cooling resulting in the ability to produce higher kilowatt output. The heat sinks or augmentors used for cooling the heat producing devices could pivot toward the optimal windflow needed for the best cooling methods.

In addition to the protection methods mentioned, the bearing 104 which connects to shaft 105 can be protected by using a structure 102 shown in fig Y and fig Z. Barrels 100

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can have a circular extension 102 for protecting the area from dirt and dust. A narrow tube 103 which protects the bearing can extend to the bottom of barrel 100 and the top of barrel 106 as a reinforcement of the protection

In FIG.6, the blades 701 (preferably 100 to 300RPM) gathering energy from the wind are connected to the 2 foot rotor shafts 702 supported by a pillar box roller bearing 703. A flange at each end of the set of six 55 gallon plastic drum blades would connect to the rotor shaft. The drum ends being cut in half and positioned may be supported by a flat plastic plywood -shaped structure in between each drum. The pillar box bearing housing would connect to steel tubing 704 with a vibration absorbing pad 705 in between the steel tubing and bearing housing. The vibration absorbing pad could be isolator mounts or any means to dampen the forces from the rotating blades. In this design, the vibration absorbing areas around the bearings and the gearbelt would not only separate the wear and tear forces of the blades with the rest of the system but allow a flexibility to limit the structural stress on the blades themselves. There would be 4 (2 foot) shafts connecting barrels at each row comprising of 2 sets of 6 drums in each set. The barrels could be made of lightweight material comprising of strong foam and preferably a high-density polyethylene to cover the foam in order to withstand the harsh environment of frequent sandstorms. The thermoformed polyethylene could be ultraviolet resistant or low density. The steel tubing could be connected and supported by 14 guy wires and 8 guy wire anchors. The guy wire radius would be at least 80% of the tower height. There could be 2 guy wires leading into one foundation on each of the two narrow sides. There would also be 6 guy wires leading into the 3 foundations on each of the two wide sides. The guy wires could comprise of extra-strength stranded-steel cable. The shaft is connected to a shaft speed increaser timing belt

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and pulley or gearbox 706 and eventually to generator 707. The gearbox increases the rotation of the shaft for the purpose of converting the mechanical energy into electrical energy by generator. A control unit controls the generator output. In FIG 7, an alternative sharp-edged version of a savonius turbine blade is shown. A side view and top view is illustrated. It allows for less expensive material to be used like corrugated plastic. In FIG. 8, the structure could be like a four legged table unlike a one legged table of other wind turbines. This is similar to the concept behind the lighter but stronger Rolm tower. Therefore it requires less material for the required stability. Although, the four legged tower would bring additional stability, the use of an off the shelf bushing of concentric sleeves with rubber, polyurethane or other isolator, absorber and /or damper securely bonded between them would isolate or dampen the vibrations of the moving blades from the steel structure. The bushings would be placed between the shaft and bearings. The sleeve structure is designed to take up torsional movements as well as axial and radial loads. The design of not having one central blade area allows this "divide and conquer" approach of isolating the vibrations to occur in a cost-effective manner. The belting connecting the generator would isolate vibrations in the electrical area.

An object of this invention is preventing excess wear and tear from the rain and snow from falling onto the turbine system and causing rapid deterioration including warping and rotting. More importantly, the reduced vibrations and a stronger tower structure would add years to the life of the turbine at a lower cost. At the same time, the ability to have a less troublesome belt and pulley system for the MAT is another advantage and object of this structure.

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Other details include:

- 1) Using the same steel structure for cost savings purposes, the rows of turbines could be a few feet back or forward as not to interfere with the steel structure if a continuous set of blades needing only 2 bearings (one on the top and one on the bottom) is needed for cost savings or engineering purposes. A bearing and shafting every 20 feet would be avoided.
- 2) Place the MAT on 50-foot supports and add guy wires and cable. Springs near the footings could be helpful toward absorbing vibrations.
- 3) Use (square or round) flanges as steel connectors similar to pipe connectors in order to accelerate the construction process and reduce the cost of labor on the steel structure. The flanges may or may not be screwed on like many round pipes.
- 4) Use of the Windside turbine as blades. Windside has been known in Europe since 1979
- 5) Use of vibration absorbers 42 for dampening in areas shown in **FIG. 11** and **FIG. 12**. The vibration absorbers comprise of two concentric sleeves with rubber securely bonded between them. The inner sleeve could be bonded to the shaft and the outer sleeve could be bonded the blade as shown in **FIG. 11** and **FIG. 12**. An inner sleeve near the shaft of the vibration absorber may not be fastened to any nearby object including the absorber. The purpose is to increase flexibility of the vibration absorber and to reduce friction even further.
- 6) In **FIG. 9** and **FIG. 10**, the vibration absorbing devices 41 are in the bearing area whereas vibration absorbers comprise of two concentric sleeves with rubber securely bonded between them. The inner sleeve could be bonded to the shaft and the outer sleeve could be bonded to the inner part of the bearing. The side view of 41 and 42 are shown

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in FIG 13. An inner sleeve near the shaft of the vibration absorber may not be fastened to any nearby object including the absorber. The purpose is to increase flexibility of the vibration absorber and to reduce friction even further.

7) Rubber or another flexible substance could be mixed in with the foam or plastic in the blade material in order to increase the durability of the blades.

8) The Steel structure may comprise of wood or other less expensive items in areas whereas the more expensive steel can be substituted without compromising the structural integrity.

We can also add augmentors or diffusers to the MAT parallel to the length of the blades especially in areas where the windspeed in from one or two directions. A tail away from the augmentor could avoid structural problem related to excess vibrations.

The use of two flange bearings 41 as shown in FIG. 9 and FIG. 12 connected to a steel flat piece which in turn is bolted or welded to the steel structure could less or eliminate the chances of misalignment during mass production.

One of the features of the invention is a wind turbine structure shown in FIG.14 comprising of a 130-foot high fabricated steel rectangular frame of 80 feet in length and 40 feet wide. The frame is attached to six footings at the ground level. The structure has 16 long shafts of 3 inches in diameter with 16 sets of blades on each shaft.

The 256 sets of blades 1101 (900 RPM) gathering energy from the wind are connected to the rotor shafts 1102 supported by pillar box bearings 1103 attached to the supporting structure frame. There are 4 sets of 5-foot diameter blades in between each bearing and structure support beam. Each set of pillar box bearing housings would connect to a steel plate attached to the steel square tubing 1104 at every 20 foot length of the shaft. The 130-foot shaft is connected on the

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ground level to a shaft speed increasing **timing belt and pulley 1105** or gearbox and eventually to **generator 1106**. There could be a plurality of timing belts connecting the generator in order to optimize the number of generators to be activated for the determined wind velocity or air flow. The weight of each shaft and the blades on it is supported by a **beefy tapered roller bearing 1107** on the ground level. The generator and gearing areas of each shaft is protected by a **cage 1108** for safety reasons with a **cage roof 1109** to protect the generator and gearing parts. The gearing increases the rotation of the shaft (2 or 3 times) for the purpose of converting the mechanical energy into electrical energy by generator. A **control unit 1110** coordinates the generator output with the utility grid. The (induction) generator has a RPM of 1800. The steel structure is supported by 4 sets of **guy wires 1111** on each side.

Shown in **FIG.15** is a typical 2 bladed Darrieus turbine set of blades at each shaft section. The blades **1101** are connected to shaft **1102**. In **FIG.16**, each two blade set shown in **FIG.15** is perpendicular to the blade next to it on the shaft axis in order to reduce mechanical stresses. A **pillar box bearing 1103** is at both ends of the shaft **1102** with blades **1101** connected to shaft **1102**.

Shown in **FIG.17** is a one bladed Darrieus turbine set of blades at each shaft section. The blade **1101** are connected to shaft **1102**. In **FIG.18**, each one bladed blade set shown in **FIG.17** is at a different angle along the axis to the blade for reducing torque ripple next to it on the shaft axis in order to reduce mechanical stresses. A **pillar box bearing 1103** is at both ends of the shaft **1102** with blades **1101** connected to shaft **1102**. The one larger blade allows for the same solidity and efficiency while taking advantage of one larger blade for added strength.

Illustrated in **FIG. 19** is the current preferred embodiment of smaller and thinner steel tubing and an alternative version comprising of bigger and fewer steel supports. Steel tubing connectors could be an improved method used for easier and faster construction. The use of pipe fittings

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could accelerate construction and reduce cost. The frame or structure could be built in an assembly line approach in pieces and put together on the ground at the location. Then, it could be raised for connection.

In FIG.20, a single shaft showing a plurality of blades is illustrated and placed inside a lattice tower.

It is a feature of the invention to have a shaft mounting plate 1120 connected to the frame structure as shown in FIG.21. Two pillar box bearings 1103 are shown to be placed near each other or about one foot in the preferred embodiment in order to reinforce the alignment of the shaft. The Shaft mounting plate with two bearings are place on a horizontal elongated structure every 20 feet or a similar distance in the preferred embodiment.

An added feature of the invention is the blade joints shown in FIG. 22 A blade 1101 is connected to a bracket 1130 which is welded to shaft 1102. In FIG. 23 a mass production front view is illustrated using a bolt -like clamp on an identical bolt-like clamp on the other side of the shaft. In FIG. 24 side view the clamp connected the the blade 1101 and shaft 1102 is given.

In FIG. 25, a top view of a cage roof with a weather protection washer connected to the shaft is shown. Shaft 1152 is connected to the washer showing outer diameter 1150 of the washer and edge 1152 of the hole in the cage roof below the weather washer.

The turbine may include air flow acceleration devices like augmentors or have a larger structure wherein the prevailing wind positions are not prevalent.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of construction differing from the type described above.

While the invention has been illustrated and described as embodied in a virtual axes turbine, it is not intended to be limited to the details shown, since it will be understood

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that various omissions, modifications, substitutions and changes in the forms and details illustrated and in its operation can be made by those skilled in the art without departing in any way from the spirit of the present invention.

The foregoing description of the preferred embodiment of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in the light of the above teaching. It is intended that the scope of the invention be limited not by this detailed description, but rather by the claims appended hereto.

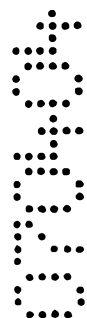
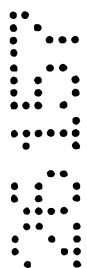
Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of the invention.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

While the invention has been described in connection with a preferred embodiment, it is not intended to limit the scope of the invention to the particular form set forth, but on the contrary, it is intended to cover such alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A multiaxis turbine, comprising:
 - a tower structure supported on the ground and comprising a plurality of vertical elongated structural members connected by a plurality of horizontal elongated structural members, the tower structure forming a box-like structure with at least two active sides;
 - a plurality of vertical shafts located coextensively with the active sides of the tower structure, each shaft carrying a plurality of blades adapted to be rotated by the wind, so that the shafts are rotated by the wind;
 - wherein each shaft is supported by a plurality of the horizontal structural members coupled to the shaft at spaced locations along the shaft, with one support location proximate the top of each shaft, one support location proximate the bottom of each shaft, and at least one support location intermediate the top and bottom support locations;
 - one or more electric generators located proximate the ground; and
 - means for connecting each shaft to a generator, to generate electricity from the wind energy.
2. The multiaxis turbine of claim 1, wherein each shaft comprises a plurality of shaft sections.
3. The multiaxis turbine of claim 2, wherein each shaft section supports only one, or a pair of blades.
4. The multiaxis turbine of claim 2, wherein each shaft section is supported at both ends by the tower structure.
5. The multiaxis turbine of claim 1, wherein the swept area of each shaft has a height to diameter ratio greater than four.
6. The multiaxis turbine of claim 5, wherein the swept area of each shaft has a height to diameter ratio of at least ten.



7. The multiaxis turbine of claim 1, wherein the blades have no twist or taper.
8. The multiaxis turbine of claim 1, further comprising a shaft bearing between the shaft and the tower horizontal structural member at each support location.
9. The multiaxis turbine of claim 8, further comprising a vibration absorbing means between each bearing and the horizontal structural member.
10. The multiaxis turbine of claim 9, wherein the vibration absorbing means comprises a sleeve between each bearing and the horizontal structural member.
11. The multiaxis turbine of claim 10, wherein the sleeve is not bonded to the bearing.
12. The multiaxis turbine of claim 1, further including control means to optimize the number of activated generators depending upon the wind velocity.
13. The multiaxis turbine of claim 1, further including means for coupling a plurality of shafts to a generator.
14. The multiaxis turbine of claim 13, wherein the means for coupling comprises a timing belt.
15. The multiaxis turbine of claim 1, further including means for increasing air flow velocity proximate the blades.
16. The multiaxis turbine of claim 1, further including a roof member covering the tower, to protect the shafts and blades from the elements.
17. The multiaxis turbine of claim 1, further including springs between the tower and the ground.



18. A multiaxis turbine, comprising:

a tower structure supported on the ground and comprising a plurality of vertical elongated structural members connected by a plurality of horizontal elongated structural members, the tower structure forming a box-like structure with at least two active sides;

a plurality of shafts located coextensively with the active sides of the tower structure, each shaft carrying a plurality of blades adapted to be rotated by the wind, so that the shafts are rotated by the wind, wherein the swept area of each shaft has a height to diameter ratio of at least ten;

wherein each shaft is supported by a plurality of the horizontal structural members coupled to the shaft at spaced locations along the shaft, with one support location proximate the top of each shaft, one support location proximate the bottom of each shaft, and at least one support location intermediate the top and bottom support locations; and

wherein each support location comprises a shaft bearing and a vibration absorbing means between the bearing and the horizontal structural member, to decrease transmission of vibration between the shafts to the support structure;

one or more electric generators located proximate the ground; and

means for connecting each shaft to a generator, to generate electricity from the wind energy.

DATED this 7th day of April 2004

Jonathon C. Ricker

By his Patent Attorneys

CULLEN & CO.



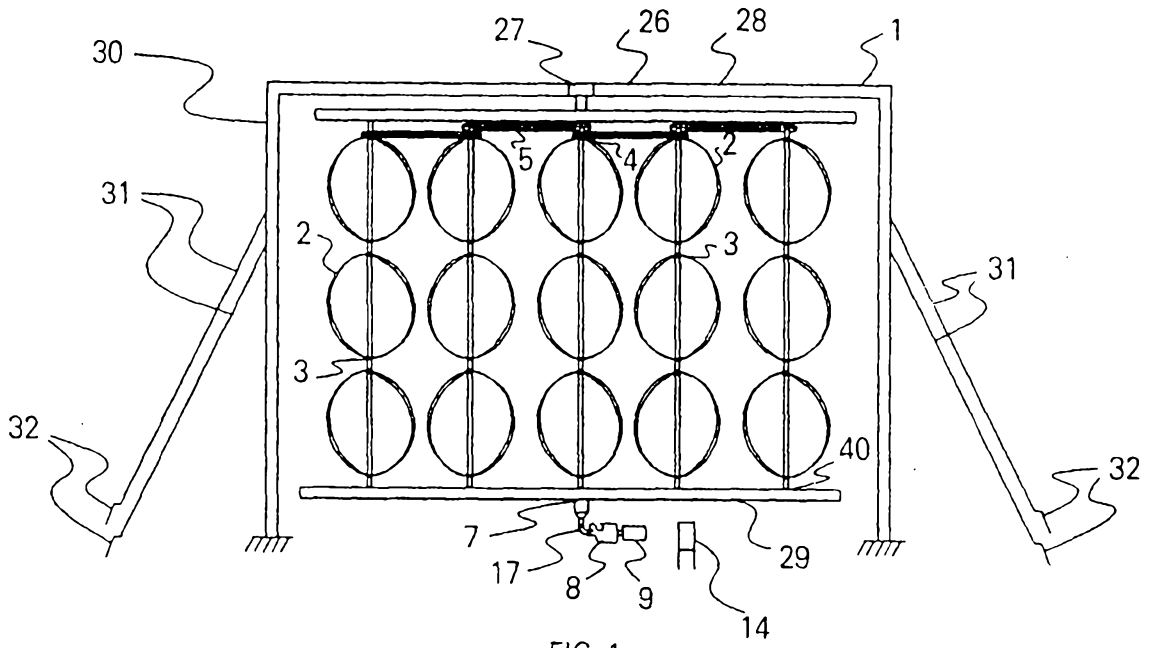


FIG. 1

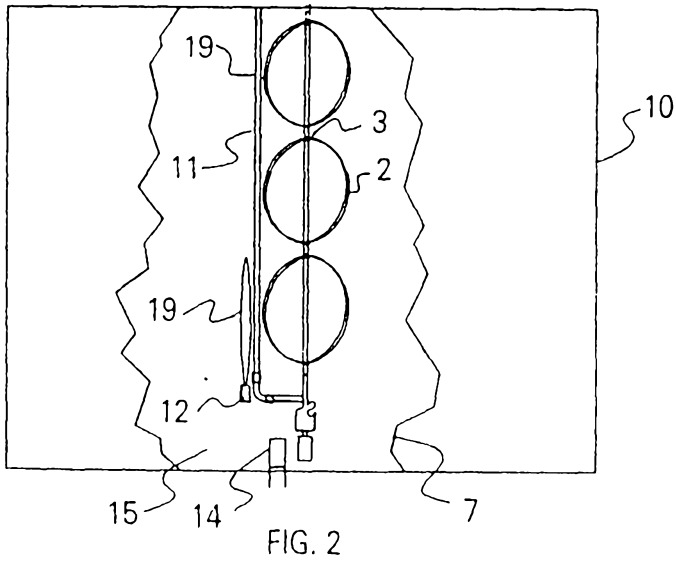


FIG. 2

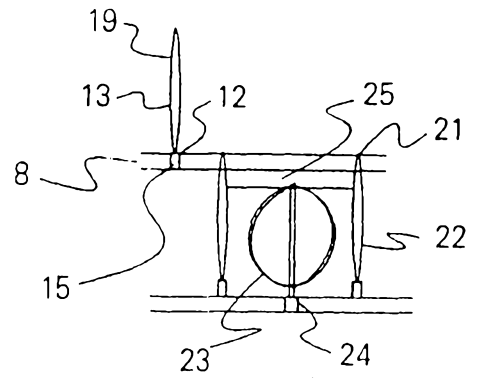
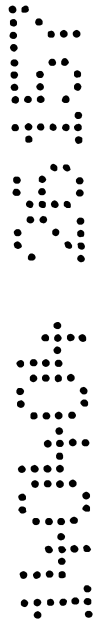


FIG. 3



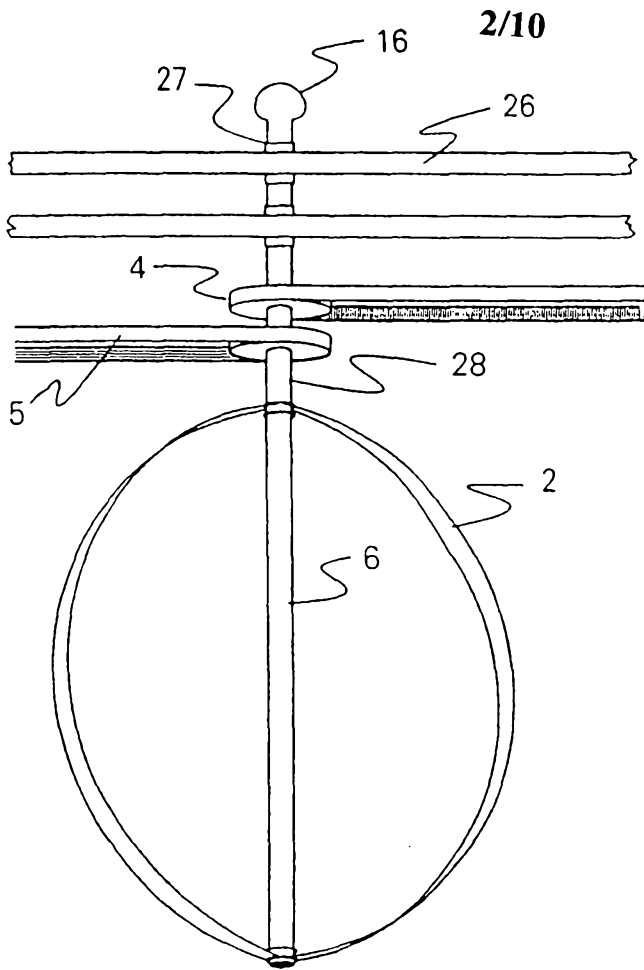


FIG. 4

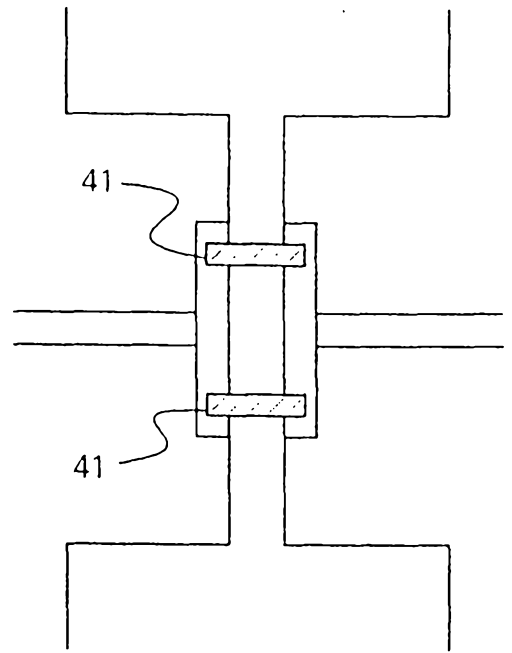


FIG. 9

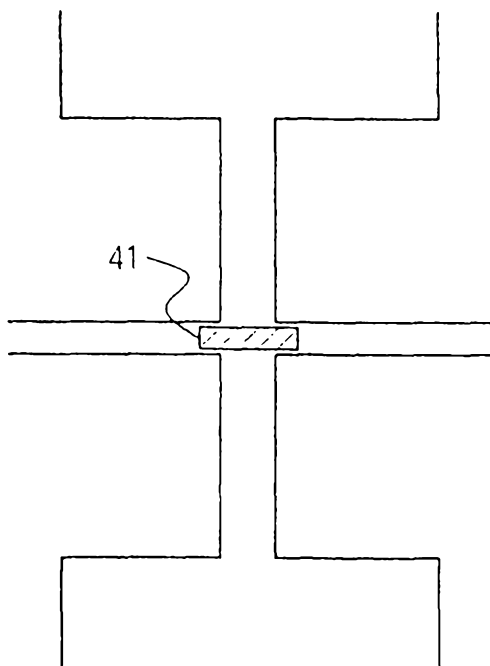


FIG. 10

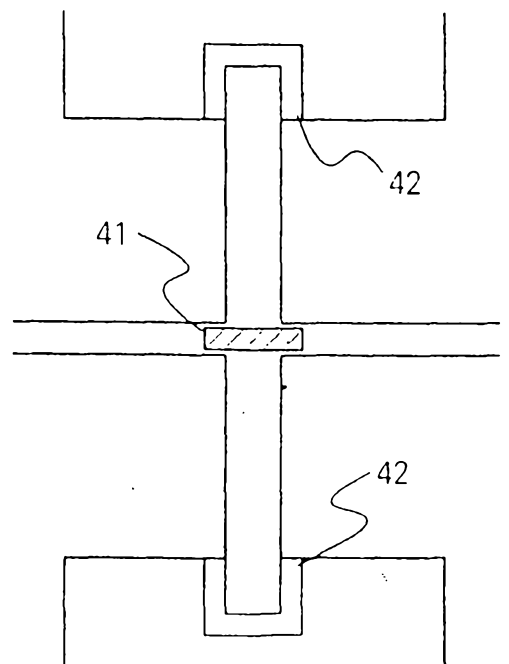


FIG. 11



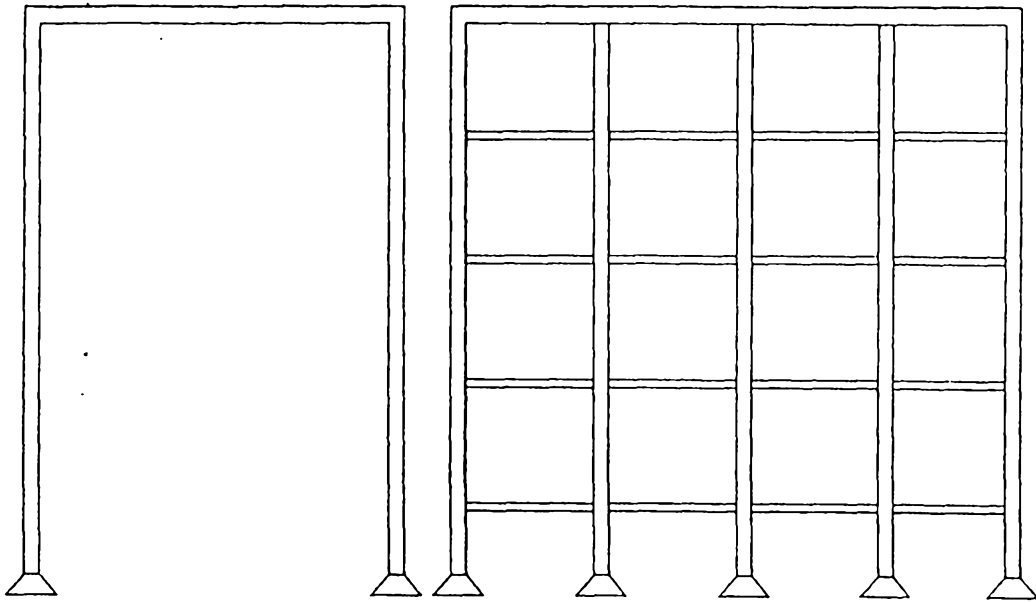


FIG. 19

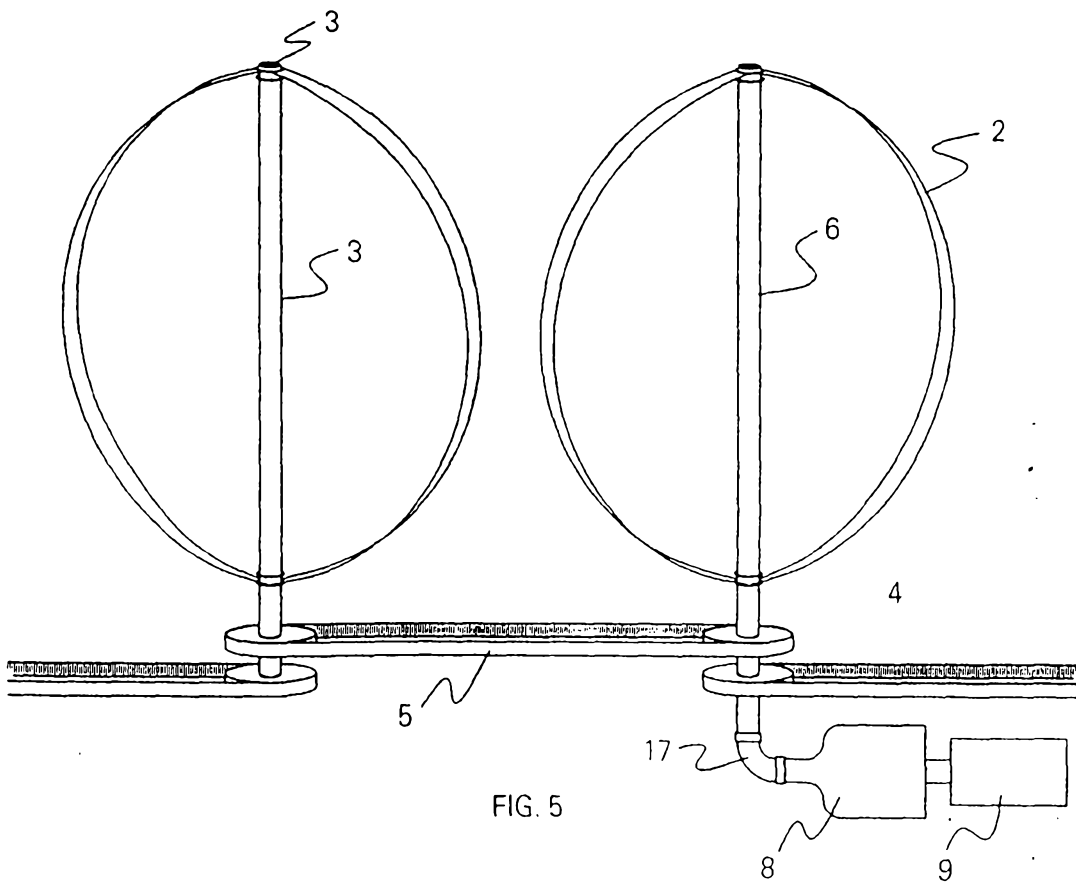


FIG. 5



FIG. 6

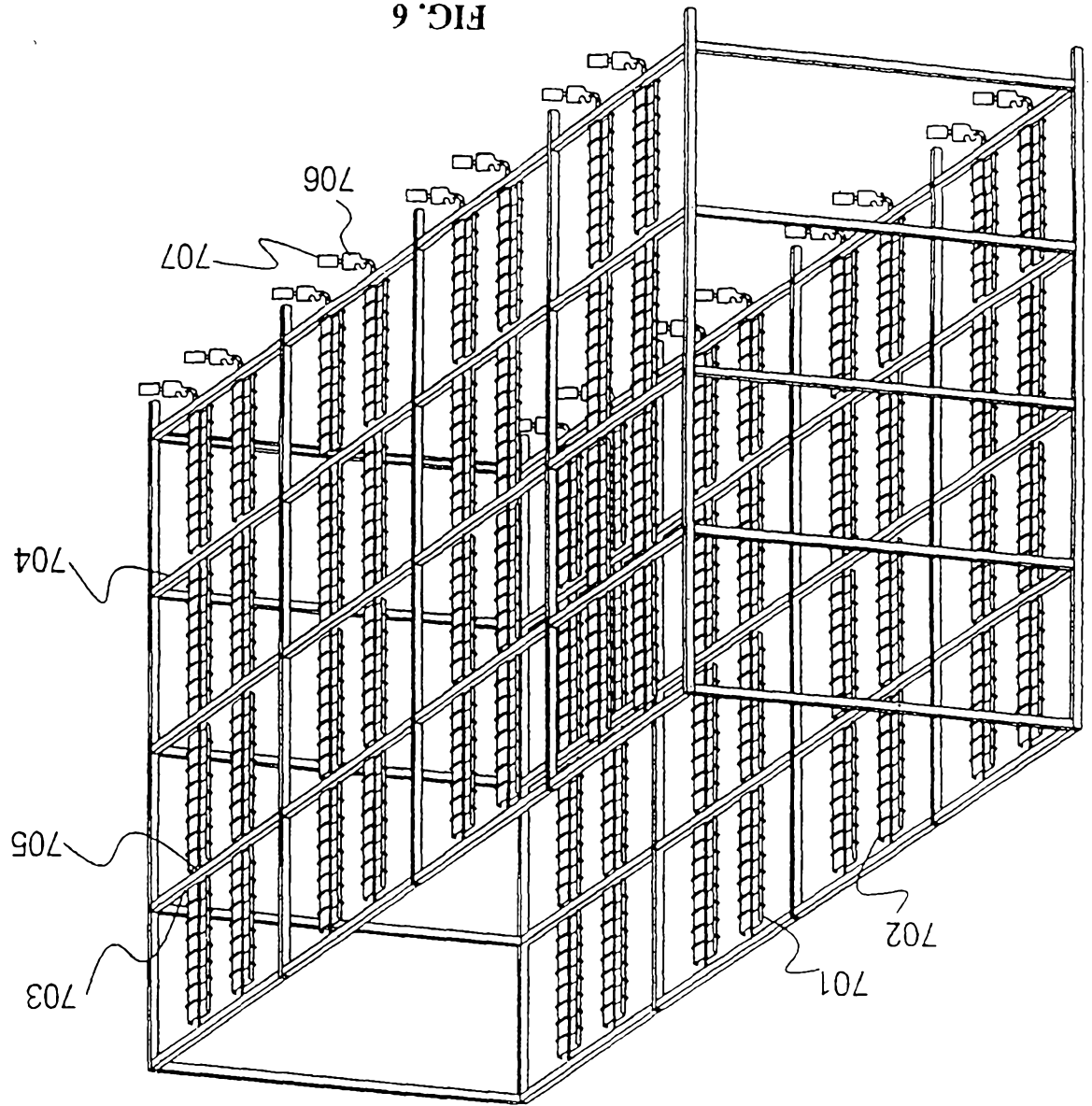


FIG. 6

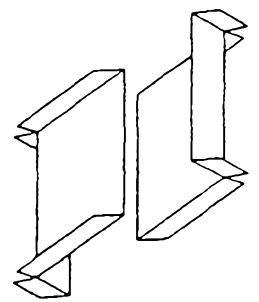


FIG. 7

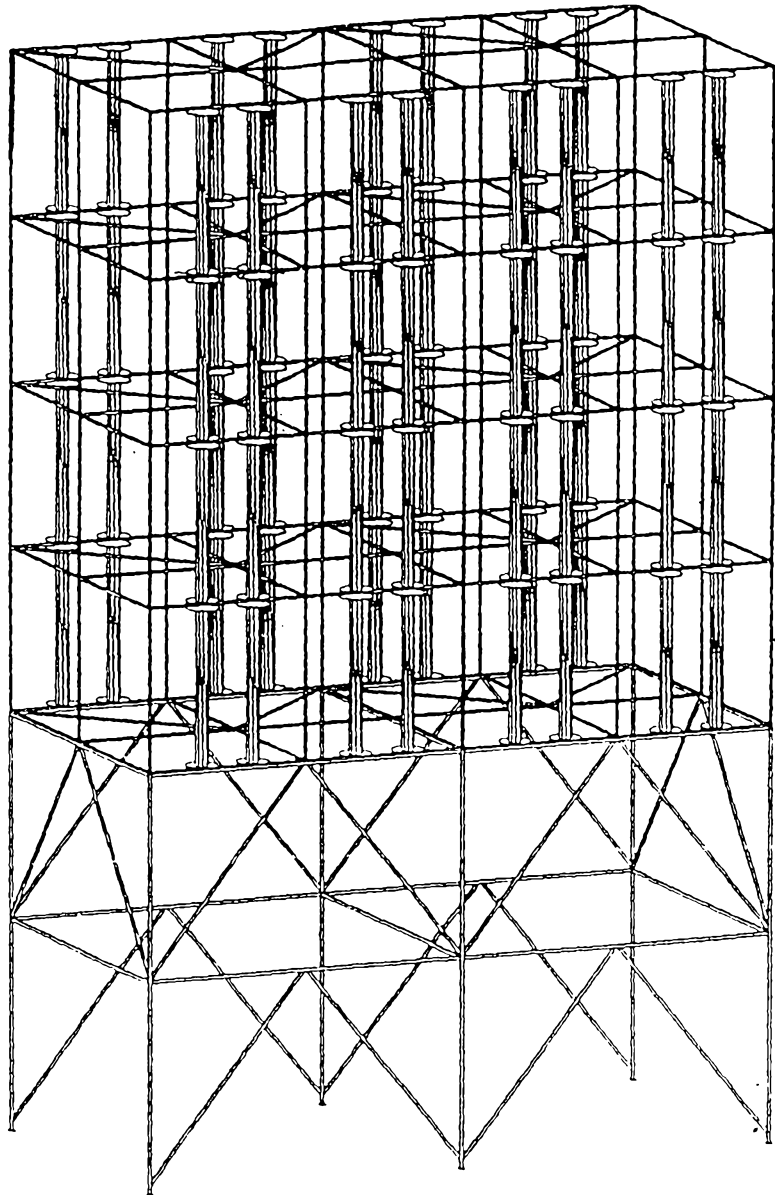
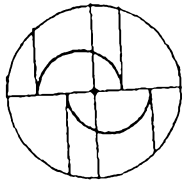


FIG. 8

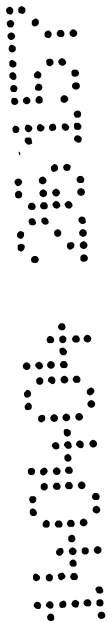
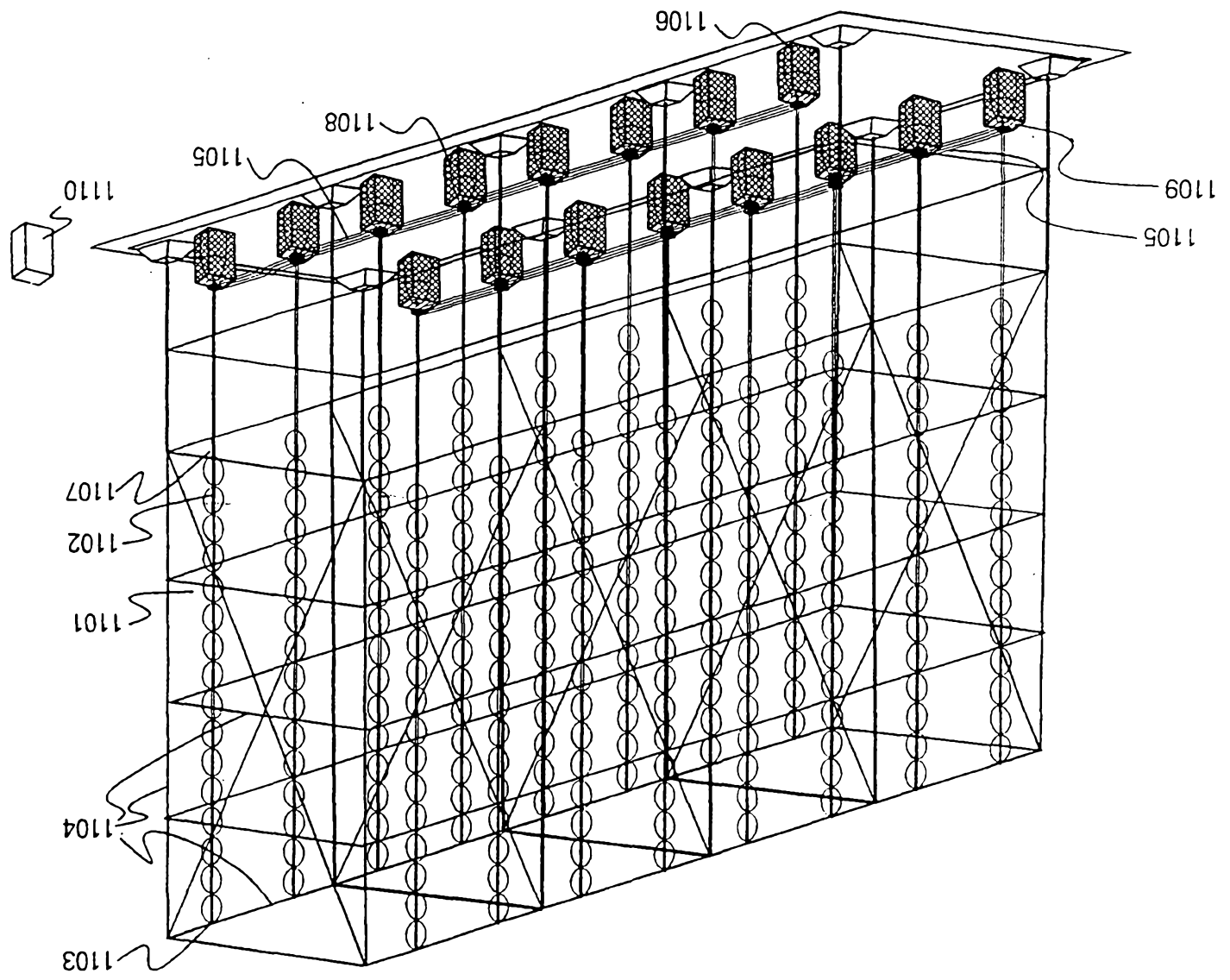


FIG. 14



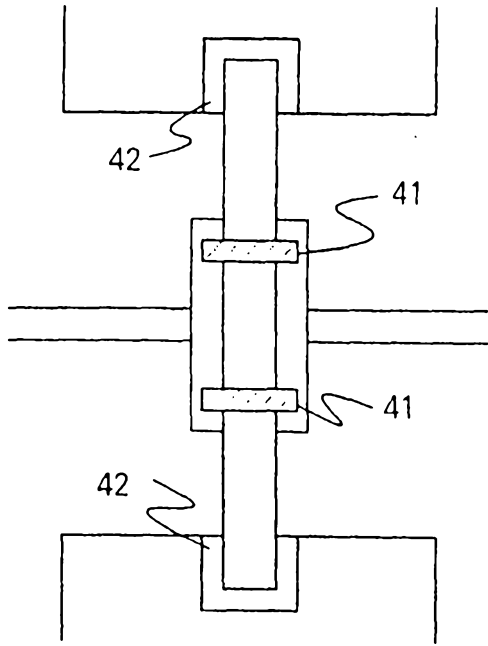


FIG. 12

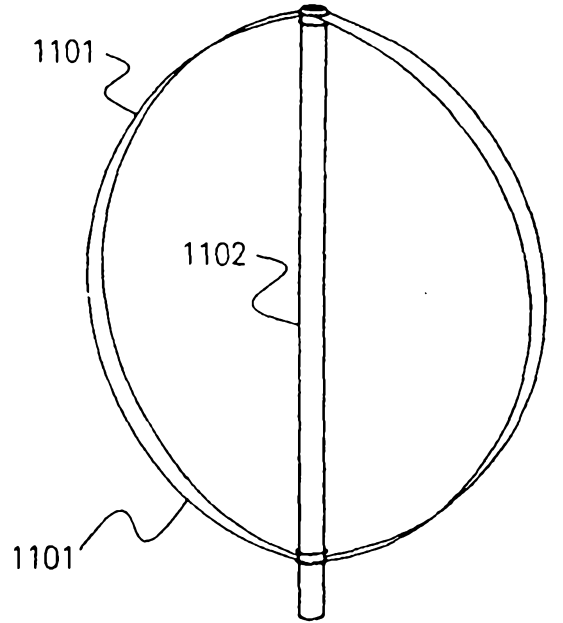


FIG. 15

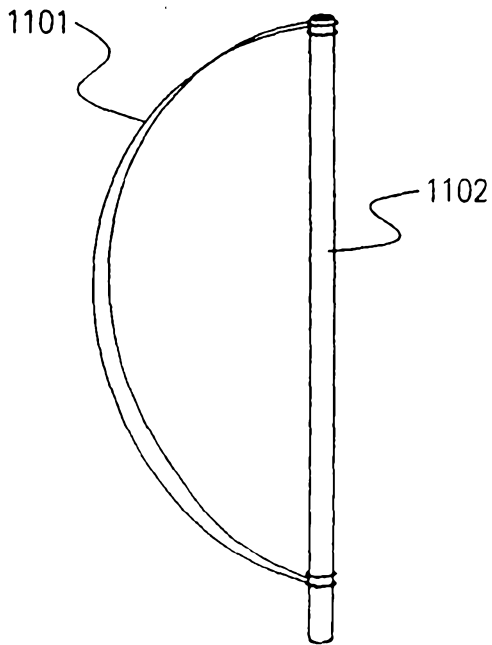


FIG. 16

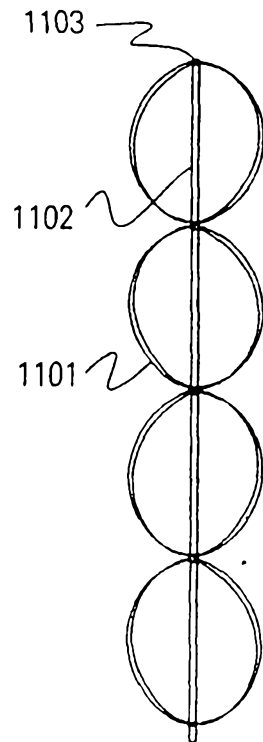


FIG. 17



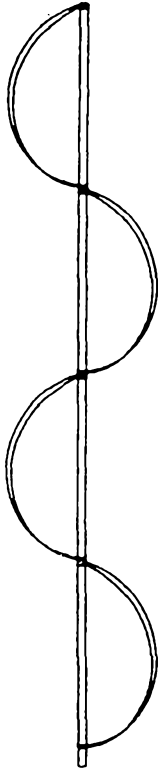


FIG. 18

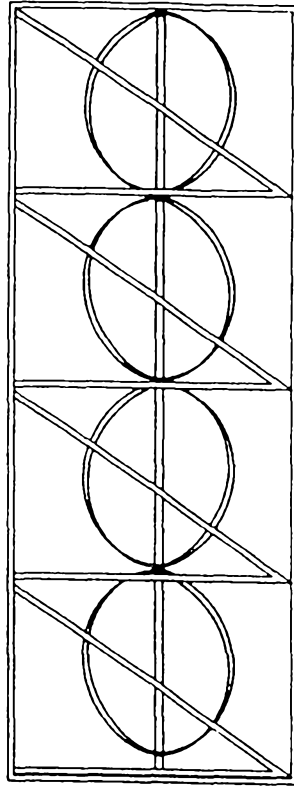


FIG. 20

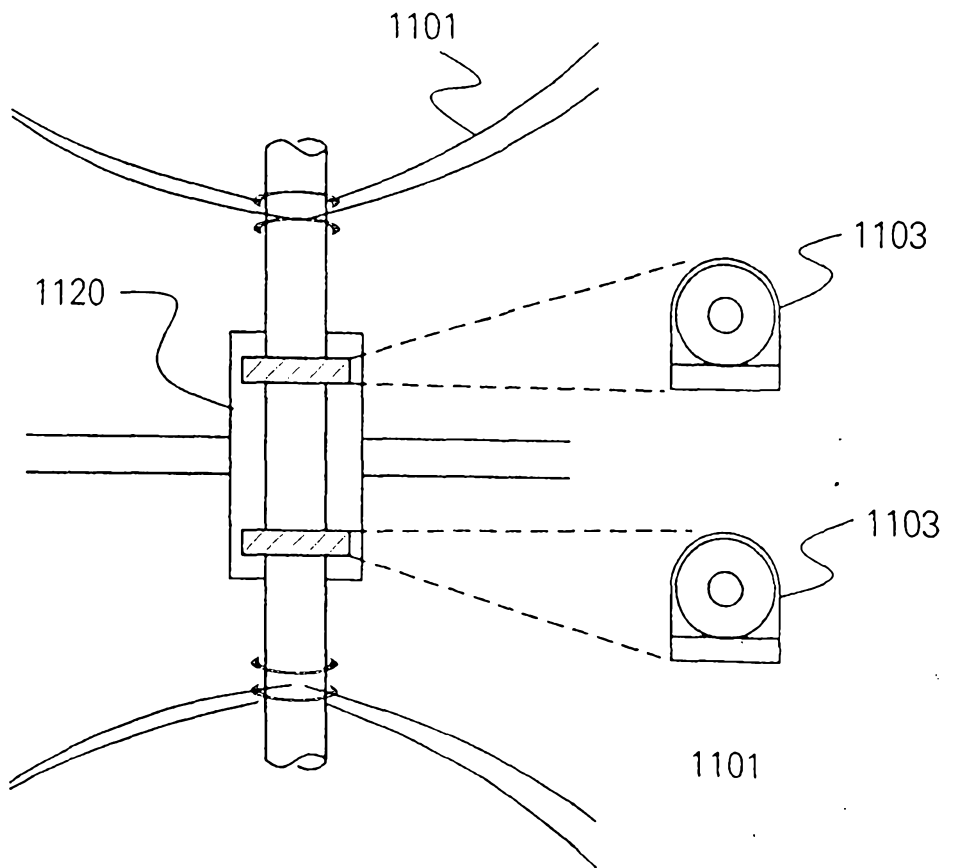


FIG. 21



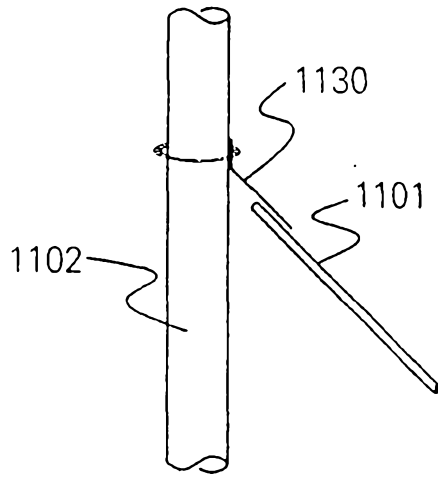


FIG. 22

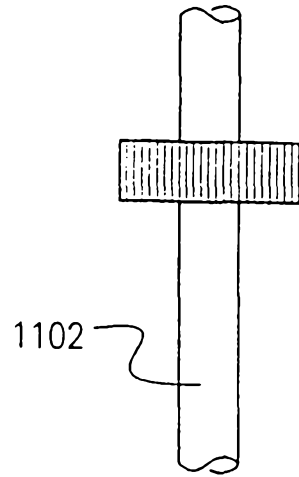


FIG. 23

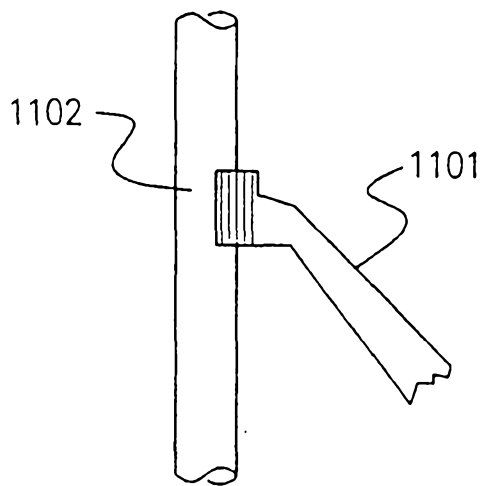


FIG. 24

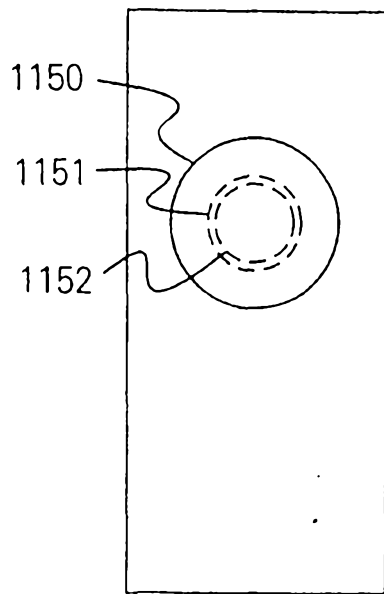


FIG. 25



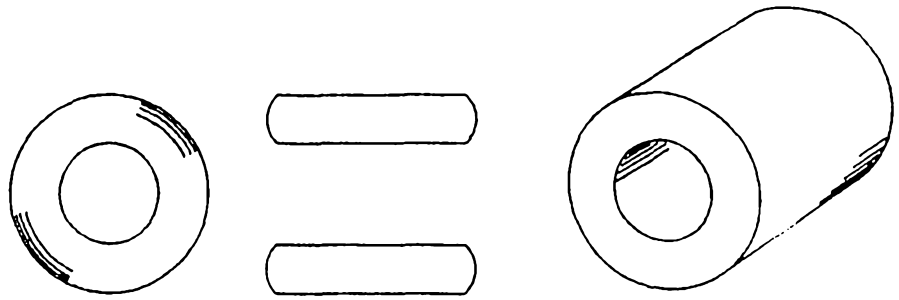


FIG. 13

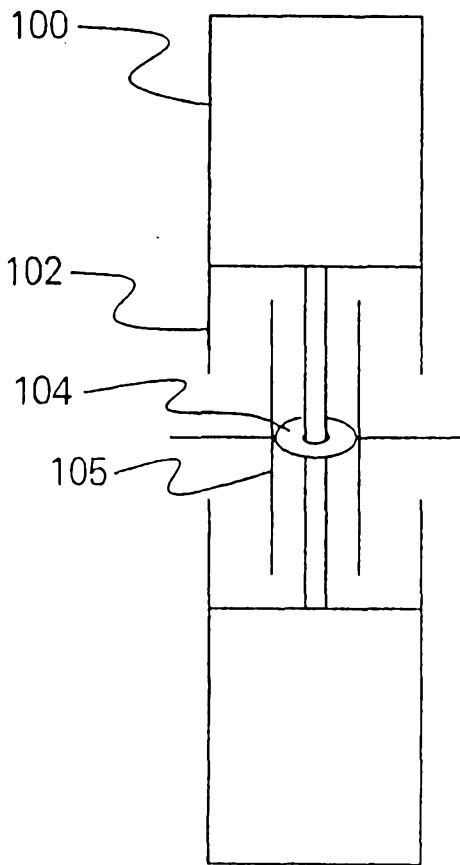


FIG. 26

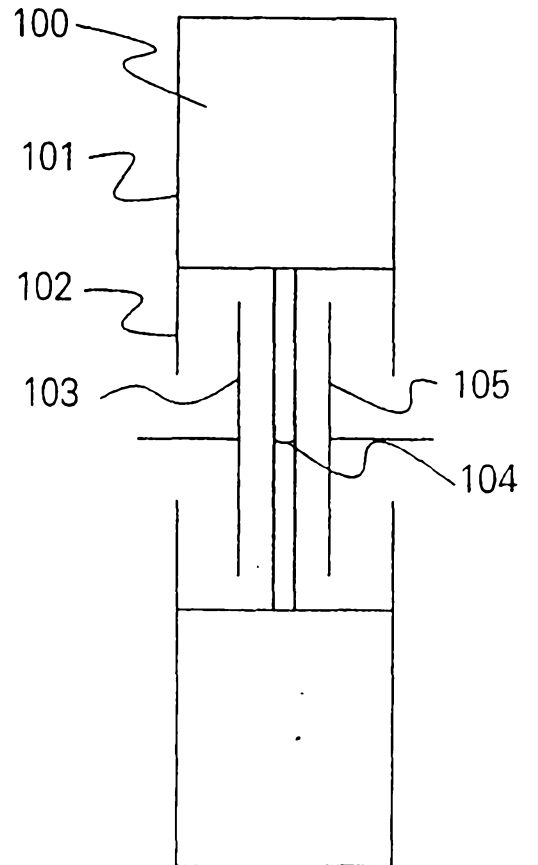


FIG. 27

