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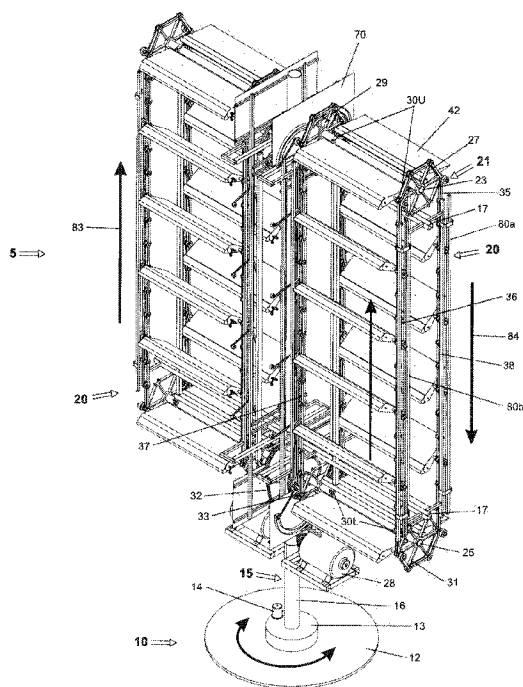


Fig 1

(57) Abstract: A wind turbine having a frame supporting a pair of rotatable axels, each having a pair of sprockets disposed on opposed ends thereof, the axels being parallel and vertically spaced from one another. Endless chains are deployed about vertically aligned sprockets on the upper and lower axels. Pivottally coupled between the chains in parallel relation is a plurality of regularly-spaced airfoils. The frame supports cowling members for directing an incident wind stream across the airfoils, producing a lift force on leading airfoils and a downward force on trailing airfoils to thereby rotate the axels and drive a generator. Cam followers affixed to the airfoils cooperate with stationary cams to steer the airfoils as they pass about the sprockets. The airfoils further include a wing-like structure with a shiftable leading edge profile to create lift forces on the leading airfoils and changing to downward forces on the trailing airfoils as they move from a leading to a trailing position.

WIND TURBINE

I. Cross Reference to Related Application.

This application is a continuation-in-part of provisional application serial number 61/095,977 filed September 11, 2008, the contents of which are hereby incorporated by
5 reference.

II. Field of the Invention.

This invention relates generally to wind turbines and more particularly to a highly efficient wind turbine for generating electrical energy of a new and novel design greatly different from known prior art structures.

10 III. Discussion of the Prior Art.

A wind turbine is a rotating machine which converts the kinetic energy in wind into mechanical energy which, when used to drive an electrical generator, converts the mechanical energy to electricity.

The first known electricity generating windmill operated was a battery charging
15 machine installed in 1887 by James Blyth in Scotland, UK. The first such windmill for electricity production in the United States was built in Cleveland, OH by Charles F. Brush in 1888 and by 1908, there were 72 wind-driven electric generators from 5 kW to 25 kW. The largest machines were on 79-foot towers with four-bladed, 75-foot diameter rotors.

A forerunner of modern horizontal-axis wind generators was in service at Yalta,
20 USSR in 1931. It was a 100 kW generator on a 100-foot tower connected to a local 6.3 kV distribution system.

Prior art wind turbines can be separated into two types based upon the axis in which the turbine rotates. Turbines that rotate around a horizontal axis are more common. Vertical-axis turbines are less frequently used.

25 Horizontal-axis wind turbines have the main rotor shaft and electrical generator at the top of a tower, and are usually pointed into the wind. Most small turbines are pointed by a simple wind vane, although there are now a number of more modern designs which are classed as downwind machines and which require no tail vane. Large turbines generally use a wind sensor coupled with a servomotor to effect repositioning relative to
30 wind direction. Most have a gearbox, which turns the slow rotation of the blades into a faster rotation that is more suitable to drive an electrical generator. Because a tower produces turbulence behind it, the turbine is usually pointed upwind of the tower.

Turbine blades are typically made stiff to prevent them from being pushed into the tower

by high winds. Additionally, the blades are placed a considerable distance in front of the tower and are sometimes tilted up at a small angle.

Downwind machines have been built, despite the problem of turbulence, because they do not need an additional mechanism to keep them in line with the wind, and
5 because, in high winds, the blades can be allowed to bend which reduces their swept area and thus their wind resistance. Because cyclic turbulence may lead to fatigue failures, most large horizontal axis wind turbines are upwind machines.

Prior art turbines used in wind farms for commercial production of electric power are usually three-bladed and pointed into the wind by computer-controlled motors. These
10 have high tip speeds of up to six times the wind speed, high efficiency, and low torque ripple, which contribute to good reliability. The blades are usually colored light gray to blend in with the clouds and range in length from 65 to 130 feet or more. The tubular steel towers range from 200-300 feet tall. The blades typically rotate at 10-22 revolutions per minute. A gearbox is commonly used to step up the speed of the generator, although
15 designs may also use direct drive of an annular generator. Some models operate at constant speed, but more energy can be collected by variable-speed turbines which use a solid-state power converter to interface to the electrical transmission system or grid.

All such wind farm turbines are equipped with a control system. These control systems employ anemometers and wind vanes to determine wind speed and direction.
20 Based on this information, the turbine yaw drive will turn the blade face into the wind, and the blade pitch can be altered to maximize output.

In very high wind speed conditions, the control system will shut the turbine down to avoid damage.

Some of the drawbacks of horizontal axis wind turbines include the fact that
25 cyclic stresses fatigue the blades, axel and bearings. Material failures are a major cause of turbine failure over the past several years. Because wind velocity often increases at higher altitudes, the backward force and torque on a horizontal-axis wind turbine blade peaks as it turns through the highest point in its circle. The tower hinders the airflow at the lowest point in the circle, which produces a local dip in force and torque. These
30 effects produce a cyclic twist on the main bearings of a horizontal axis wind turbine. The combined twist is worse in machines with an even number of blades, where one is straight up when another is straight down. To improve reliability, teetering hubs have been used which allow the main shaft to rock through a few degrees, so that the main bearings do not have to resist the torque peaks.

Furthermore, the rotating blades of a wind turbine act like a gyroscope. As it pivots along its vertical axis to face the wind, gyroscopic precession tries to twist the turbine disc along its horizontal axis. For each blade on a wind generator's turbine, precessive force is at a minimum when the blade is horizontal and at a maximum when
5 the blade is vertical. This cyclic twisting can quickly fatigue and crack the blade roots, hub and axel.

Vertical-axis wind turbines have the main rotor shaft arranged vertically. A key advantage of this arrangement is that the turbine does not need to be pointed into the wind to be effective. This is an advantage on sites where the wind direction is highly variable.

10 It is difficult to mount vertical-axis turbines on towers, meaning they are often installed nearer to the base on which they rest, such as the ground or a building rooftop. This can provide the advantage of easy accessibility to mechanical components. However, wind speed is slower at a lower altitude, so less wind energy is available for a given size turbine. Airflow near the ground and other objects can create turbulent flow,
15 which can introduce issues of vibration, including noise and bearing wear which may increase the maintenance or shorten the service life. In designs that do not have helical rotors, significant torque variations occur.

The Jonsson published U.S. Application 2007/0297902 A1 describes a vertical axis turbine having a plurality of airfoils affixed to a rotatable annular frame and
20 extending parallel to the axis of rotation of the frame. The airfoils are pivotally affixed to the frame such that they exhibit a high profile while moving in the wind direction and a low profile when moving counter to the wind direction. The camber of the airfoils remains fixed and no provision is made for adjusting the pitch of the airfoils as a function of wind velocity.

25 Extensive research on wind turbines carried out in the late 1970s and 1980s by the Department of Energy included some vertical axis designs; none of these designs succeeded in the marketplace due to inherent downfalls in this design. When it comes down to cost of electricity as a result of efficiency, reliability and economy of materials, vertical axis wind turbines could not compete with the horizontal axis type. In addition,
30 many of the claims of current vertical axis wind turbine manufacturers are unsubstantiated or are incorrect.

It is an object of the present invention to provide an efficient wind turbine system for generating electrical energy that does not suffer from the disadvantages attendant in horizontal axis and vertical axis wind turbines of the type described above.

It is another object to provide an efficient, power generation system which utilizes the Bernoulli principle to improve efficiency by creating upward forces on a plurality of airfoils while at the same time creating a downward force on a second plurality of airfoils which are constrained to move in a perpendicular, linear direction to the wind.

5

SUMMARY OF THE INVENTION

In its simplest form, the wind turbine of the present invention comprises a frame that supports first and second pairs of wind-driven assemblies where the wind-driven assemblies each comprise an upper axel on which a first pair of sprockets is rotatably mounted in parallel, spaced-apart relation and a lower axel, oriented parallel to the upper
 10 axel, on which a second pair of sprockets is rotatably mounted. The second pair of sprockets is generally vertically aligned with the first pair of sprockets on the upper axel. Endless chains extend around the aligned sprockets on the upper and lower axels of each of the pair of wind-driven assemblies to form first and second chain flights on each such endless chain. A plurality of airfoil members are connected between the pairs of endless
 15 chains on each of the pair of wind-driven assemblies, that when acted upon by a wind stream, apply an upward lift force to the first chain flight and a downward force on the second chain flight. An electrical generator is adapted to be driven from rotational movement of one of the upper and lower axels.

Other objects, features and advantages of the present invention will become more
 20 apparent from the following detailed description of the preferred embodiment in which like numerals in the several views refer to corresponding parts.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a front side isometric view of a preferred embodiment of the invention depicting an entire assembly of the apparatus and showing the general movement
 25 capabilities of a dual generator system mounted to a central support;

Figure 2 is a front side isometric view of the embodiment of Figure 1 with cowling for directing fluid flow added;

Figure 3 is a rear isometric view of the embodiment of Figure 2;

Figure 4a is a top view of the embodiment of Figure 2;

30

Figure 4b is a left side view of the embodiment of Figure 2;

Figure 4c is a front view of the embodiment of Figure 2;

Figure 4d is a right side view of the embodiment of Figure 2;

Figure 5a is a front view like that of Figure 4c, but with side cowls added;

Figure 5b is a left side isometric view of the embodiment of Figure 2;

Figure 6a is an enlarged, partial front view of the preferred embodiment showing drive chains with attached airfoil assemblies;

Figure 6b is side view of the embodiment of Figure 1 depicting the movement of the drive chains with a chain guide and interaction of airfoil cams with associated cam guides;

Figure 7 is an enlarged, partial isometric view of a top chain sprocket and drive chain with attached airfoil assembly according to the present invention;

Figure 8 is an enlarged, partial isometric view of an upper cam guide assembly according to the present invention;

Figure 9 is an enlarged, top view of a wind-driven assembly forming a segment of the embodiment of Figure 1 and showing a top chain sprocket and drive chain with attached airfoil assembly and upper cam guide assembly;

Figure 10 is an enlarged, partial side view showing an upper cam guide assembly for airfoil adjustment;

Figure 11 is an enlarged, partial isometric rear view showing the top chain sprocket and drive chain with attached airfoil assembly traversing the upper sprocket;

Figure 12 is an enlarged, partial front view detailing the top drive chain sprocket and drive chain with attached airfoils;

Figure 13 is an enlarged, partial side view of the top drive chain sprocket and drive chain with attached airfoils showing the airfoil leading edge transitioning as the upper sprocket is being traversed;

Figure 14 is an enlarged, isometric view of the lower drive chain sprocket and drive chain with attached electricity generating assembly;

Figure 15 is a detailed isometric view showing the lower cam guide assembly and electricity generating assembly according to the present invention;

Figure 16 is an enlarged partial side view of a lower cam guide assembly with airfoil pitch adjustment features,

Figure 17 is a further isometric view of a lower drive chain sprocket and drive chain with attached airfoil assembly like that of Figure 15, but from a different viewing angle;

Figure 18 is an enlarged partial front view of the lower drive chain sprocket and drive chain with attached airfoil assembly;

Figure 19 is a side view like that of Figure 13, but of a bottom drive chain sprocket and drive chain with attached airfoils;

Figure 20a is an isometric view showing the combination airfoil body with first cam and an independent, adjustable airfoil leading edge with second cam assembly;

Figure 20b is a top view of the combination airfoil body;

Figure 20c is a front view of the combination airfoil body;

5 Figure 20d is a side view of the combination airfoil body with first cam and an independent adjustable airfoil leading edge in a first disposition; and

Figure 20e is a view like that of Figure 20d, but with the adjustable leading edge in its second disposition.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

10 This description of the preferred embodiments is intended to be read in connection with the accompanying drawings, which are to be considered part of the entire written description of this invention. In the description, relative terms such as “lower”, “upper”, “horizontal”, “vertical”, “above”, “below”, “up”, “down”, “top” and “bottom” as well as derivatives thereof (e.g., “horizontally”, “downwardly”, “upwardly”, etc.) should be
15 construed to refer to the orientation as then described or as shown in the drawings under discussion. These relative terms are for convenience of the description and do not require that the apparatus be constructed or operated in a particular orientation. Terms such as “connected”, “connecting”, “attached”, “attaching”, “join” and “joining” are used
20 interchangeably and refer to one structure or surface being secured to another structure or surface or integrally fabricated in one piece, unless expressly described otherwise.

Referring first to Fig. 1, there is shown a wind flow power generating apparatus or wind turbine 5 constructed in accordance with the present invention. The exemplary embodiment 5 includes a base component 10 which may comprise a solid base formation of differing configurations depending upon the mounting location on which the wind
25 turbine assembly 5 is to be placed. For example, if installed on the ground, the base foundation member 12 may be concrete whereas if the wind turbine is to be roof mounted, the base may comprise a steel plate adapted to be bolted to the building's structural beams.

The base component 10 may also contain a rotational component 13 in the form of
30 an electric motor and gearing for allowing rotation of the wind turbine assembly 5 to directly face an ambient wind stream so as to be normal to the direction of flow of the air stream. In this regard, an electronic control system (not shown) responsive to wind direction may be used to power a motor 14 to allow the wind turbine assembly 5 to be

rotated about a vertical axis as indicated by the double headed arrow shown on the base foundation 12.

The wind turbine assembly 5 includes a structural support frame indicated generally by numeral 15. As shown in Fig. 1, the exemplary structural support frame 15 may comprise a primary structural support 16 in the form of a centrally located pole of a desired height dimension to which secondary structural support members, as at 17, are welded or otherwise affixed. The primary structural support 16 provides the central framework to which the working components of the wind turbine assembly are secured. The secondary structural support members 17 are strategically placed and used to position and support the individual working components of the system. Those skilled in the art will recognize from the present teaching that a variety of materials and structural configurations may be employed to create support structures for spatially placing the working components comprising the power generating apparatus 5.

The exemplary embodiment shown in Fig. 1 comprises first and second pairs of wind-driven assemblies 20, each of substantially identical construction that are symmetrically mounted to the primary structural support 16. In that the two wind-driven assemblies 20 are generally identical in construction, only one need be described in detail.

As depicted in Fig. 1, the wind-driven assemblies 20 each comprise a movable structure 21 having an upper axel 23 on which a first pair of sprockets 27 and 29 are rotatably mounted in parallel-spaced apart relation, and a lower axel 25 that is oriented parallel to the upper axel 23 and on which is rotatably mounted a second pair of sprockets 31 and 33. The second pair of sprockets is generally vertically aligned with the first pair of sprockets on the upper axel 23. The wind-driven assemblies 20 may be connected to the structural support frame 15 by being directly fastened to the primary structural support pole 16 or indirectly fastened to the primary structural support 16 through the secondary structural support members 17 as illustrated.

The sprockets 27 and 29 on the upper axel 23 are fixedly attached to the upper axel which is journaled for rotation in pillow blocks as at 30U. Likewise, the lower sprockets 31 and 33 are fixedly attached at the lower axel 25, that axel being journaled for rotation in pillow blocks 30L. As best seen in Fig. 6a, the lower axel 25 is also fixedly attached to a pulley that is connected to an electrical generator 28 by a V-belt 32.

The first upper sprocket 27 and the first lower sprocket 31 are vertically aligned and cooperatively connected by a first drive chain 35 and thereby define chain flights 36 and 38. Likewise, the upper sprocket 29 and the lower sprocket 33 are also vertically

aligned and cooperatively connected by a second drive chain 37. The drive chain 37 also can be considered as comprising a pair of flights, namely a front flight and a rear flight, when viewed in Fig. 1.

As best seen in Figs. 7 and 8, the first drive chain 35 and the second drive chain
5 37 comprise a plurality of links 39 and pivoting link joints 41. The first drive chain 35 and second drive chain 37 are spaced and cooperatively connected by a plurality of airfoils 42. Each airfoil 42 is affixed to an airfoil axel 45 that is cooperatively connected at a first end to the first drive chain 35 and at a second end to the second drive chain 37 (Fig. 20a). Mounted on the airfoil axel 45 is a pair of spaced airfoil axel guide rollers 46
10 that are rotatably and cooperatively attached to the airfoil axel 45 with the airfoil 42 disposed between the airfoil axel guide rollers 46.

With continued reference to Figs. 20a-d, each airfoil 42 comprises an airfoil main body 43 and an adjustable airfoil leading edge 44 that is pivotally joined adjacent an edge of the airfoil main body 43. The airfoil main body 43 has a first main body surface 43a
15 and a second main body surface 43b which may be thin, lightweight sheets of aluminum that serve as skins covering an interior foam material so as to provide a lightweight article having substantial mechanical rigidity. The surfaces 43a and 43b meet at a trailing edge such that wind streams flowing over the upper and lower surfaces meet with as little turbulence as possible. The adjustable leading edge 44 is configured so as to alter the
20 shape (camber) of the airfoil in such a manner that the force on the airfoil by the Bernoulli effect can be shifted from one airfoil main body surface to the other. The manner in which this is achieved will be described in greater detail herein below. Suffice it to say now that on a cambered airfoil at zero angle of attack, the pressures on the upper surface are less than on the lower surface. The bearings 46 function as low-friction
25 rollers cooperating with guides 80a – 80d.

Also fixedly attached to the airfoil axel 45 is a cam arrangement 68 comprising a pair of arms joined together at a 90° angle at their point of attachment to the airfoil axel 45 and having rollers 68a and 68b journaled for rotation on the free ends of the arms. Also seen in the views of Fig. 20 is an axel member 44a that serves as a pivot axis for the
30 airfoil leading edge member 44 relative to the airfoil main body 43. Fixedly attached to the axel 44a is a second cam assembly 69 also having a pair of arms joined and extending normal to one another and equipped with rollers on the free ends thereof.

As seen in Figs. 2-5, the preferred embodiment of the wind turbine of the present invention includes cowling indicated generally by numeral 47 and including a center

cowling member 48 having a leading edge 48a and a trailing edge 48b. The cowling 47 further includes peripheral cowling members 49 (Fig. 5) affixed to the frame proximate the outer edges of the pair of wind-driven assemblies 20. The center cowling 48 and first peripheral cowling 49 create a frontal opening 50 (Fig. 4a) defined by the center cowling leading edge 48a and the peripheral cowling leading edge 49a. The cowling has the effect of steering wind currents against the airfoils with a more laminar flow conducive to a more efficient operation of the wind turbine.

With reference to Fig. 4a, the cowling possesses a mid-region 53 that is defined by the center cowling mid-region 54 of the center cowling 48 and the first peripheral cowling mid-region 55 of peripheral cowling 49 contiguous with the distal trailing edge 48b and the distal trailing edge 49b respectively. The proximal ends of both mid-regions 54 and 55 face the wind entry direction. The mid-regions 54 and 55 are spaced apart to accommodate the moveable framework 21 (Fig. 2) and the plurality of airfoils 42 therebetween. The distal ends of both mid-regions 54 and 55 face the wind exit direction. The mid-region works in a fashion similar to the central portion of a Venturi tube, whereby the velocity of the fluid flow is increased in the mid-region over the ambient air speed external to the turbine assembly.

The cowling 47 defines a wind entry region 59, as defined by the center cowling 48 exit region 61, and the first peripheral cowling 49 exit region 63. The center cowling 48 and first peripheral cowling 49 create an exit 60 defined by a center cowling 48 trailing edge 48c and the peripheral cowling 49 trailing edge 49c.

Referring next to Figs. 7 and 8, the wind-driven assemblies 20 include a component support plate 70 held in position by a secondary frame member 17 and affixed to the inward facing surface of the plate 70 are a first airfoil body cam guide 72a and a second airfoil body cam guide 72b. As will be explained in greater detail herein below, the first and second airfoil body cam guides 72a and 72b cooperatively engage the airfoil main body cam 68 (Fig. 19) to effectuate control of the airfoil main body plane of attack as the airfoil traverses from the first chain flight 36 to the second chain flight 38 (Fig. 1) in passing over the upper sprocket 27.

Also visible in Figs. 8 and 10 is a frame mounted airfoil leading edge cam guide 74 designed and positioned to cooperate with the airfoil leading edge cam 69 (Fig. 20). The first airfoil leading edge cam guide functions to configure the leading edge of the airfoil main body surface 43b to experience a low pressure due to the Bernoulli effect.

Referring now to Figs. 9, 10, 11 and 13, each of the wind-driven assemblies 20 of the wind turbine 5 includes four, vertically extending airfoil axis guides 80a, 80b, 80c and 80d fixedly attached to the central support frame 15 and that extend alongside each of the chain flights of the endless chains 35 and 37 (Fig. 1). Each of the airfoil axis guides comprises a channel member of C-shaped cross-section 81 that is mounted in parallel, spaced-apart relation to a tubular rod 82 of square cross-section. During travel of the endless chains, the rollers 46 on the axis 45 of the airfoils are constrained to pass between the channels 81 and the bar 82, thus holding the plural airfoil members in parallel, spaced-apart relationship across the width dimensions of the pair of wind-driven assemblies 20 as they travel through their linear primary power stroke and linear secondary power stroke cycle represented by the arrows 83 and 84 in Figs. 1 and 2.

Referring next to Figs. 15, 16, 17 and 19, in the preferred embodiment of the wind turbine apparatus 5, there is included a first, lower component support panel 90 and a third airfoil body cam guide 92a and a fourth airfoil body cam guide 92b. The third and fourth airfoil body cam guides 92a and 92b cooperatively interact with the airfoil main body cam 68 to effectuate control of the airfoil main body plane of attack as the airfoil traverses the lower sprockets 31 and 33.

Also seen in Fig. 19 is a second airfoil leading edge cam guide 94 which cooperatively interacts with the airfoil leading edge cam 69 to flip the leading edge of the airfoil from its second disposition back to its first disposition as the airfoil progresses about the lower sprocket. This has the effect of reconfiguring the airfoil main body surface 43a to a different camber such that the low pressure Bernoulli effect acts on the surface 43a as a wind stream passes through the wind-driven assemblies 20.

Seen at 100 in Figs. 6b, 10 and 16 is a linear actuator affixed to the frame and which is responsive to control signals from an anemometer (not shown) that measures wind velocity. Based upon the control signal, the linear actuator 100 functions to alter the positions of the cam guides 102 and 104 over which the rollers 68a and 68b on the airfoil cams 68 are constrained to move. This has the effect of altering the pitch of the airfoil members 42 as is perhaps best visualized in the view of Fig. 6b where the double headed arrow signifies displacement of the guides 102 and 104 and the downwardly directed arrow signifies a change in pitch angle.

OPERATION

Having described the constructional features of the wind turbine of the present invention in detail, consideration will next be given to its manner of operation. The wind-

driven assemblies 20 are continuously positioned by the rotational component 13 on the base 12 so as to be oriented generally perpendicular to the prevailing wind direction by the electric motor 14 and its associated controller (not shown). The shroud or cowling 47, including the center section 48 and the peripheral sections 49, functions to increase the velocity of the airstream impinging upon the wind-driven assemblies. Facing the wind stream is a plurality of airfoil members 42 with the adjustable airfoil leading edge 44 disposed so as to create lift on the airfoil members due to the Bernoulli effect. As the wind stream exits the trailing edges of the column of airfoil members producing lift, it impinges upon a second column of airfoil members where the leading edge thereof has been adjusted so that the Bernoulli effect produces a downwardly directed force on the second column of airfoil members. The combined forces result in the rotation on the chains 35 and 37 in a clockwise direction when viewed as in Figs. 1 and 2.

The chains are deployed about upper and lower sprocket wheels that are respectively attached to rotatable axels 23 and 25. As seen in Fig. 6a, a pulley is fixedly attached to the rotatable axel 25 and a V-belt 32 is deployed about that pulley and about a sheve secured to the drive shaft of an electrical generator 28 whose output may be coupled to an electrical distribution grid.

As the chains carrying the airfoil members rotate, the several airfoil members sequentially reach an upper position, at which point roller-carrying cam arms 68 engage cams 72a and 72b to guide the airfoil members about the upper sprockets 21 and 29 so that the leading edge of the airfoil members remains pointed into the wind. In traversing the upper sprockets 27 and 29, the leading edge cam followers 69 are brought into abutment with a cam surface 74 to flip the adjustable leading edge to thereby convert the airfoil members from a lift-producing orientation it had on chain flight 36 to a downward force-producing orientation when traveling along chain flight 38.

Guide structures 80a-80d positioned closely adjacent the upwardly and downwardly moving chain flights 36 and 38 cooperate with rollers 46 on the axels of the airfoil members to constrain the movement of the airfoil members by the wind forces to a vertical direction only. A second set of movable guide members 102 and 104, which are adapted to be moved by a linear actuator 100, cooperate with the rollers on the cam arm 68 to vary the pitch angle of the airfoil members. The linear actuators for shifting the movable guides are controlled by an electronic controller (not shown) capable of sensing wind velocity and setting the airfoil members at a pitch angle conducive to maximizing the lift forces on the airfoil members occupying the wind inlet side of the assembly and

the downward forces due to the Bernoulli effect on the airfoils on the downwind side of the assembly.

The following table is provided for ease of reference.

Ref. No.	Item
5	entire assembly
10	base generally
12	base foundation
13	rotational assembly on base
14	motor on base
15	general reference to frame
16	central support pole
17	secondary structural support members
18	not used
19	not used
20	the first and second wind-driven assemblies, generally
21	movable members of 20 generally
23	upper axel
25	lower axel
26	pulley
27	upper sprocket – outer
29	upper sprocket – inner
31	lower sprocket – outer
32	V-belt
33	lower sprocket – inner
30U	upper axel pillow blocks
30L	lower axel pillow blocks
28	electrical generator
35	first drive chain
36	one flight of chain 35
38	second flight of chain 35
37	second drive chain
39	chain links
41	link joints
42	airfoils generally
45	airfoil axel
46	airfoil axel roller bearings
43	main body of airfoil (Fig. 20)
44	adjustable airfoil leading edge
43a	first main body <u>surface</u> of airfoil
43b	opposite main body <u>surface</u> of airfoil
68	first cam assembly on airfoil axel
68a	roller on cam assembly
68b	roller on cam assembly
44a	axel of leading edge member 44
69	second cam assembly on 44a

Ref. No.	Item
47	cowling generally
48	center cowling member
48a	leading edge of center cowling
48b	trailing edge of center cowling
49	peripheral or side cowling structures
49a	peripheral cowling 49 leading edge
53	mid-region of cowling (between 54 and 55)
54	mid-region of center cowling 48
55	mid-region of peripheral cowling 49 that is contiguous with 48b and 49b
59	wind entry region of cowling 47 defined by 61
60	wind exit opening between 48c and 49c
61	wind exiting region of center cowling 48
63	exiting region of cowling 49
70	component (cam) support plate (Figs. 7 & 8)
72a	first airfoil body cam guide
72b	second airfoil body cam guide
74	airfoil leading edge cam guide
80a, b, c and d	airfoil axis guides adjacent the chain flights
81	C-shaped channel component of 80
82	square cross-section rod of 80
83	arrow in Figs. 1 & 2
84	arrow in Figs. 1 & 2
90	lower component support panel (Figs. 15-17 & 19)
92a	third airfoil body cam guide
92b	fourth airfoil body cam guide
94	second airfoil leading edge cam guide (Fig. 19)
100	linear actuator
102	movable cam guides driven by 100 (Fig. 10)
104	movable cam guides driven by 100 (Fig. 10)

While certain aspects and embodiments of the invention have been described, these have been presented by way of example only, and are not intended to limit the scope of the invention. Indeed, the novel methods and systems described herein may be embodied in a variety of other forms without departing from the spirit thereof. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the invention.

What is claimed is:

CLAIMS

1. A wind turbine comprising:

a frame supporting first and second pairs of wind driven assemblies, said wind driven assemblies each comprising an upper axel on which a first pair of sprockets is rotatably mounted in parallel, spaced-apart relation and a lower axel, parallel to the upper axel, on which is rotatably mounted a second pair of sprockets, the second pair of sprockets being generally vertically aligned with the first pair of sprockets on the upper axel, endless chains extending around the aligned sprockets on the upper and lower axels of each of the pair of wind driven assemblies to form first and second chain flights on each such endless chains;

a plurality of airfoil members connected between the pairs of endless chains on each of the pair of wind driven assemblies that when acted upon by a wind stream apply an upward lift force to the first chain flight and a downward force on the second chain flight; and

an electrical generator adapted to be driven from rotation of one of the upper and lower axels.

2. The wind turbine of claim 1 wherein said frame is rotatably mounted to a base member for rotation about a vertical axis such that the airfoil members remain generally aligned normal to the direction of the wind stream.

3. The wind turbine of claim 1 wherein the airfoil members each comprise first and second major surfaces where a first major surface is generally planar and the second major surface is arcuate at a leading edge and tapered to meet the first major surface at a trailing edge.

4. The wind turbine of claim 1 wherein the airfoil members are pivotally attached at opposed ends thereof to the pair of endless chains.

5. The wind turbine of claim 1 wherein the airfoil members are each mounted on a shaft extending a length dimension of the airfoil member and beyond, the shaft having rollers proximate opposed ends thereof and the frame further including guide tracks aligned with the first and second flights on which the rollers are confined to move.

6. The wind turbine of claim 3 wherein the arcuate leading edge is pivotable between a first disposition and a second disposition.

7. The wind turbine of claim 6 wherein the arcuate leading edge of the airfoil members flips from the first disposition to the second disposition upon traversing the first

pair of sprockets and from the second disposition to the first disposition upon traversing the second pair of sprockets.

8. The wind turbine of claim 4 and further including means for controlling the pitch of the airfoil members as a function of wind direction and wind speed.

5 9. The wind turbine of claim 5 and further including a pair of arms fixedly attached to said shaft in perpendicular relation relative to one another, each arm carrying a roller at a free end thereof, a pair of vertically oriented guide channels adapted to receive the rollers therein and slidably mounted to said frame for lateral movement and a linear actuator mounted on the frame for shifting the vertically oriented guide channels
10 laterally whereby the pitch of the airfoil members is adjusted.

10. The wind turbine of claim 1 and further including means disposed proximate the wind-drive assemblies for channeling incident wind onto said plurality of airfoil members while increasing the velocity of the incident wind.

11. The wind turbine of claim 10 wherein the means for channeling comprises
15 a center cowl member having a relatively wide center portion and a relatively narrow leading edge and trailing edge, the center cowl member disposed between said first and second pairs of wind-driven assemblies, and peripheral cowl members having a relatively wide center portion and relatively narrow leading and trailing edges, the center portion of the peripheral cowl members being disposed adjacent outer ends of the first and second
20 pairs of wind-driven assemblies.

12. The wind turbine of claim 3 wherein the airfoil members each comprise an arcuate leading edge affixed to an axel member, the axel member having a cam follower attached at one end location thereof, the cam follower adapted to operate with cam surfaces located proximate the upper and lower axels to switch the leading edge between
25 a first and second disposition proximate the upper axel and from the second disposition to the first disposition proximate the lower axel.

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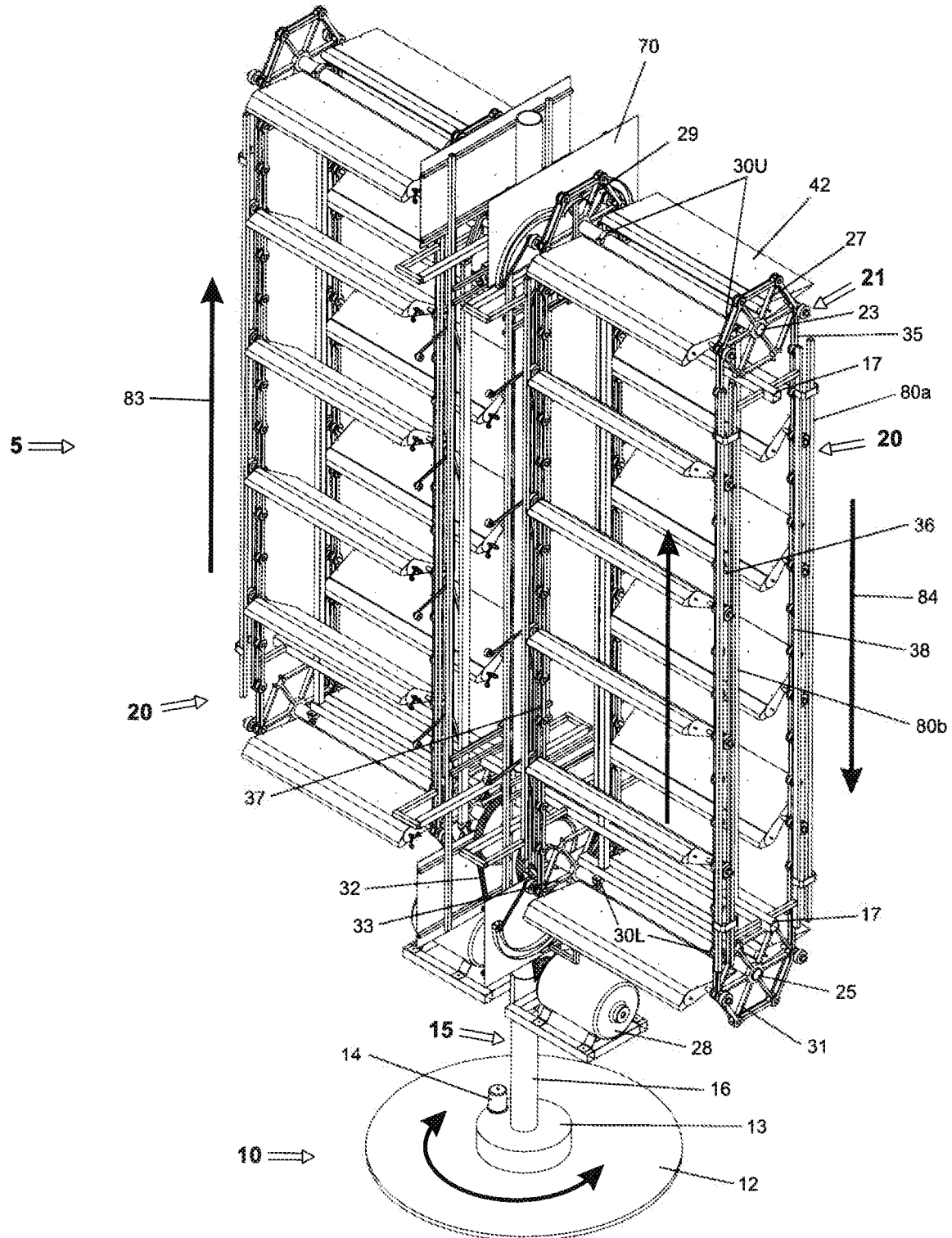


Fig 1

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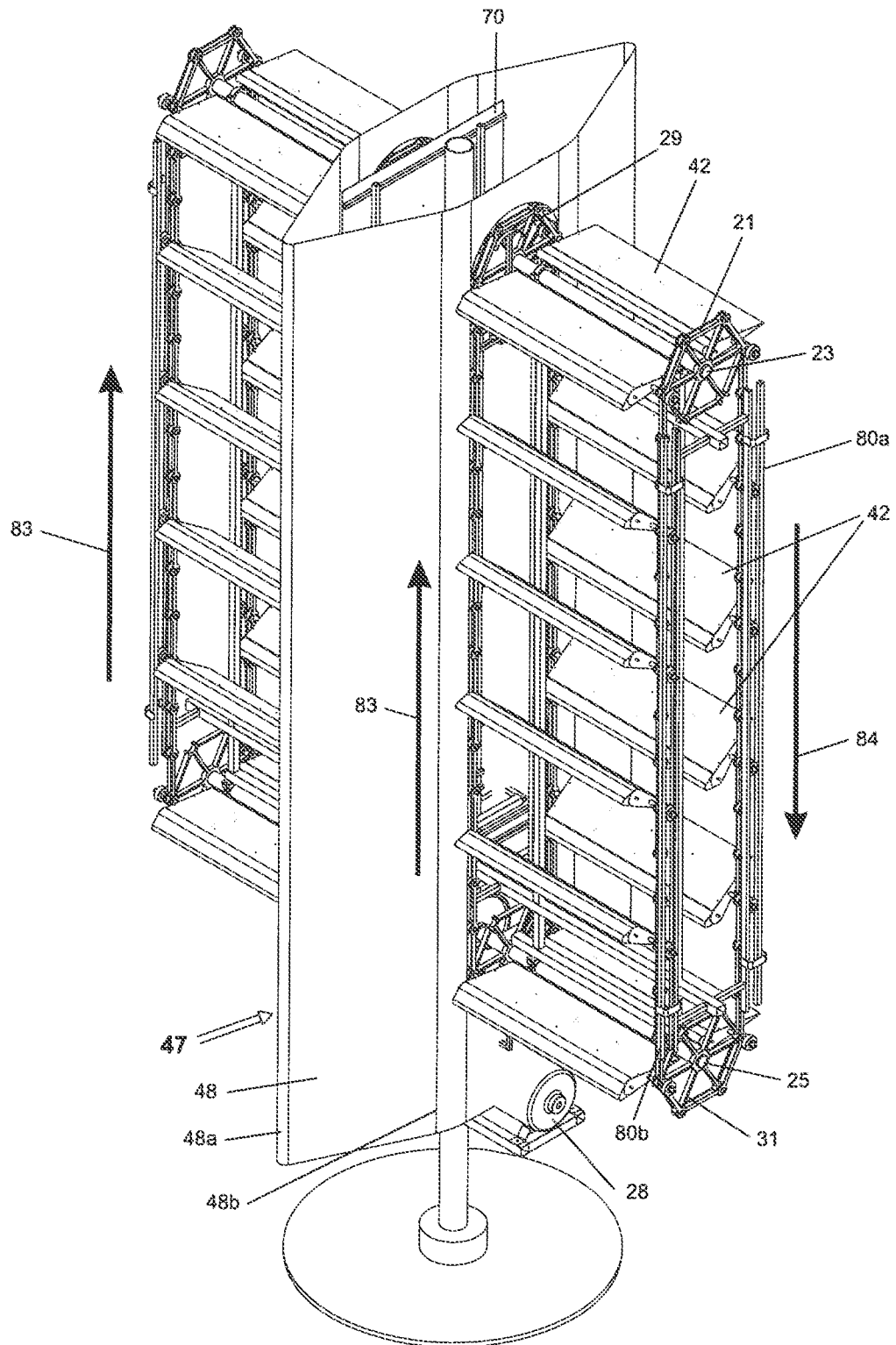


Fig 2

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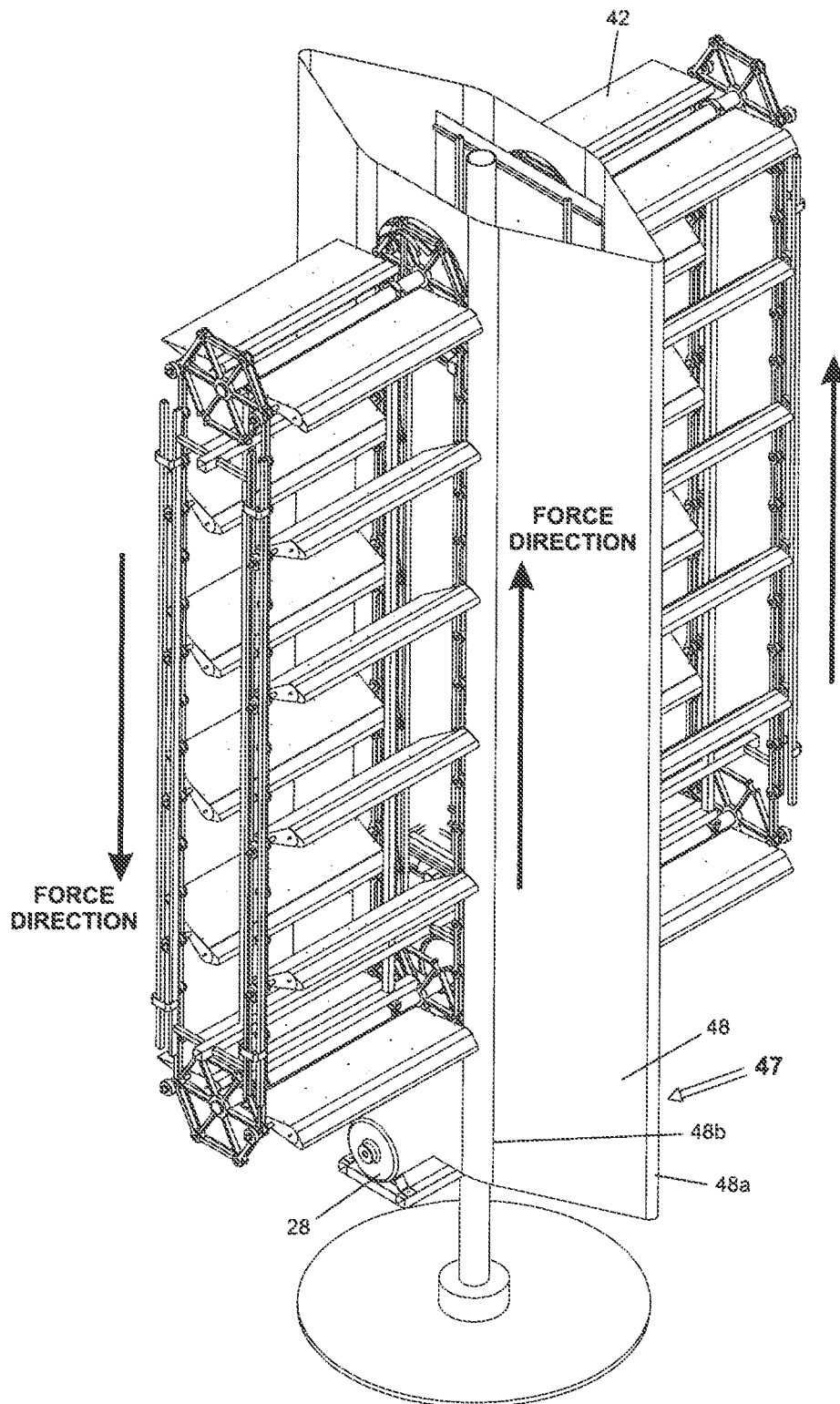
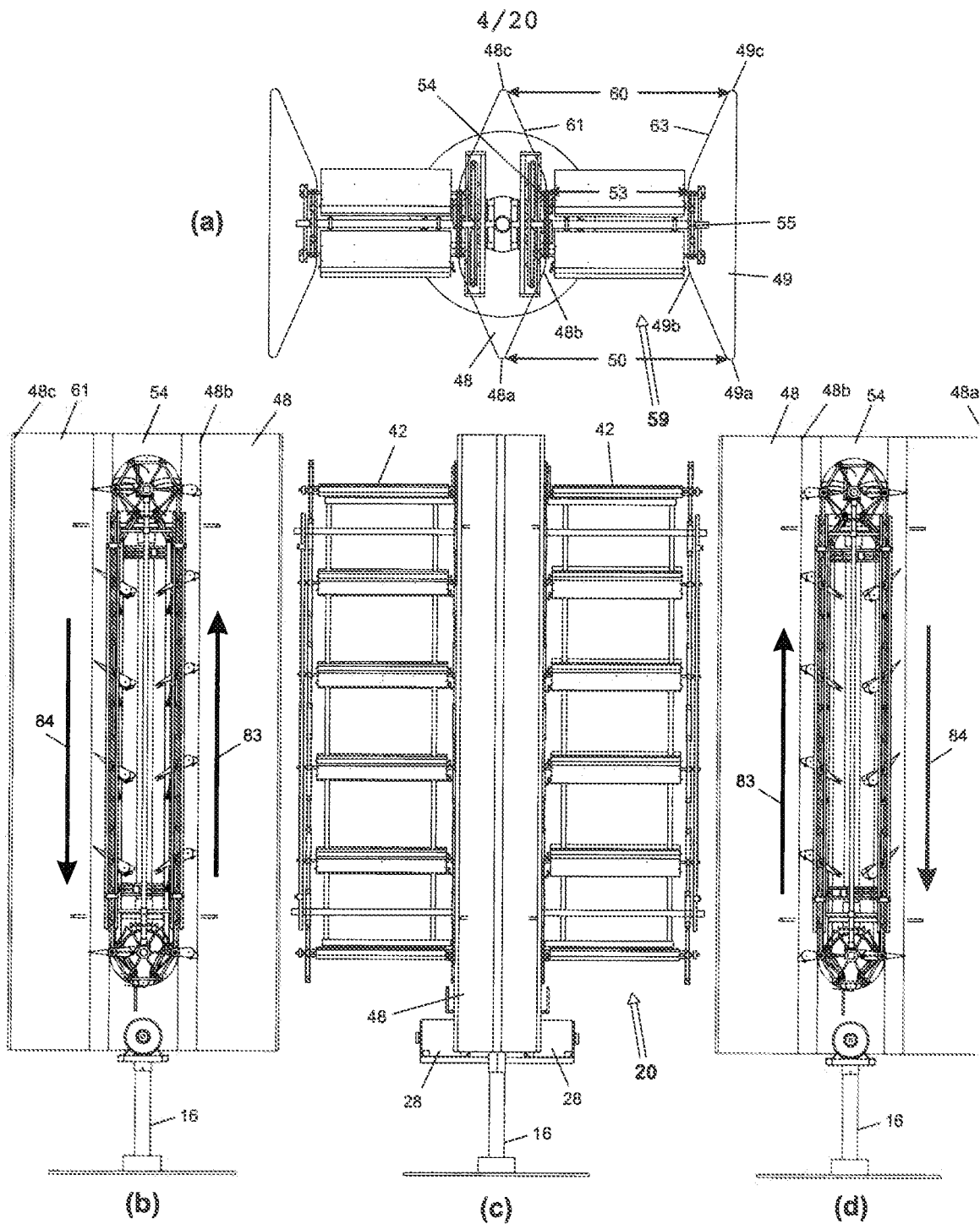


Fig 3



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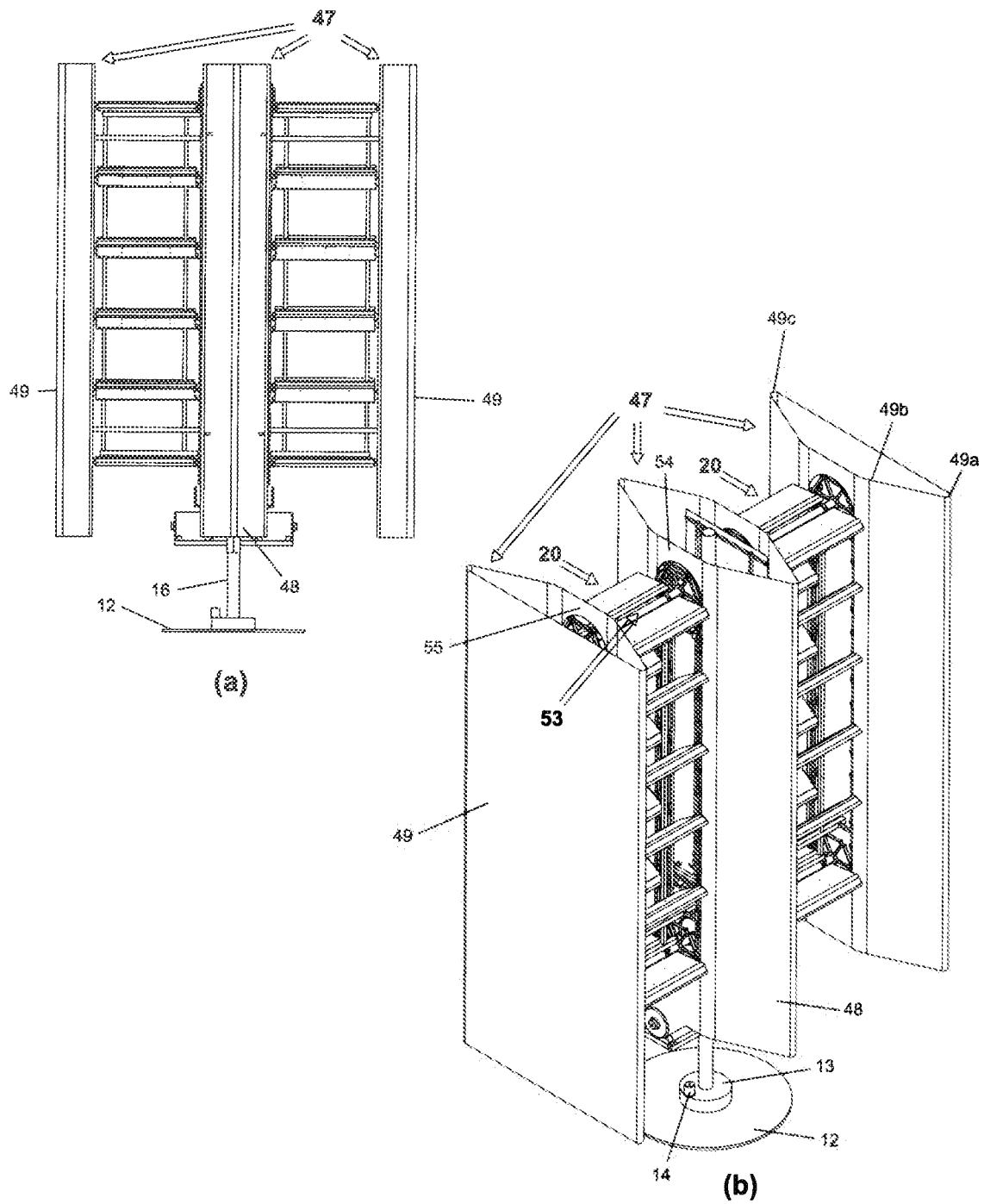


Fig 5 a-b

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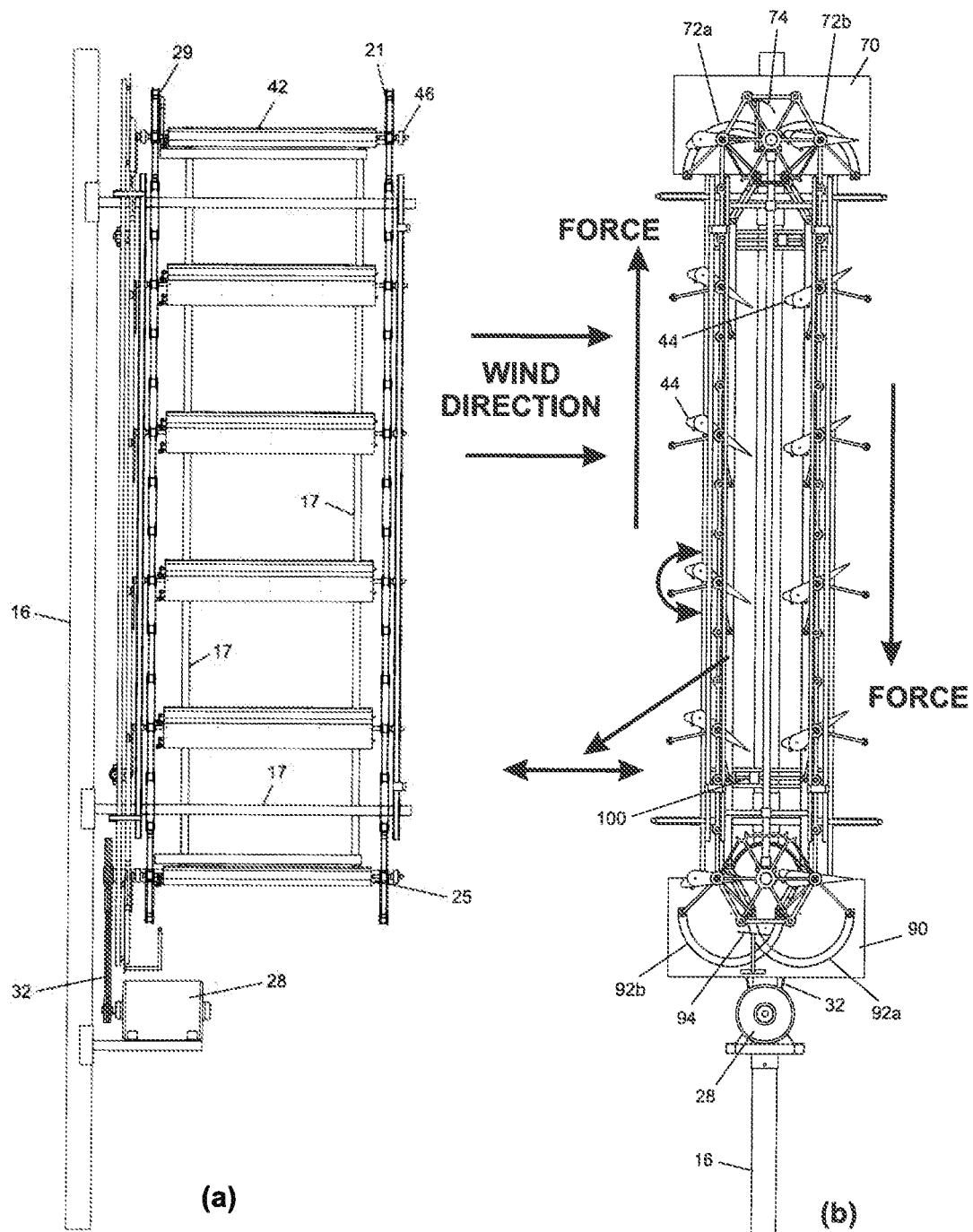


Fig 6 a-b

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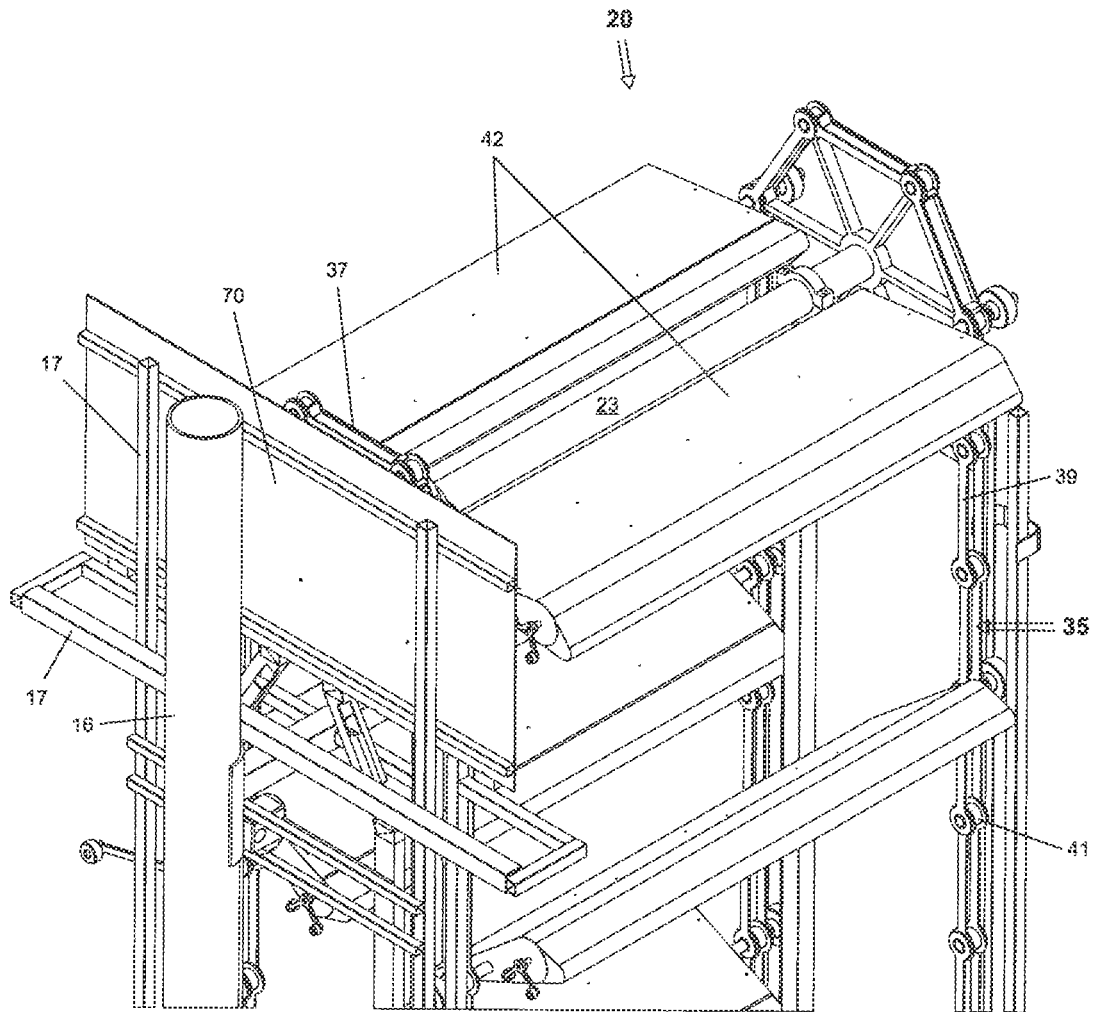


Fig 7

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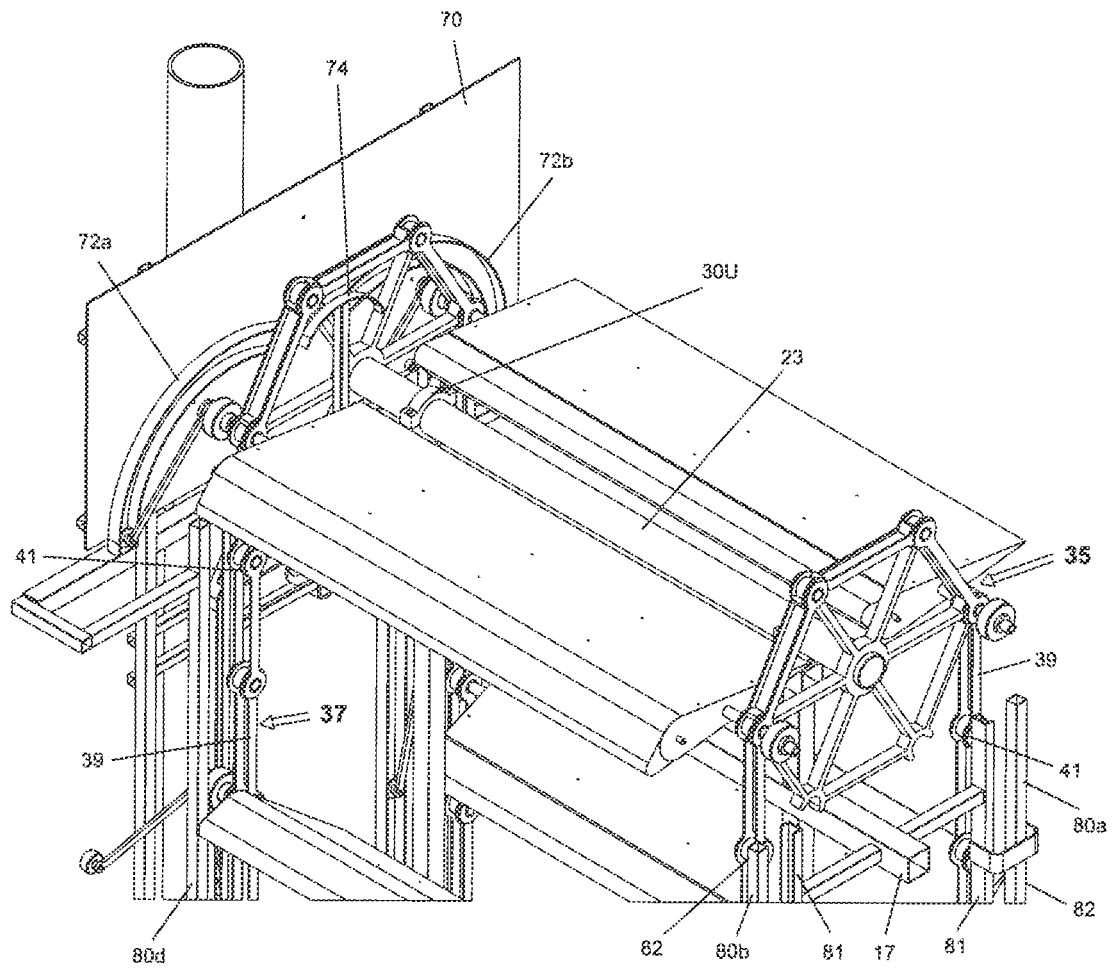


Fig 8

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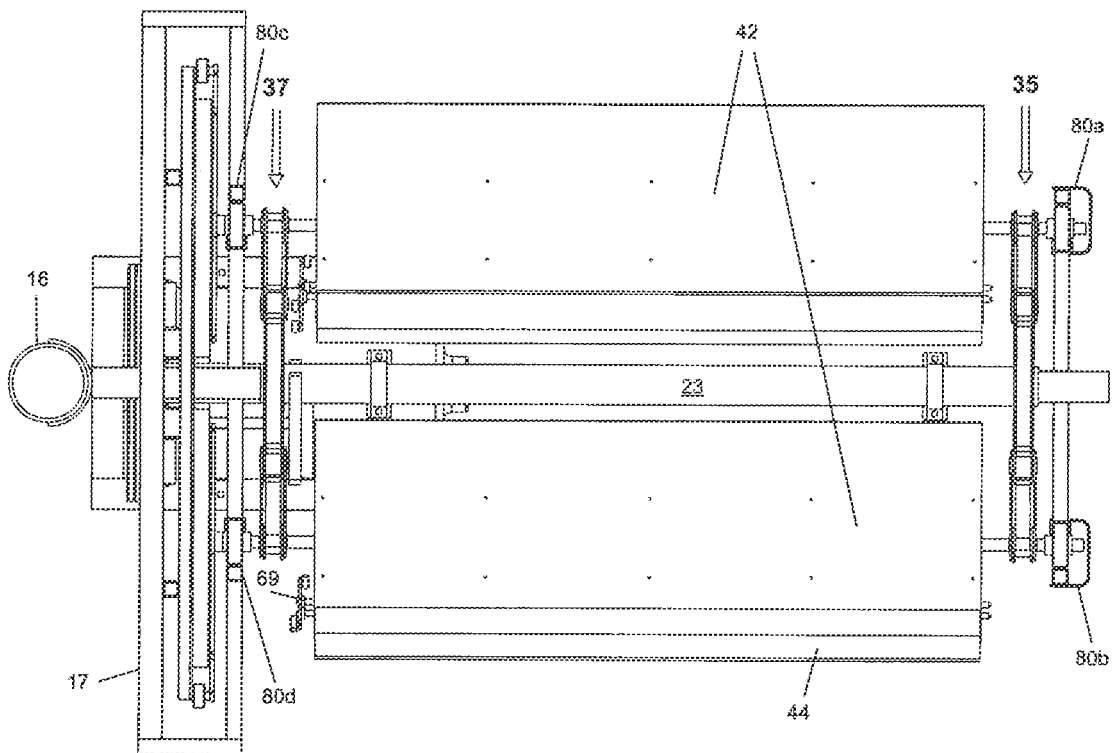


Fig 9

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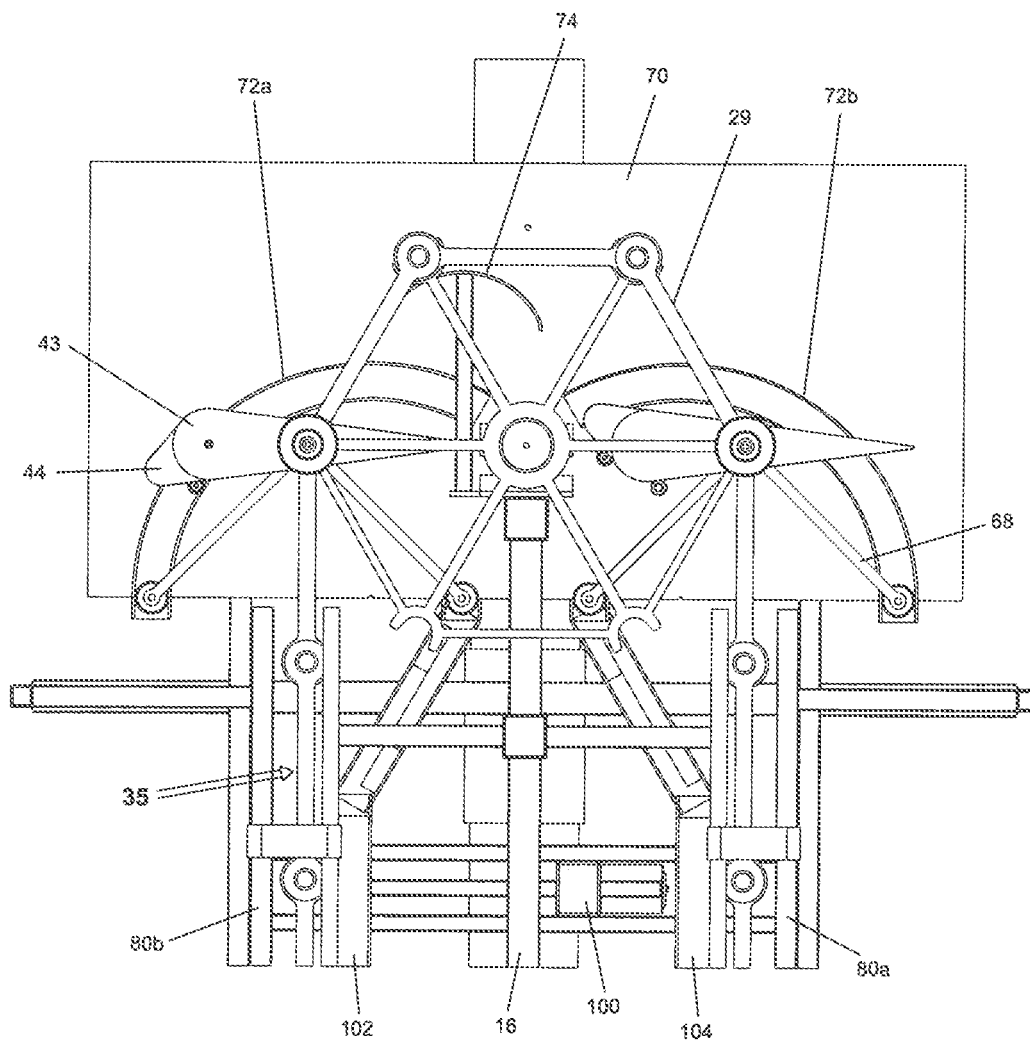


Fig 10

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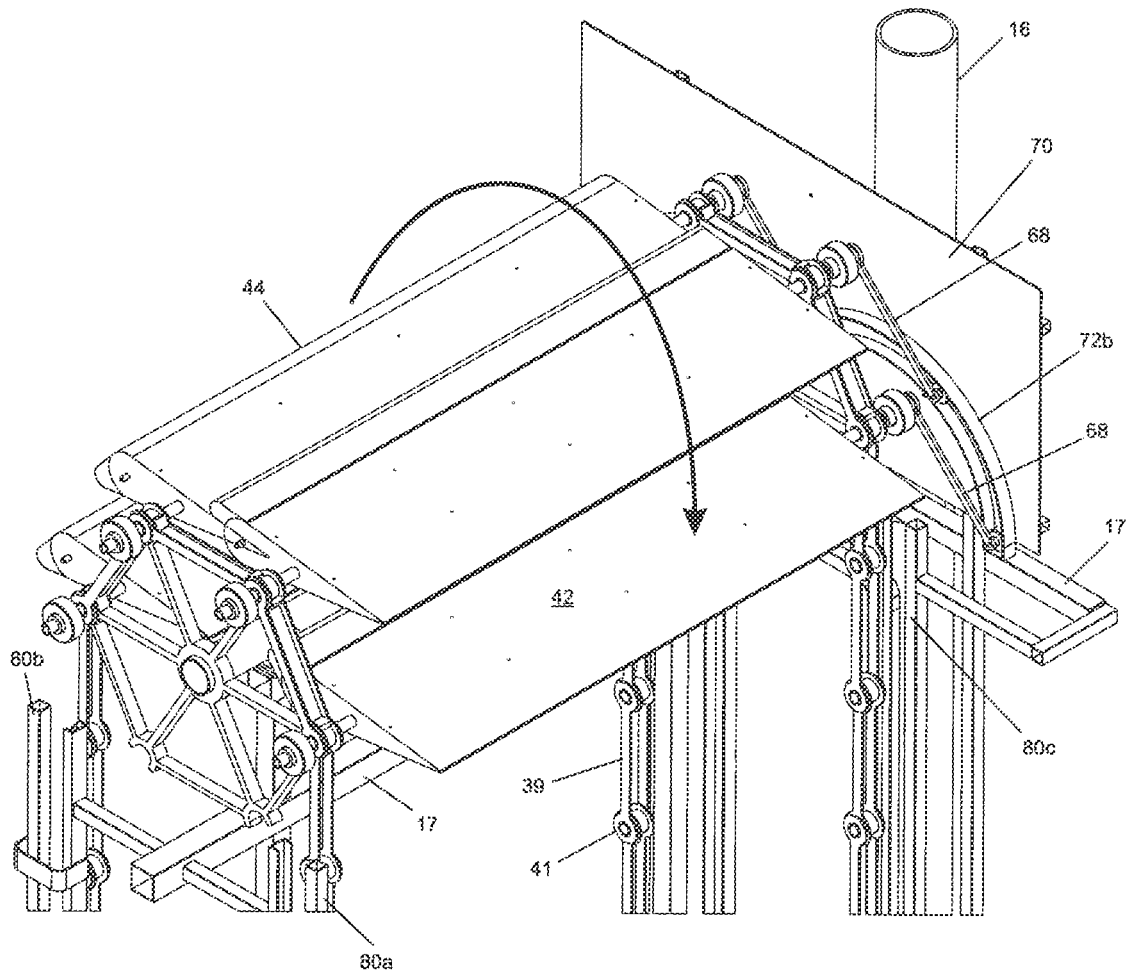


Fig 11

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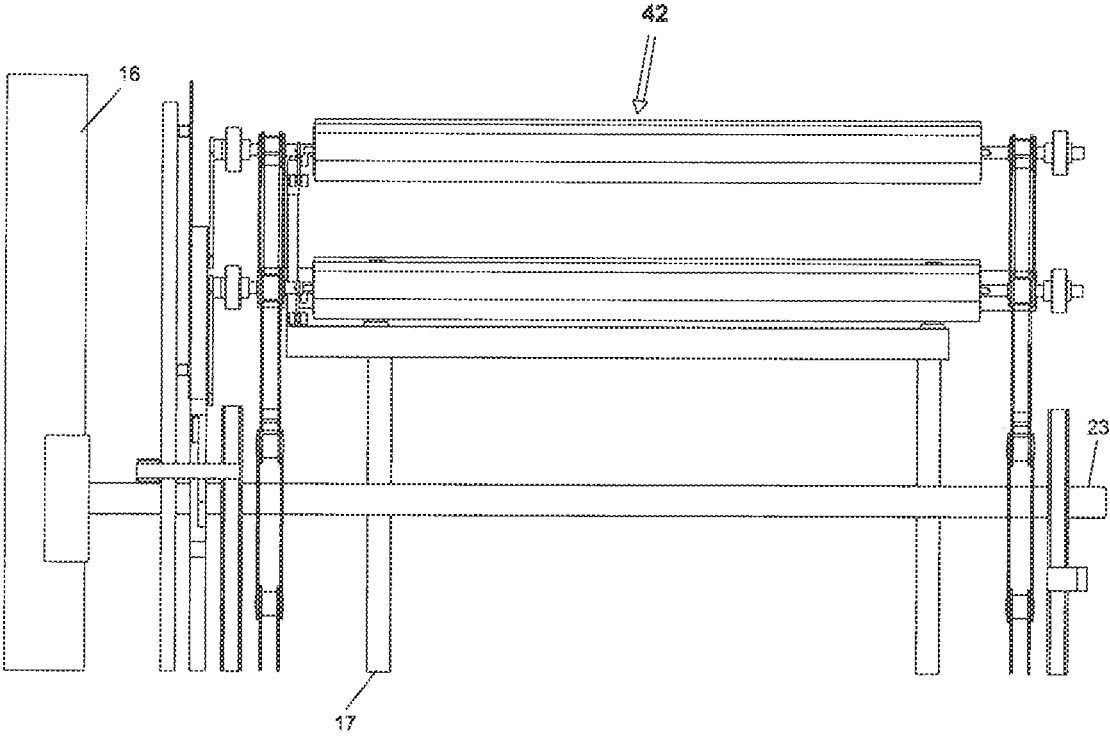


Fig 12

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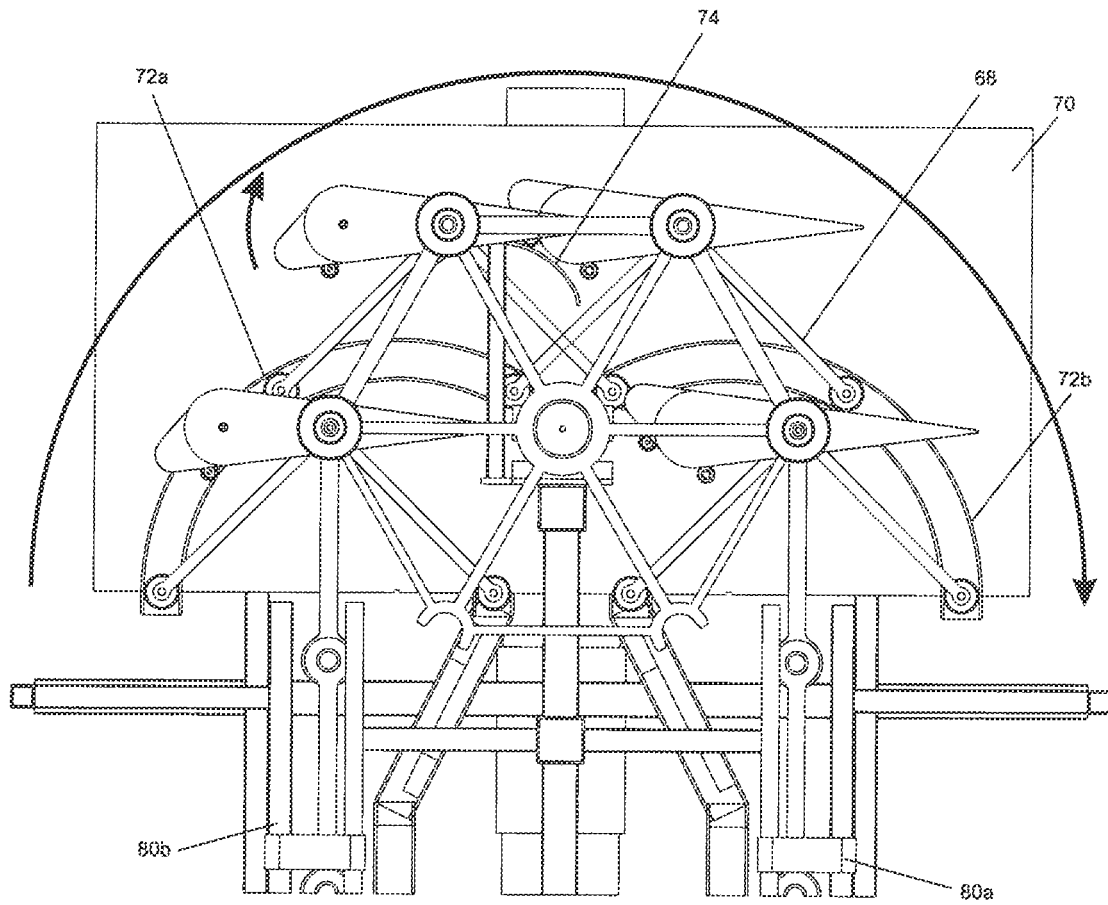


Fig 13

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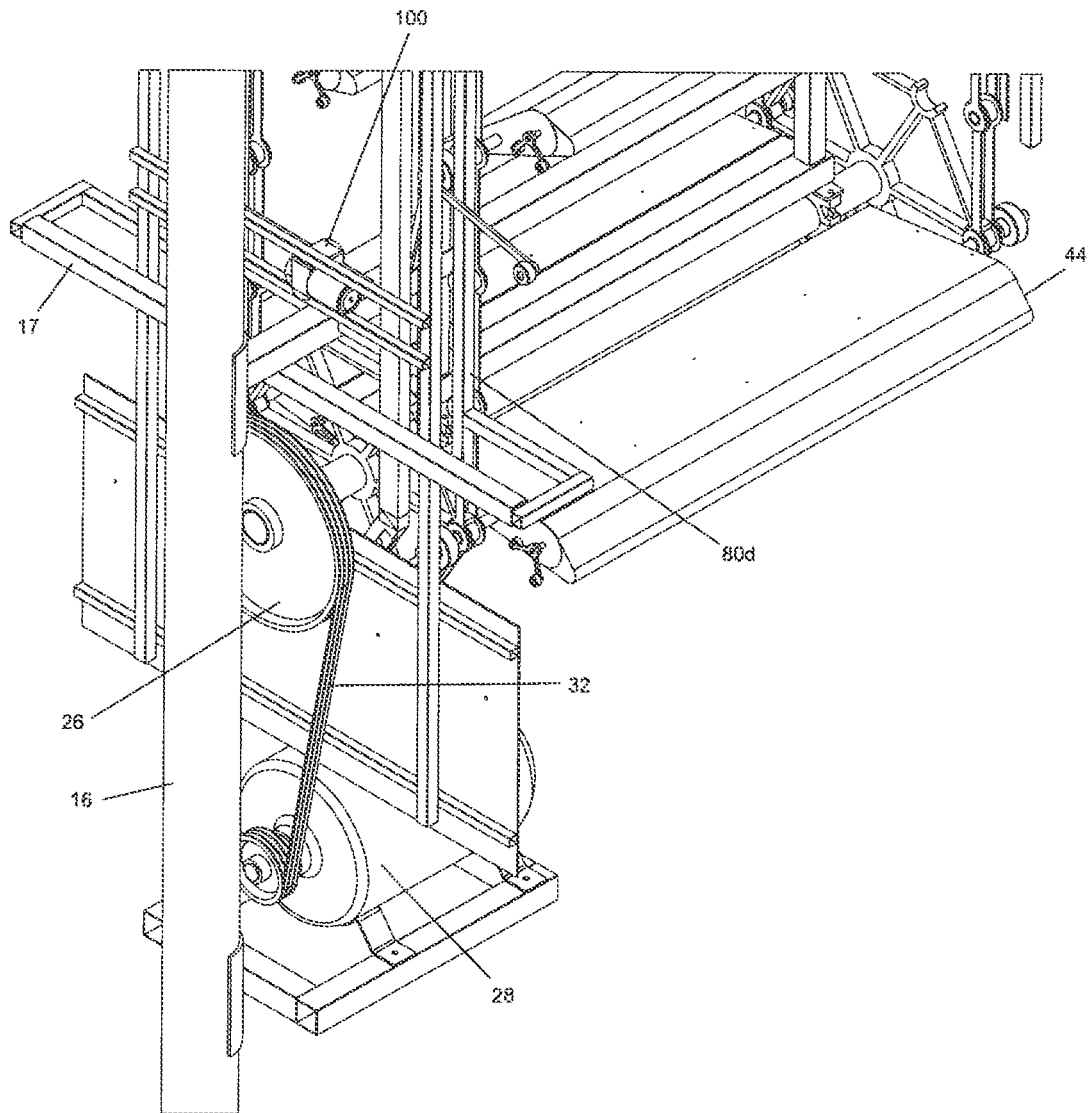


Fig 14

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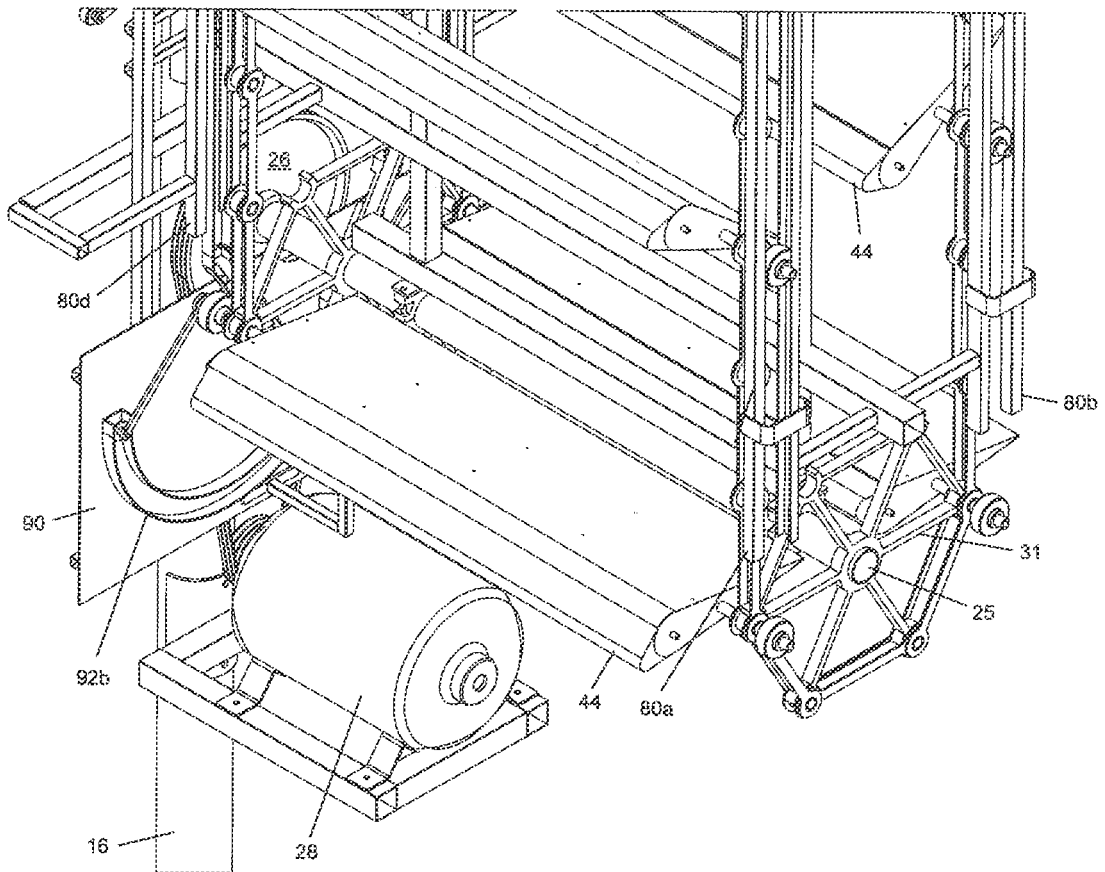


Fig 15

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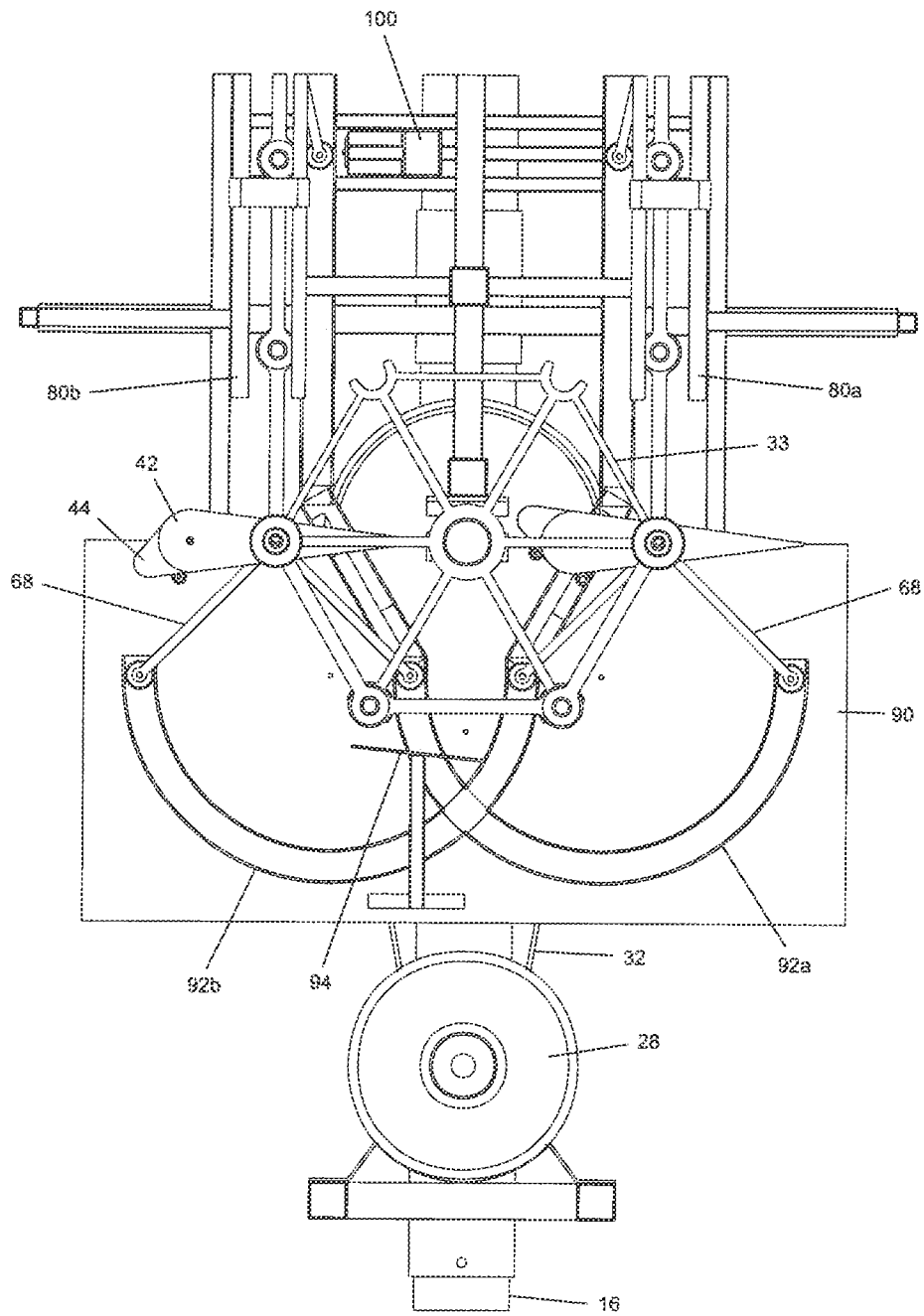


Fig 16

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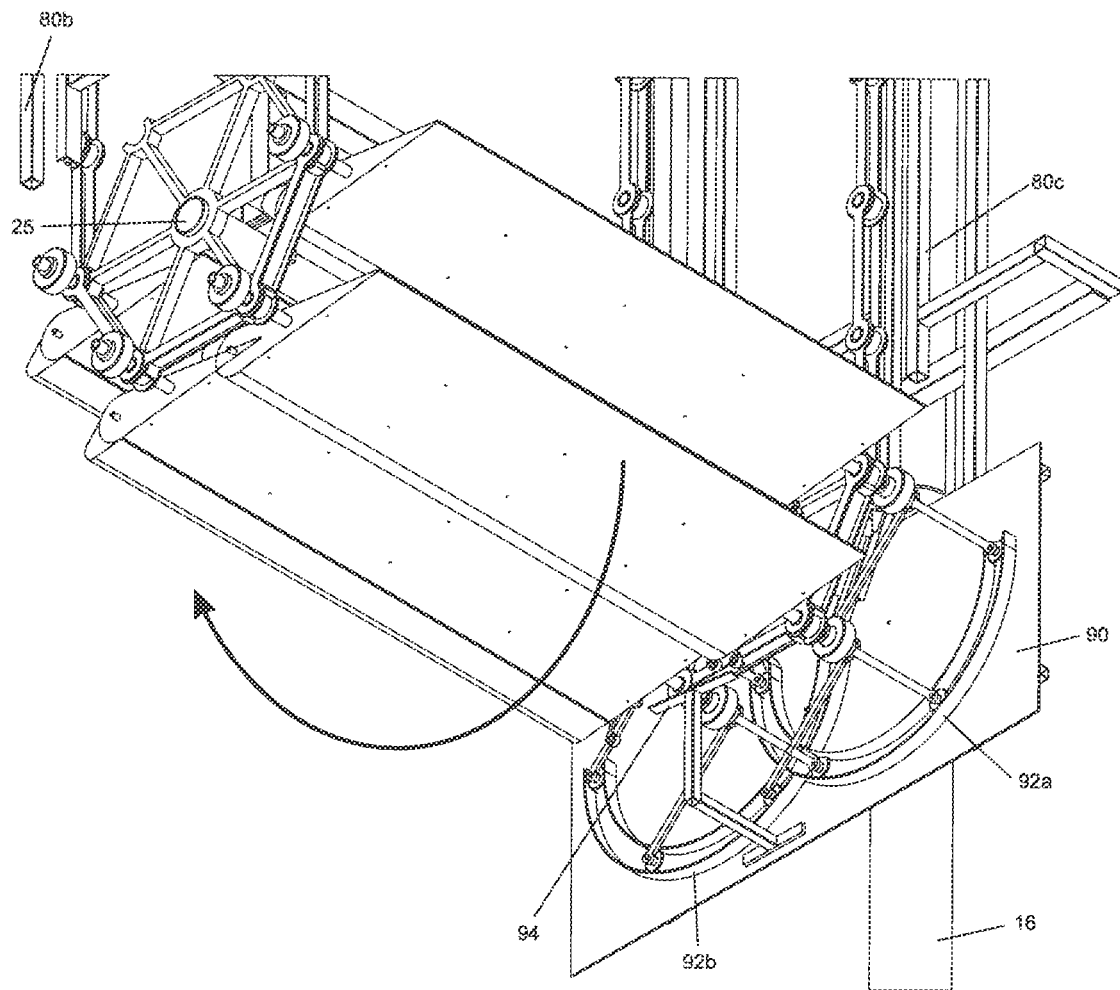


Fig 17

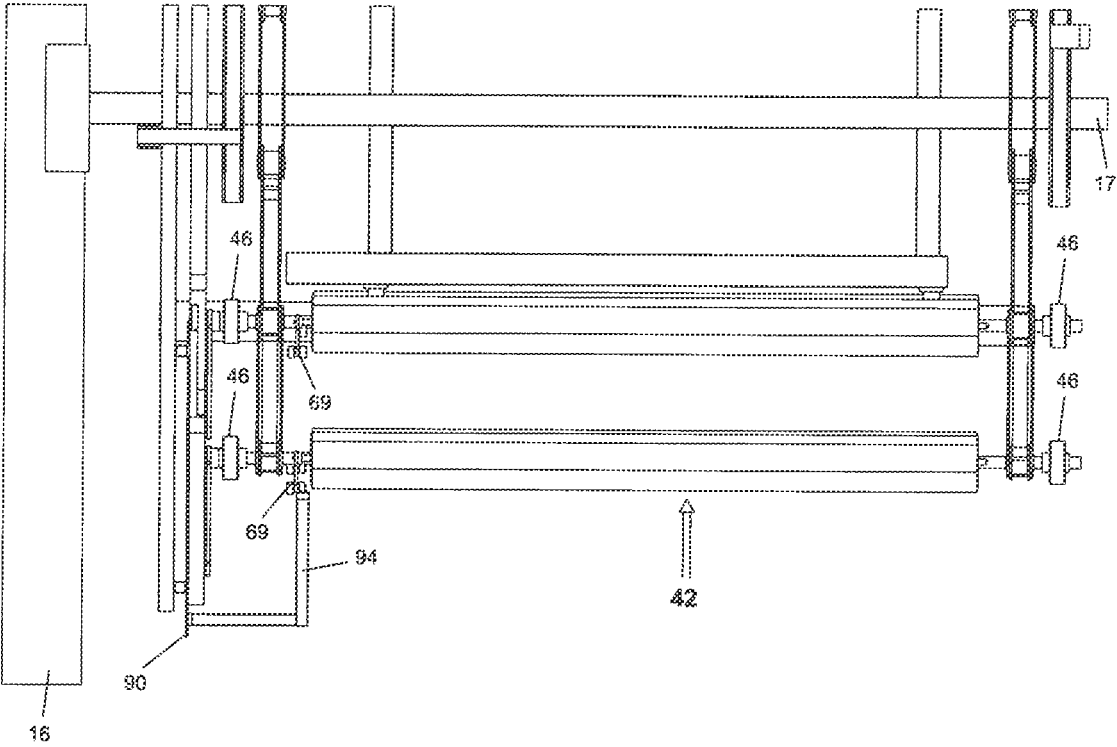


Fig 18

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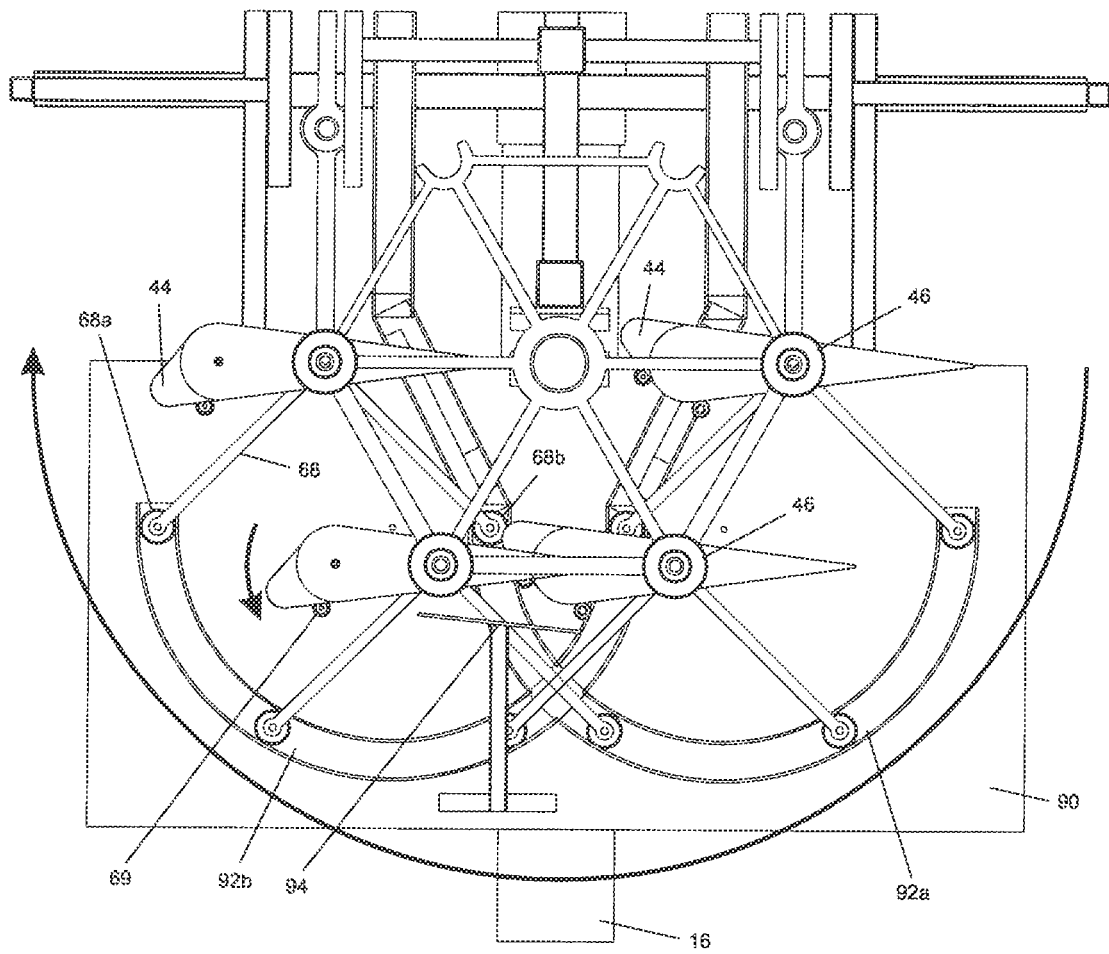


Fig 19

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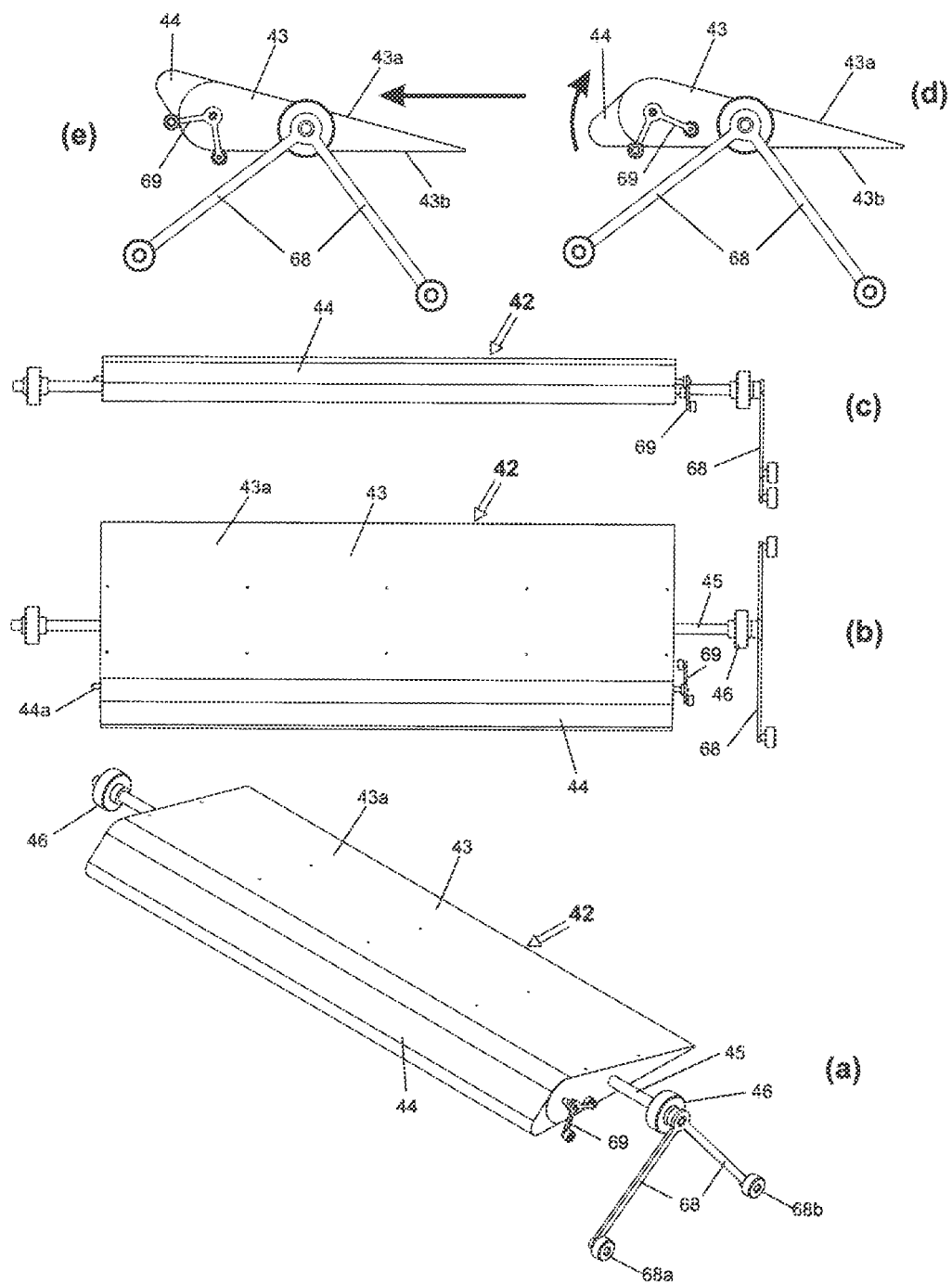


Fig 20 a-e