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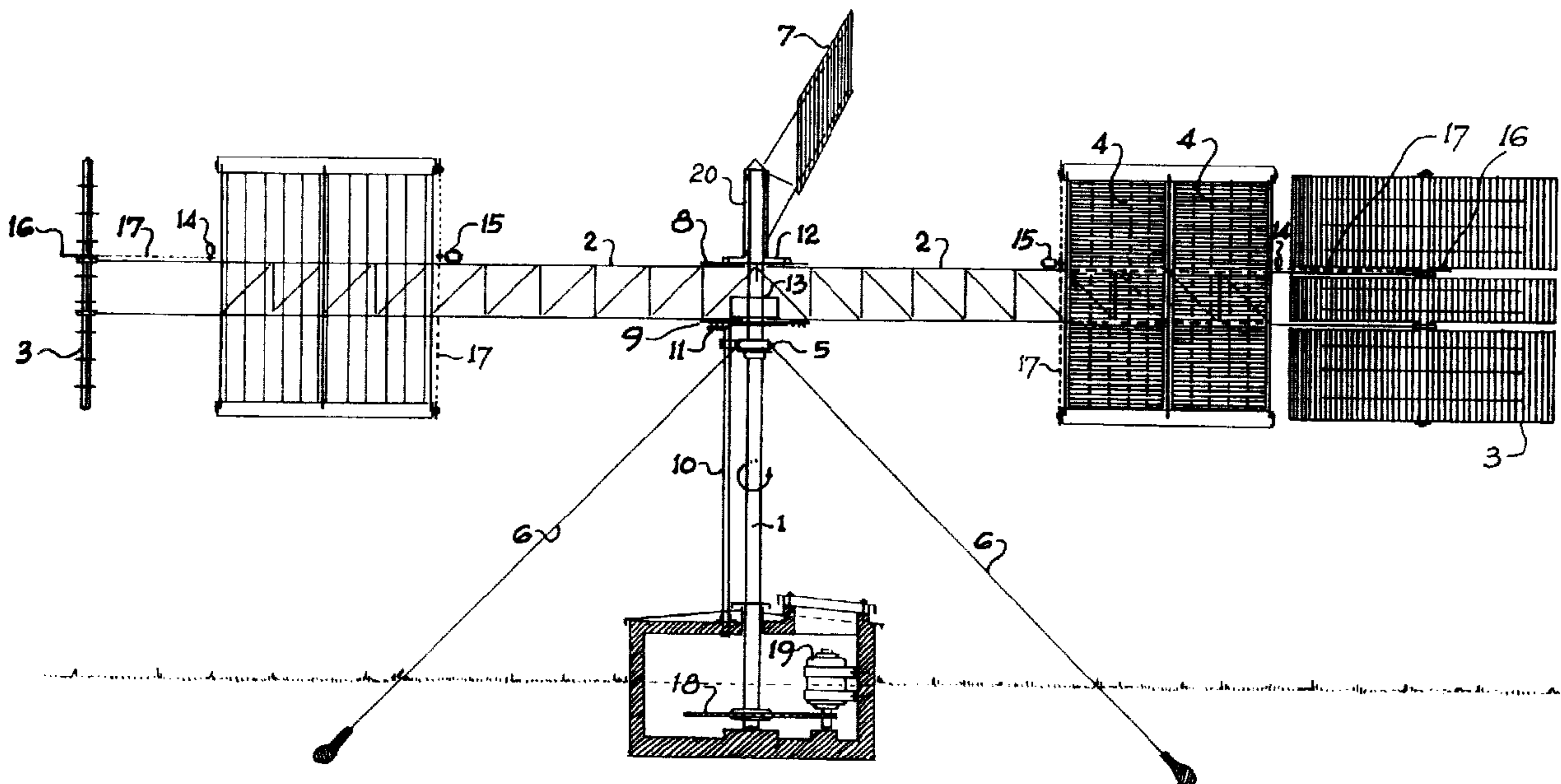
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(72) Inventeur/Inventor:
MOLLINGER, SID S., CA

(73) Propriétaire/Owner:
MOLLINGER, SID S., CA

(54) Titre : EOLIENNE A AXE VERTICAL MUNIE DE PALES PLATES VARIABLES ET DE RIDEAUX DE SURPRESSION
(54) Title: VERTICAL AXIS WIND MILL WITH VARIABLE PITCH FLAT BLADES AND BOOSTER CURTAINS



(57) Abrégé/Abstract:

A vertical axis wind mill with variable pitch flat blades and booster curtains that are all moved by electrical motors which are controlled by a weather vane.



A B S T R A C T :

A vertical axis wind mill with variable pitch flat blades and booster curtains that are all moved by electrical motors which are controlled by a weather vane.

S P E C I F I C A T I O N :

The present invention relates to a vertical axis wind mill having variable pitch flat blades and booster curtains attached to the ends of radial arms. Present practice for wind energy converters is to use horizontal axis propeller type wind turbines with the generator at the same difficult to service elevation as the propeller. These wind turbines have a relatively low efficiency and are self-starting at wind speeds of only 15 to 20 km/hr. some only at 30 km/hr or even higher wind speed. The present invention makes the most of the fact that work is the product of force time lever arm. Wind blowing on a large flat area that is attached to a vertical shaft exerts a substantial torque on the shaft. This principle is applied in the present invention by using variable pitch flat blades and booster curtains attached to the ends of structural arms that extend radially from a vertical shaft and rigidly connected thereto thus creating a torque on the vertical shaft. The vertical shaft is guyed to the ground using a slip collar and guy wires for lateral stability and it has at the bottom a large sprocket wheel rigidly attached to it which transfers the torque to a small sprocket wheel of a generator. The generator is thus easily accessible at or below ground level. A considerable advantage over conventional wind turbines, Also, most parts of such relatively simple wind mill can be made by steel fabricators anywhere.

The arrangement presented four problems which had to be solved in an inventive way. They are:

- a) The manner in which the structure is stabilized,
- b) how, when, where and at what rate the pitch of the flat blades is to be changed to attain best efficiency,
- c) the use of booster curtains,
- d) how, when and where the booster curtains are to be lowered and raised.

Having thus generally described the nature of the invention, reference is made to the accompanying drawings showing by way of an example specific embodiments thereof and in which :

Figure 1 is an elevation of the vertical axis wind mill with a right hand arm at the 0 position and the opposite arm at the 180 degree position of a circle in a plan view as shown in dotted lines in Figure 2.

Figure 2 is a plan view showing in diagrammatic way the radial arms, the weather vane, the motor control switches for blade pitch and curtain control, the motor speed and direction control device, the direction of the wind and the pitch of the flat blades to be attained at various positions of the radial arms.

The following reference characters are used :

- | | |
|--|---|
| 1 vertical shaft | 6 guy wire |
| 2 radial arm | 7 weather vane |
| 3 variable pitch, three
section, flat blade | 8 top circular steel plate
with motor control switches |
| 4 booster curtain | 9 bottom circular steel plate
with power pick-up rings |
| 5 slip collar | |

- | | |
|--|---|
| 10 external power supply conduit | 22 switch actuator for pitch control motors on arms at the 135 and 315 degree positions |
| 11 power pick-up rings | 23 switch actuator for pitch control motors on arms at the 45 and 225 degree positions |
| 12 circular cover plate with switch actuators, a rim and perimeter seal | 24 directional on-off switch for curtain control motor |
| 13 motor control box | 25 directional on-off switch actuator for curtain control motor at position 270 |
| 14 variable speed, bi-directional electric motor, moving pitch of blades | 26 directional on-off switch actuator for curtain control motor at position 90 |
| 15 bi-directional electric motor raising or lowering booster curtains | 27 speed and direction control device for pitch control motors |
| 16 sprocket wheel or sheave | 28 direction of wind |
| 17 drive chain or belt | 29 windward side |
| 18 large diameter sprocket wheel | 30 leeward side |
| 19 generator | 31 small diameter wheel |
| 20 sleeve over vertical shaft | |
| 21 alternate on-off switch for pitch control motors | |

0,45,90,135, } are positions of radial arms in degrees on a circle
 180,225,270, } in plan view, where 0 is at the right hand side.
 315 and 360 }

Figure 1 is to a large degree self explanatory to a structural or mechanical engineer. Variable pitch flat blades 3 need to be in three sections in order to use the area between the top and bottom chords

of the truss-like radial arms 2. The three sections of blades 3 are rigidly attached to a vertical axis which is rotated by sprocket wheel or sheave 16 that is moved by a chain or belt 17 driven by motor 14. Booster curtains 4 are shown to be of the pull down type, rolled around a horizontal shaft at the top of a structural frame when open. Motor 15 will do both, raise or lower the curtains. The top and bottom chords of truss-like radial arms 2 are connected to vertically spaced apart top and bottom circular steel plates 8 and 9 respectively and these horizontal plates are rigidly attached to vertical shaft 1, thus transferring torque, vertical and lateral loads thereto. Lateral stability of the structure is attained by the solid attachment to vertical shaft 1 of a circular angle just below bottom steel plate 9, the placement of a slip collar 5 on top of the circular angle and the connection of four guy wires 6 at 90 degrees to the slip collar 5 and anchored to the ground. Slip collar 5 does not rotate.

A pipe-like sleeve 20 is placed over an extension on top of vertical shaft 1. On the side of that sleeve 20 is rigidly connected weather vane 7 and at the bottom a circular cover plate 12 with a rim and a perimeter seal to keep out rain, wind and ice from motor control switches that are located between cover plate 12 and top circular steel plate 8. Motors 14 and 15 need electric power which is supplied from generator 19 or a power grid via stationary conduit 10 to power pick-up rings 11 on the underside of the normally rotating bottom circular steel plate 9. At the bottom of vertical shaft 1 is attached a large diameter sprocket wheel 18 that drives a small diameter sprocket wheel of generator 19.

The example shown in diagrammatic fashion in Figure 2 shows a wind mill with four radial arms 2 extending cross-like from the vertical shaft 1 but rotated by 45 degrees. In dotted lines is the preceding position when two arms were in the 0 to 180 degree direction to illustrate the pitch of flat blades 3 in the corresponding positions of the four arms. In the shown example the wind blows in the direction 28 i.e. from the bottom of the page to the top of the page, thus holding weather vane 7 on the leeward side 30 of vertical shaft 1 i.e. the 90 degree position and rotates the wind mill counterclockwise. This counterclockwise rotation of the wind mill is achieved by the force of the wind acting on flat blades 3 that are turned to such a pitch with respect to the radial arms 2 and by the booster curtains 4 so as to attain maximum counterclockwise torque substantially on the right hand side of the wind mill and near minimum resistance from the blades and the curtains when returning against the wind, substantially on the left hand side of the wind mill.

In the example shown in Figure 2 the four radial arms are in a 45 degree diagonal position thus obtaining four 90 degree sections, one at the top in which weather vane 7 is exactly in the middle, one at the bottom, one at the right and one at the left side of a circle. These sections remain always aligned with weather vane 7 and are significant for the pitch control of flat blades 3 as follows. in the top and bottom 90 degree sections the pitch of flat blades 3 will not change. In other words, the 45 degree right slash pitch of flat blade 3 on radial arm 2 at the 45 degree position does not change until radial arm 2 reaches the 135 degree position. And in the bottom 90 degree section the 45 degree

left slash pitch of flat blade 3 on radial arm 2 does not change until this radial arm 2 reaches the 315 degree position. In both, the left and right 90 degree sections the flat blades 3 will rotate clockwise by 90 degrees. In other words, when a radial arm reaches position 135 or position 315, the flat blades 3 will begin to rotate clockwise at a rate that by the time radial arms 2 reach position 45 or 225 flat blades 3 will have rotated clockwise by 90 degrees and the stop.

Booster curtain 4 on arm 2 that reaches a position opposite weather vane 7 i.e. the 270 degree position, will be lowered i.e. closed. When the opposite arm 2 reaches the position under weather vane 7 i.e. the 90 degree position, booster curtain 4 on that arm will be raised i.e. opened. All the movements of flat blades 3 and booster curtains 4 are accomplished by electric motors 14 and 15 which are controlled by weather vane 7 in such a way that the relative positions of blades 3 and curtains 4 with regard to the weather vane 7 are always attained, no matter from what direction the wind is blowing.

At the bottom of sleeve 20 is attached a circular cover plate 12, the bottom of which is about one inch from the top of top circular steel plate 8. In this space of about one inch between these two horizontal plates are located eight switches, four switch actuators and a motor speed and direction control device. All positions mentioned hereafter are on a circle of 360 degrees and are relative to the position of weather vane 7 which is always at position 90 i.e. on the leeward side of vertical shaft 1. On top of top circular steel plate 8 are mounted four alternate on-off switches 21, one each on diagonals in the 45, 135, 225 and 315 degree position on a radius so as not to interfere with speed and

direction control device 27. Also on top of top circular steel plate 8 are mounted four directional on-off switches 24, one each on the same diagonal positions as switches 21 but on a smaller radius so as not to interfere with switch actuators 22 and 23. In addition, on top of top circular steel plate 8 is mounted the axis of speed and direction control device 27 near the rim of circular cover plate 12 at the 270 degree position. Mounted to the underside of circular cover plate 12 are four switch actuators. Switch actuator 22 is attached at the diagonal 315 degree position on a radius so as to switch on alternate on-off switches 21 when they pass by. Switch actuator 23 is mounted at the 45 degree diagonal position on the same radius as switch actuator 22 so as to switch off alternate on-off switches 21 when they pass by when top circular steel plate 8 rotates. Directional on-off switch actuators 25 and 26 are mounted on the underside of circular cover plate 12 at the 270 and 90 degree positions respectively at a radius so as to switch on or off directional on-off switches 24 for curtain control motors. On the outside rim of circular cover plate 12 will be attached a seal so as to keep out rain, snow and ice. The seal will be in contact with top circular steel plate 8 producing some friction thus requiring a certain force to rotate cover plate 12. However, weather vane 7 will be of a size and have an arm of a length so that it will overcome the inertia at a wind speed of about 3 km/hr. All power to all electric motors will be switched off when the wheel of speed and direction control device 27 stops, i.e. when the wind mill as well as the weather vane 7 stop turning.

In the diagram as shown in Figure 2 the wind blows in direction 28 or from position 270 to position 90 or from the bottom to the top of the page thus keeping weather vane 7 steady on the leeward 30 side of vertical shaft 1 and turning the wind mill and with it top circular steel plate 8 in a counterclockwise direction. When one radial arm 2 reaches position 315 and the opposing arm position 135 switch actuator 22 will trigger switch 21 to start two motors 14 so as to begin to rotate blade 3 on the extremity of each of these two arms in a clockwise direction. At the same time the other two radial arms 2 of a four arm wind mill will reach positions 45 and 225 when switch actuator 23 will trigger alternate on-off switch 21 to stop motors 14 and with them the rotation of blades 3 on these two arms 2. Since blade 3 at the end of arm 2 in position 315 is on a 45 degree backslash pitch with respect to arm 2 and blade 3 of arm 2 in position 45 is in a 45 degree forward slash pitch the clockwise rotation of blades 3 is by exactly 90 degrees between these two positions of arm 2. This is also the case for blade 3 on the opposite arm 2 between positions 135 and 225.

Since the perimeter speed of the wind mill under heavy wind conditions will be higher and therefore the time to rotate radial arms 2 by 90 degrees will be reduced while the clockwise rotation of blades 3 will still be by the required 90 degrees in a shorter time, it is necessary that motors 14 have controllable speed. Such control is coming from speed and direction control device 27, which operates in the following manner. The location of device 27 has been specified earlier. Device 27 consists of a small diameter shaft attached to the top of top circular steel plate 8 at such a position that a small

diameter wheel 31 touches the rim of circular cover plate 12. Under normal operation the wind mill and top circular steel plate 8 turn in counterclockwise direction at a certain speed and weather vane 7 with circular cover plate 12 are stationary. This will turn the small wheel 31 of speed and direction control device 27 in a clockwise direction at a speed in a certain ratio to the perimeter speed of the wind mill. Device 27 can therefore send via motor control box 13 two signals to motors 14 i.e. in what direction to turn and at what speed.

In the case when the direction of the wind shifts so as to turn weather vane 7 in a clockwise direction it will have the effect of turning the small wheel 31 of speed and direction control device 27 faster in the same direction and device 27 will therefore send the signal to turn faster to the two motors 14 that are changing the pitch of blades 3.

In the case when the direction of the wind shifts so as to turn weather vane 7 in a counterclockwise direction it can have three different effects, depending on the speed at which weather vane 7 is rotated counterclockwise :

- a) When weather vane 7 rotates counterclockwise at less than the speed of the wind mill, which also rotates counterclockwise. In this case the small wheel 31 of speed and direction control device 27 will slow down, thus sending the signal to do the same to the two motors 14 that are on at that time.
- b) When weather vane 7 rotates counterclockwise at the same speed as the wind mill, which also rotates counterclockwise. In this case the small wheel 31 of device 27 stops rotating, thus sending the signal to the two operating motors 14 to stop.

- c) In the rare case when weather vane 7 rotates counterclockwise at greater speed than the wind mill, which also rotates counterclockwise. In this case all pitch and booster curtain controls will work in reverse as switches will be triggered in reverse and the small wheel 31 of device 27 will rotate counterclockwise, thus sending the signal to the two motors 14 that are operating to rotate blades 3 counterclockwise at the specific speed that depends on the speed of the counterclockwise rotation of small wheel 31.

C L A I M S :

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1 A wind mill having a vertical shaft from which radially extend four arms at right angle to each other, at the end of said four arms are attached a variable pitch, flat, three section blade pivotally mounted about a vertical axis and a booster curtain within a structural frame fixed parallel to said arm adjacent to said blade and whereby the pitch of said blade is changed by a variable speed bi-directional electric motor and the said booster curtain is opened or closed by a bi-directional electric motor and whereby said electric motors are controlled by a weather vane which is rigidly attached to the side of a pipe-like sleeve of an assembly, comprising the weather vane, the pipe-like sleeve, a horizontal and circular cover plate with a rim and a seal around its perimeter and two sets of two switch actuators attached to the underside of said cover plate, a first set of two switch actuators on positions 90° and 270° on a small distance from the vertical shaft and a second set of two switch actuators on positions 45° and 315° on a larger distance from the vertical shaft and said cover plate is centrally attached to the bottom of the pipe-like sleeve; the assembly is lowered over an extension of the top of the vertical shaft so as to leave a space of about one inch

between the cover plate and a top circular steel plate that is attached to the arms and that will rotate and has on its surface two sets of four motor control switches, a first set of four motor control switches, one motor control switch over the center of each arm on a smaller distance from the vertical shaft and a second set of four motor control switches, one motor control switch over the center of each arm on a somewhat larger distance from the vertical shaft so that the two sets of four motor control switches interact with the two sets of two switch actuators on the assembly to turn motor control switches on or off and thereby lowering the booster curtain at position 270° and raising the booster curtain at position 90° and rotating or stopping the blades from rotating in the four quarters of a circle in plan view, with 0° (zero degree) being on the right hand, as follows; in the quarter from 315° to 45° the blade will rotate clockwise by 90° as the motor control switch at position 315° will be turned on to start the variable speed bi-directional electric motors and begin to turn the blade clockwise at a speed so that by the time the arm reaches position 45° the blade will have turned clockwise by 90° and will therefore remain perpendicular to the direction of the wind in this quarter circle thus producing the majority of the torque on the vertical shaft; in the quarter circle from 45° to 135° the blade will not rotate as

the power to the variable speed bi-directional electric motor is switched off by the switch actuator on position 45° thus keeping the blade at a 45° right slant with respect to the center line of the arm; in the quarter circle from 135° to 225° the blade will rotate clockwise by 90° as the power to the variable speed bi-directional electric motor is switched on by the switch actuator on position 315° thus keeping the blade parallel to the direction of the wind, thereby reducing drag to a minimum; in the quarter circle from 225° to 315° the blade will not rotate as the power to the variable speed bi-directional electric motor is switched off by the switch actuator on position 45° thus keeping the blade at a 45° left slant with respect to the center line of the arm, and the booster curtain at position 90° will be raised i.e. opened by the switch actuator on position 90° to reduce drag from position 90° to position 270° and the booster curtain at position 270° will be lowered i.e. closed by the switch actuator at position 270° to provide a boost to the performance of the wind mill between positions 270° and 90°; in addition, there is a speed and direction control device for the variable speed and bi-directional electric motors that control the pitch of blades; said speed and direction control device consists of a small diameter wheel, the axis of which is

mounted on the top of the upper circular steel plate in a position so that the perimeter of the small diameter wheel touches the rim of the circular cover plate, thereby recording and sending the perimeter speed of the wind mill to the motor control box that contains known technology to calculate the speed that the variable speed bi-directional electric motors require to turn the respective blades by 90° by the time the wind mill rotates also by 90°; said speed and direction control device also records and sends any signals for any variations of speed and direction caused by the rotation of the weather vane which can result in a change of the speed of rotation and a change of direction of the blades from clockwise to counterclockwise, therefore the requirement of variable speed, bi-directional electric motors for changing the pitch of plates.

2 A wind mill as claimed in claim 1 wherein each of said four radial arms is an assembly of two vertical and two horizontal trusses, said trusses being connected to two vertically spaced apart horizontal and circular steel plates that are centered on said vertical shaft and are rigidly connected near the top of and to the vertical shaft, thus transferring the torque and the lateral and vertical loads to

the vertical shaft and wherein the lateral stability of the wind mill is attained by the use of a slip collar that is placed over a fixed collar that is rigidly attached to the vertical shaft just below the lower of the two vertically spaced apart horizontal and circular steel plates and whereby guy wires are attached to the slip collar and anchored to the ground; The slip collar does not rotate.

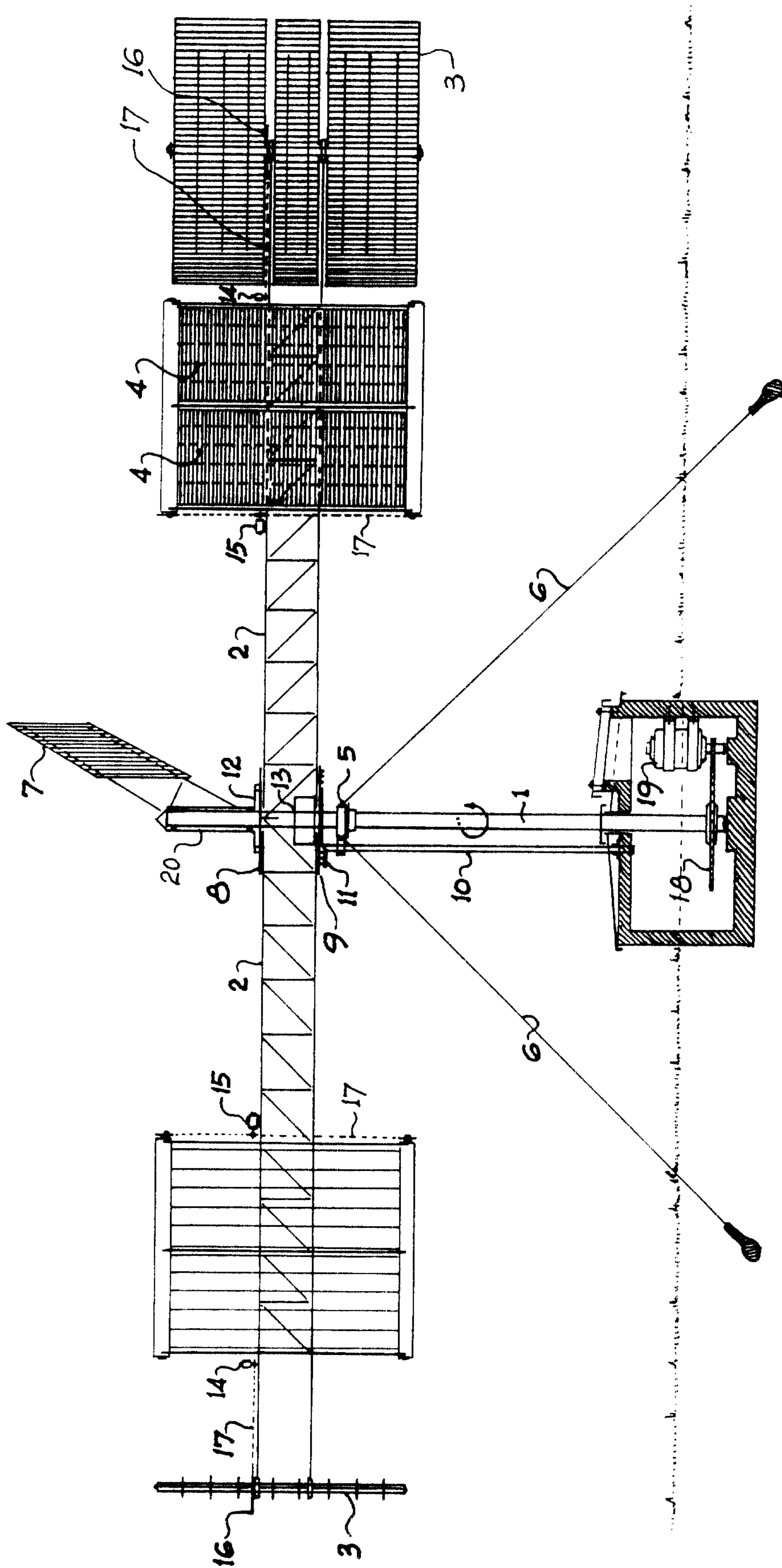


FIG. 1

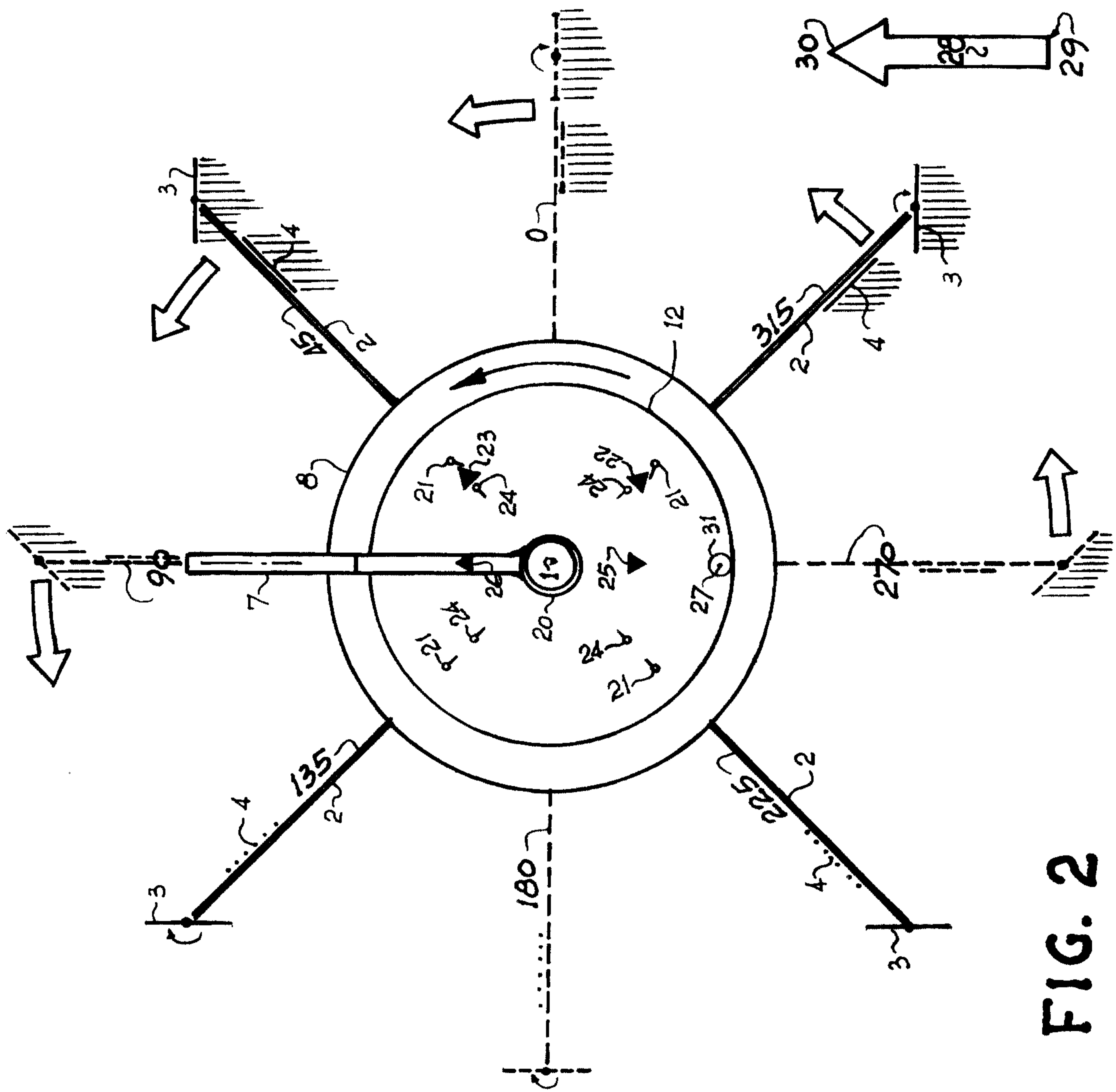


FIG. 2

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