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Twin turbine system which follows the wind/water (windtracker) for wind and/or water power, with optimized blade shape

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(71) Applicant(s)
Dennis Steel

(72) Inventor(s)
Steel, Dennis Patrick

(74) Agent / Attorney
Spruson & Ferguson, L 35 St Martins Tower 31 Market St, Sydney, NSW, 2000

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(72) Erfinder; und
(71) Anmelder : STEEL, Dennis Patrick [DE/DE]; Bullermannshof 21, 47441 Moers (DE).

(74) Anwalt: SCHOENEN, Norbert; Postfach 10 22 09, 47412 Moers (DE).

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(54) Title: TWIN TURBINE SYSTEM WHICH FOLLOWS THE WIND/WATER (WINDTRACKER) FOR WIND AND/OR WATER POWER, WITH OPTIMIZED BLADE SHAPE

(54) Bezeichnung : ZWILLINGSTURBINENSYSTEM, DAS DEM WIND/WASSER FOLGT (WINDTRACKER), FÜR WIND- UND/ODER WASSERKRAFT, MIT OPTIMIERTER FLÜGELFORM

(57) Abstract: The turbine system for wind and/or water power, wherein the radial turbines have a rotor which can rotate about an axis and comprises one or more turbine blades, wherein the turbine blades are aligned parallel to the rotor, wherein the turbine blades are arranged within a cylindrical shell, which is arranged concentrically around the axis and has an outer radius R1 and an inner radius R2, is characterized in that the turbine blades have a specific geometry and in that two radial turbines (1, 2) which are aligned alongside one another and parallel are arranged, which radial turbines (1, 2) are connected to one another and can pivot about a pivoting axis (15) parallel to the turbine axes (18), wherein the pivoting axis and the guide surfaces (3, 4) are not located on the connecting line between the turbine axes, and are both located on the same side of the connecting line. It is proposed that the abstract be published without any drawing.

(57) Zusammenfassung: Das Turbinensystem für Wind- und/oder Wasserkraft, wobei die Radialturbinen einen um eine Achse drehbaren Rotor aufweisen, welcher einen oder mehrere Turbinenflügel umfasst, wobei die Turbinenflügel parallel zum Rotor ausgerichtet sind, wobei die Turbinenflügel innerhalb einer konzentrisch um die Achse angeordneten Zylinderschale mit einem äußeren Radius R1 und einem inneren Radius R2 angeordnet sind, ist dadurch gekennzeichnet, dass die Turbinenflügel eine bestimmte Geometrie haben und dass zwei nebeneinander und parallel ausgerichtete Radialturbinen (1, 2) angeordnet sind, die miteinander verbunden und um eine Schwenkachse (15) parallel zu den Turbinenachsen (18) verschwenkbar sind, wobei die Schwenkachse und die Leitflächen (3, 4) außerhalb der Verbindungslinie der Turbinenachsen und beide auf der gleichen Seite der Verbindungslinie liegen. Es wird vorgeschlagen, die Zusammenfassung ohne Zeichnung zu veröffentlichen.

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TWIN TURBINE SYSTEM WHICH FOLLOWS THE WIND/WATER (WINDTRACKER) FOR WIND AND/OR WATER POWER, WITH OPTIMISED BLADE SYSTEM

TECHNICAL FIELD

The invention relates to a turbine system for wind and/or water power, with an optimised blade system.

BACKGROUND OF THE INVENTION

Savonius turbines are known. These rotors may consist of two horizontal circular discs which are attached to a vertical rotor shaft and between which two semi-circular curved blades are attached in a vertical position.

A decisive unbalance as a result of the cyclically varying load strength from the flow during rotation is characteristic of the Savonius rotor, even when the weight distribution is perfectly balanced. This unbalance due to load alternation can be minimised by arranging a larger number of blades, generally three, instead of two. However, this greatly reduces the efficiency of the Savonius rotor, by approximately 30 %.

By comparison with the known three-blade wind generators having a horizontal axis of rotation and aircraft-type blades, a radial turbine has the major advantage of operating independently of the direction of the incident wind. Thus, the radial turbine having a vertical axis of rotation does not have to be turned to the wind.

In a particularly economical embodiment, the radial turbine is provided with deflector plates, which collect the wind energy and deflect it onto the blades of the radial turbine in a concentrated form. However, this has the drawback that, because of the deflector plate, independence from the wind direction is no longer achieved. The radial turbine comprising a deflector plate therefore has to be tracked to the wind.

If the Savonius turbine is equipped with deflector plates, it gains at low wind speeds, but loses all the more at higher wind speeds.

There is a need for much better use of the wind energy, with a much higher efficiency than in conventional Savonius turbines. It should still be possible to use the wind turbine even when the wind would be too weak to drive conventional Savonius turbines.

The wind turbines should operate with no noise and very little vibration, in such a way that they can even be used on residential buildings in urban areas.

A radial turbine is also to be used which comprises a deflector plate and which automatically turns to an optimum angular position with respect to the incident wind, and is thus self-tracking, without a tracking arrangement being necessary for this purpose. The advantages of the deflector plate in the radial turbine are thus to be combined with the independence of the radial turbine from the incident wind direction.

A minimum unbalance with high performance is to be ensured by way of the special construction and geometry.

It is known that the Savonius rotor and the Darrieus rotor do not gain in performance as a result of deflector plates. The Savonius rotor gains in weak wind, but this is conditional on speed, and leads to losses at higher wind speeds. Since the turbine is dependent on the wind direction, it decreases in overall efficiency.

OBJECT OF THE INVENTION

It is the object of the present invention to substantially overcome or at least ameliorate one or more of the disadvantages of the prior art, or at least provide a useful alternative.

SUMMARY OF THE INVENTION

According to the present invention, there is disclosed a turbine system for wind and/or water power, comprising two radial turbines, wherein the radial turbines comprise a rotor which can rotate about a turbine shaft and which comprises one or more turbine blades, the turbine blades being orientated parallel to the rotor, the turbine blades being arranged within a cylindrical shell, which is arranged concentrically about the turbine shaft and has an external radius R1 and an internal radius R2, the radial turbines having upper ends and lower ends, wherein the internal radius is

$$R2 = f1 \times R1$$

where f1 = 0.19 to 0.32,

wherein each turbine blade has a first region which extends from the internal radius R2 to the external radius R1, is curved towards the turbine shaft, and has a radius of curvature

$$R3 = f2 \times R1$$

where f2 = 1.2 to 2.4, and

a second region, which is externally adjacent to the first region and having a radius of curvature R4, is positioned on the outside of the cylindrical shell, and has a curvature towards the turbine shaft, the curvature pointing to the same side as the curvature of the first region, the radius of curvature R4 of the second region being

$$R4 = f3 \times R1$$

where f3 > 0.7,

wherein the second region is of a width

$$B2 = f8 \times R1$$

where f8 = 0.11 to 0.19, and

wherein two radial turbines, orientated parallel side by side, are arranged with vertical rotation turbine shafts, are interconnected, and are pivotable about a pivot shaft parallel to the turbine shafts, the pivot shaft and a V-shaped wind splitter being positioned outside a line connecting the turbine shafts and both being on the same side of said line,

the radial turbines having concentration plates and/or wind guide plates located at the upper ends and the lower ends of the radial turbines and

the turbine blades are mounted on a plurality of milled support arms, which in turn are fastened to a rotary part on the turbine shaft,

wherein the wind splitter comprises a deflector surface orientated parallel to the rotor is arranged outside the cylindrical shell, and is of a width

$$B3 = f9 \times R1$$

where f9 = 0.7 to 2.5,

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the deflector surface having an edge facing the turbine shaft,

the edge of the deflector surface being at a distance A2

$$A2 = f6 \times R1$$

where f6 = 0.25 to 0.55 from a first longitudinal section plane through the turbine shaft, and at a distance A1

$$A1 = f5 \times R1$$

where f5 = 1.00 to 1.10 from a second longitudinal section plane through the turbine shaft, the second longitudinal section plane being perpendicular to the first longitudinal section plane, and wherein the deflector surface has an angle of incidence

$$\alpha = 40° \text{ to } 60°$$

with respect to the first longitudinal section plane.

As a result of the aerodynamic nose (wind splitter) together with the turbine of the construction in at least an embodiment of the present invention, energy yield is demonstrably increased at all wind strengths.

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As a result of the optimum arrangement of the aerodynamic parts, including the rotary connection, the turbine system in at least an embodiment of the present invention follows the wind in all directions without a motor drive.

As a result of the specific shape and arrangement of the turbine blades in connection with the wind splitter in at least an embodiment of the present invention, and in accordance with the parameter ranges as described above, rotational speeds up to three times higher than in known Savonius turbines are obtained, along with an efficiency of up to 66 %, by contrast with the efficiency of 28 % achieved by conventional turbines. The turbine in at least an embodiment of the present invention can be used even in very weak wind which would no longer be sufficient to drive conventional Savonius turbines.

By contrast with the Savonius rotor, the wind turbine in at least an embodiment of the present invention does not have an unbalance of the type described above, even in a preferred embodiment where three turbine blades are provided.

In at least an embodiment of the present invention, it is particularly expedient to combine the geometry of the turbine blades with a deflector surface, also known as a wind splitter.

Another important consideration: suppose there are two turbines in a system enclosed by deflector plates and having additional bevelled concentration plates and/or wind guide plates which are attached above and below the turbines. As a result of the closed system and the additional concentration plates and/or wind guide plates, optimum use is made of what is known as the Magnus effect, and as a result, the system in at least an embodiment of the present invention, which is mounted on a mast, can rotate to the wind automatically and thus always receive an optimum wind flow. This “turning to the wind” has been demonstrated in a number of specific models in natural wind.

The Magnus effect, named after Heinrich Gustav Magnus (1802-1870), who discovered it, is a phenomenon in fluid mechanics, specifically the transverse force effect (force) experienced by a round rotating body (cylinder or ball) in a flow.

By way of frictional effects, a rotating roller induces rotation in the fluid surrounding it. If there is additionally a flow over the roller, the different speeds of fluid overlap. As a result, the fluid flows around the rotating roller faster on one side than on the other (in the rest system of the roller). On the side of the roller where the frictional effects are greater, it is as if the fluid were flowing more rapidly. This results in "deflection" of the roller, pushing the roller downwards (see Fig. 10).

Examples

- Football players kick the ball with spin in such a way that it flies into the goal in an arc. The more quickly it rotates, the greater the deviation of the path (curling cross, knuckleball).
- Table tennis players and tennis players use this effect, for example with topspin and slicing.
- Curveballs in baseball and riseballs in softball.
- Spin-bowling in cricket.
- Golf balls have a large number of small depressions on the surface, known as dimples. As turbulators, they improve the adhesion of the boundary layer which lies against the ball and is entrained by the rotation thereof. This increases the formation of turbulence and the associated deviation of the ball due to the Magnus effect. Since the golf ball rotates backwards as a result of the wedge shape of the golf club, it is lifted by the Magnus effect; it does not simply fly like a cannonball, but instead experiences a lift. Additional deviations to the left or right are possible, and are also used by players who have mastered this technique. Moreover, the supercritical turbulent circulation reduces the air resistance, and this in turn leads to greater flight distances.

In at least an embodiment of the present invention, high performance is achieved in combination with low installation costs, in such a way that the cost-effectiveness, in terms of power output, is much greater than in the known wind generators comprising a horizontal shaft and blades of the aircraft-wing type.

To increase the cost-effectiveness, a ring generator in at least an embodiment of the present invention is provided for power generation. In addition, to increase the cost-effectiveness further, the mast and the wind splitter can be used as advertising space.

In at least an embodiment of the present invention, with the blade shape of the individual turbines and the specific arrangement of the two turbines with respect to one another, it is particularly advantageous that the two turbines do not obstruct one another, but can instead

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boost one another, even at low wind speeds, assisted by the low-frequency pressure oscillation taking place in the rear cavity of the V-shaped wind splitter.

By contrast with the known wind generators comprising a horizontal shaft and three blades, the radial turbine in at least an embodiment of the present invention can be operated even at relatively low wind speeds. As a result of the Magnus effect, the radial turbine in at least an embodiment of the present invention “pulls” the wind in, as it were, and amplifies low wind speeds. For example, the radial turbine in at least an embodiment of the present invention can also be used in circulating winds, in which the wind speed is greater below at a low height than at the large height at which the three-blade wind generators have to be operated simply because of the blade size. A wind speed which is too low for the known three-blade turbines in any case is sufficient for energy production with the radial turbine in at least an embodiment of the present invention.

In the event of fluctuations in the wind direction, the radial turbine in at least an embodiment of the present invention adjusts itself automatically, partly as a result of the Magnus effect, and immediately rotates to the optimum direction, even at wind speeds of less than 1 m/s. Rapid adaptations of this type of the generator are not possible with the known three-blade turbines.

Since the radial turbine in at least an embodiment of the present invention only takes up a small amount of space, it can be used as an add-on to pre-existing parts of buildings or structural elements, for example as an attachment to a street light.

Embodiments

Preferred embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings wherein:

Fig. 1 is a schematic cross-section through the wind turbine according to the invention in accordance with a particularly preferred embodiment,

Fig. 2 is a graphical representation of the free-running rotational speeds, plotted against the wind speed, for the wind turbine according to the invention (upper curve and crosses) and for a conventional Savonius wind turbine (lower curve and circles),

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Fig. 3 to 5 are graphical representations of the rotational speeds of the wind turbine according to the invention and a conventional Savonius wind turbine together with the incoming flow angle of the wind and the wind speed, plotted against time,

Fig. 6 is a schematic cross-sectional drawing of a conventional Savonius wind turbine, showing the mode of operation thereof,

Fig. 7 is a perspective drawing of the wind generator according to the invention comprising two radial turbines,

Fig. 8 shows the constructional details of an embodiment as a tubular mast mounting system in a view from the side in accordance with A-A in Fig. 9,

Fig. 9 is a plan view of the wind generator,

Fig. 10 shows a rotating roller with surrounding fluid,

Fig. 11 shows the thread test,

Fig. 12 to 14 show further variants with modified wind splitters 29 and additional concentration plates 30,

Fig. 15 shows torque vs. rotational speed characteristics,

Fig. 16 shows further characteristics,

Fig. 17 to 26 are various perspective views of a wind generator according to the invention which has been improved further,

Fig. 27a shows a grid mast construction, which is and/or can be used for the special accumulator and turbine mounting system,

Fig. 27b is the section A-A,

Fig. 28 shows "support hearts", which are fixed to a rotary part on the shaft.

Wind flows onto the wind turbine according to the invention of Fig. 1 in a primary wind direction 101 and subsidiary wind directions 102, 103. The significance of the remaining reference numerals in Fig. 1 can be seen from Tables 1 and 2 below, which also specify the ranges of values according to the invention for the parameters and the particularly preferred values of the parameters in the two embodiments.

A grid mast construction is provided above the rotary connection, and is used and can be used as a frame for the special accumulator mounting system and turbine system.

A safety space, which is protected and earthed by the outer shell of the mast, preferably a thick-walled steel tube, and may contain various sensitive technological components, is located below the rotary connection, without any additional costs. The use according to the invention of the turbine system makes it possible to create safety spaces, and to use wind generators in the pre-existing infrastructure (streets, rails etc.), in areas where construction would otherwise be impossible.

Fig. 2 shows the measurement results for the free-running rotational speed of the wind turbine according to the invention and of a Savonius wind turbine. The rotational speeds in revolutions per minute are plotted against the wind speed in m/s. The upper curve is a line of best fit for the rotational speed values of the wind turbine according to the invention, which are plotted using crosses. The measurement values for the conventional Savonius wind turbines are shown as circles. The lower curve is a line of best fit.

It can clearly be seen that in a wind speed range from approximately 0.7 to 1.8 m/s a conventional Savonius turbine is stationary, but the wind turbine according to the invention rotates at rotational speed of 50 to 150 revolutions per minute. In the wind speed range from approximately 1.7 to 2.7, the wind turbine according to the invention rotates at approximately 2 to 15 times the rotational speed of the conventional Savonius turbine.

Table 1: Parameters	**Range of values for the parameter (first alternative)**	**In the first embodiment:**
R1 = Radius of the turbine	as desired	0.125 m
R2 = Distance from the centre of rotation (point P_0) to the inner blade end (point P_1) = $f_1 \times R1$	$f_1 = 0.28 - 0.32$	0.036 m
R3 = Radius of curvature of the cylindrical shell, adjacent to the point P_1, of a blade = $f_2 \times R1$	$f_2 = 1.2 - 2.4$	0.165 m

R4 = Radius of curvature of the cylindrical shell, adjacent to the point P_2 on the outer radius of the turbine, of a blade = $f_3 \times R1$	$f_3 > 0.7$	0.125 m
R5 = Radius of curvature of the kink between the two cylindrical shells of a blade = $f_4 \times R1$	$f_4 = 0.02 - 0.08$	0.003 m
A1 = Distance of the edge of the deflector plate facing the turbine (point P_3) from the second longitudinal section plane 5 (perpendicular to the first longitudinal section plane 4) = $f_5 \times R1$	$f_5 = 1.04 - 1.10$	0.135 m
A2 = Distance of the edge of the deflector plate facing the turbine (point P_3) from the first longitudinal section plane 4 (= primary wind direction) = $f_6 \times R1$	$f_6 = 0.25 - 0.30$	0.035 m
B1 = Width of a turbine blade (distance between the points P_1 and P_2) = $f_7 \times R1$	$f_7 = 0.9 - 1.0$	0.120 m
B2 = Width of the outer cylinder shell of a turbine blade (i.e. distance between the intersection of the respective extrapolated circles of the two cylindrical shells of a blade and the point P_2) = $f_8 \times R1$	$f_8 = 0.11 - 0.16$	0.016 m
B3 = Width of the deflector plate = $f_9 \times R1$	$f_9 = 0.7 - 1.0$	0.110 m
D1 = Diameter of the shaft = $f_{10} \times R1$	$f_{10} = 0.09 - 0.13$	0.012 m
α_1 = Angle of incidence of the deflector plate with respect to the primary wind direction	$\alpha_1 = 40° - 60°$	45°

A series of measurement results for the properties of the wind turbine according to the invention and for a conventional Savonius wind turbine, which were both exposed to the same wind conditions, is shown graphically in Fig. 3 to 5. The upper curve 110 represents the respective angle of incidence of the wind in the range from +80° to -80°. The curve 111 shows the wind speed, in this diagram in a range of 0 to 6.5 m/s. The curve 112 shows the rotational speed of the wind turbine according to the invention in a range of 0 to 500 revolutions per minute. The curve 113 shows the corresponding rotational speeds for a conventional Savonius wind turbine. Since the Savonius wind turbine is often stationary at these wind speeds, the curve 113 is always close to or even on the zero line.

Fig. 6 is a schematic drawing of a Savonius wind wheel, shown by way of prior art. The flow direction of the air and the direction of rotation are shown.

As regards the prior art, it can additionally be established that 2 basic types of wind generators have achieved success:

a) Horizontal-axis wind turbines (HAWTs) with wind incident in the axial direction
b) Vertical-axis wind turbines (VAWTs) with wind incident transverse to the axial direction

The inventive solution disclosed herein relates primarily to VAWTs, although horizontal mounting with an incident wind flow transverse to the axial direction is also possible in special cases.

There are also many variations/modifications among commercially available VAWT systems, starting from 2 basic types (see for example German Wikipedia "Windturbine"):

- Savonius rotor
- Giromill/Darrieus rotor

Unlike the turbine according to the invention, the Savonius rotor cannot run faster as a result of a deflector plate or deflector surface. However, this can be demonstrated with the invention.

The variations relate to the number and the special shape of the rotor blades, the attachment of wind guide elements, and in some cases a screw-shaped configuration for achieving a more constant speed during rotation. The solution according to the invention thus relates to particular, relatively precisely determined shapes and arrangements which have been found to be particularly efficient in the development process.

This description of the invention is therefore supplemented by a further embodiment, in connection with a further narrowly defined parameter space analogous to Table 1 for describing the shape, as follows.

The further embodiment of the wind turbine according to the invention also corresponds to Fig. 1; and wind flows onto it in a primary wind direction 101 and subsidiary wind directions 102, 103. The significance of the remaining reference numerals in Fig. 1 can be seen from Table 2 above, which also specifies supplementary or expanded ranges of values according to the invention for the parameters and the particularly preferred values of the parameters in the second embodiment.

For completeness, it is noted that the height (or length) of the turbine may be in a wide range of ratios to the radius. That is to say, depending on the place of use, the height or length of the turbine is approximately 0.3 to 100 times the turbine radius, it also being possible, for reasons of construction or stability, to understand a long or high turbine as a positive coupling of a plurality of turbines to a shaft which may optionally be connected by means of positive couplings.

The purpose of the turbine system is to obtain energy from wind in an optimum manner, priority being given to obtaining electrical energy. For this purpose, a generator is mechanically connected to the turbine shaft positively or non-positively, directly or indirectly via a transmission, in a manner adapted to the turbine system, said turbine shaft being positively or non-positively connected to the turbines so as to ensure force transmission from the turbine to the generator. In this context, one generator may be used for both turbines, or each turbine may be connected individually to one respective generator.

Table 2: Parameters	**Range of values for the parameter (second alternative)**	**In the second embodiment:**
R1 = Radius of the turbine	as desired	0.510 m
R2 = Distance from the centre of rotation	$f_1 = 0.19 - 0.32$	0.110 m

(point P_0) to the inner blade end (point P_1) $= f_1 \times R1$		
R3 = Radius of curvature of the cylindrical shell, adjacent to the point P_1, of a blade $= f_2 \times R1$	$f_2 = 1.2 – 2.4$	0.685 m
R4 = Radius of curvature of the cylindrical shell, adjacent to the point P_2 on the outer radius of the turbine, of a blade $= f_3 \times R1$	$f_3 > 0.7$	> 0.50 m
R5 = Radius of curvature of the kink between the two cylindrical shells of a blade $= f_4 \times R1$	$f_4 = 0.01 – 0.08$	0.005 m
A1 = Distance of the edge of the deflector plate facing the turbine (point P_3) from the second longitudinal section plane 5 (perpendicular to the first longitudinal section plane 4) $= f_5 \times R1$	$f_5 = 1.00 – 1.10$	0.534 m
A2 = Distance of the edge of the deflector plate facing the turbine (point P_3) from the first longitudinal section plane 4 (= primary wind direction) $= f_6 \times R1$	$f_6 = 0.25 – 0.55$	0.275 m
B1 = Width of a turbine blade (distance between the points P_1 and P_2) $= f_7 \times R1$	$f_7 = 0.9 – 1.0$	0.535 m
B2 = Width of the outer cylinder shell of a turbine blade (i.e. distance between the intersection of the respective extrapolated circles of the two cylindrical shells of a blade and the point P_2) $= f_8 \times R1$	$f_8 = 0.11 – 0.19$	0.081 m
B3 = Width of the deflector plate $= f_9 \times R1$	$f_9 = 0.7 – 2.5$	1.12 m

D1 = Diameter of the shaft = f_{10} × R1	f_{10} = 0.03 – 0.13	0.020 m
α_1 = Angle of incidence of the deflector plate with respect to the primary wind direction	α_1 = 40° - 60°	43°

The generator is controlled in a manner adapted to the wind speed, in such a way that by regulating the generated power an electromagnetic braking torque is transmitted to the turbine, so as to set an optimum tip speed ratio (TSR) for energy conversion, which is between 45 % and 65 % of the tip speed ratio of the unbraked turbine. This ensures that the maximum possible energy can always be “harvested”.

In the embodiment, a height : radius ratio of approximately 20 is set, the turbines on a shaft being mounted individually approximately every 5 m, and being interconnected via a flexible positive coupling and connected to the end of a shaft directly or indirectly via a transmission comprising a current generator.

For increased efficiency, two turbine deflector plate systems may advantageously be brought together with reflective symmetry as a wind splitter system, in such a way that for example with a vertical axis of rotation, the left deflector plate deflects the wind to the left turbine and the right deflector plate deflects the wind to the right turbine as seen in the primary wind direction. In this context, the deflector plates may advantageously be in the form of a “nose” with a rounded “bridge” as a connection between the two deflector plates, so as to form a closed wind guide system, the wind splitter.

Fig. 7 is a perspective drawing of the wind generator according to the invention, comprising two radial turbines 1, 2 and a V-shaped wind splitter 3, the radial turbines and wind splitter being attached to a steel mast 5 or another base part 6 so as to be rotatable (pivotable) as a whole about a vertical axis.

Preferably, the distance between the V-shaped wind splitter and the turbines is variable and adjustable, so as to achieve optimum operating conditions for all wind conditions.

As a function of the wind speed, the V-shaped wind splitter is brought into the optimum position, based on the distance and inclination with respect to the turbine blades and the turbine shaft.

For an overall height of 20 m, the height of the turbines is 10 m. The turbines have a diameter of 1 m. The expected capacity for a site on the coast, where the wind generator captures the circulating coastal wind, is approximately 21,700 kWh, with an efficiency averaged over the year of 38 %.

Fig. 8 shows the constructional details of an embodiment as a tubular mast mounting system in a view from the side corresponding to A-A in Fig. 9. Three support plates 7, 8, 9 are attached to the 20 m high steel mast 5 by means of bearings 10, 11, 12, 13, 14 so as to be rotatable about the longitudinal axis 15 of the steel mast 5. The lower support plate 7 has three rotary bearings 10 on the steel mast 5 and two turbine bearings 16, 17 on the turbine shaft 18. The central turbine plate 8 has three rotary bearings 12 and two turbine bearings 19, 20, and the upper support plate 9 has three rotary bearings 14 and two turbine bearings 21, 22. The turbine bearings 17, 20 and 22 are not shown in Fig. 8, and are associated with the other turbine.

The rotary bearings 10, 11 on the one hand and 13, 14 on the other hand are kept at a distance by a spacer collar 23, 24. The spacer collar is in the form of a hollow tube.

Finally, Fig. 9 is a plan view of the wind generator. The turbine blades 25 can be seen. The wind direction, when the wind generator according to the invention has turned to the wind in such a way that the tip of the V-shaped wind splitter 3 points counter to the wind, is also indicated with an arrow.

What is known as a thread test was carried out on the system according to the invention (Fig. 11). Wind 28 at up to 6 m/s was blowing into the system. The ratio of the circumferential speed of the turbine to the wind was up to 3 : 1. The point where the thread direction breaks away can be seen clearly in Fig. 11 (at the bottom of the picture). The system according to the invention can extract energy from the pressure difference or the potential energy of the wind, not just from the kinetic energy of the moving air.

The significance of the reference numerals in Fig. 11 can be seen from the list of reference numerals.

A side effect is the ping-pong ball which is "suspended" in an oblique airstream. As a result of the Coandă effect, the flow of the airstream is not stripped away from the ball, but encircles it (almost) completely without being stripped away. Since the ball is suspended slightly below the centre of the airstream, the air does not flow around it symmetrically. More air is deflected downwards, since the flow speed and flow cross-section are lower at the underside of the ball than at the upper side. As a result, the ball experiences an upward force. This is superposed on the Magnus effect (the ball rotating). The two effects each prevent the ball from falling downwards and only allow it to "slip" along the underside of the airstream. The resistance of the ball to the flow holds it at a distance from the nozzle, and gravity prevents it from simply being blown away. Thus, the ball can float in a more or less stable position.

Fig. 12 to 14 show further variants with modified wind splitters 29 and additional concentration plates 30.

Evaluation of static and dynamic torque measurements on the wind turbine according to the invention of diameter 1 m and length 1m in Moers

The following data are taken into account, directly or indirectly, in the evaluation:

- Static torque measurements (stationary torque) from 24 to 26 September 2010
- Dynamic torque measurements in the period from 4 to 8 November 2010

An eddy current brake, with which various braking forces could be set by varying the coil current, was also used during the dynamic measurements in each case.

The measurement values were checked for plausibility and evaluated using various averaging and filtering methods.

The result data for wind speeds of between 2 and 8 m/s are compiled in the following table.

Table

Result data on the evaluation of static and dynamic torque measurements (September/November 2010) on the wind turbine according to the invention of diameter 1 m and length 1 m in Moers

Wind speed [m/s]	Rotational speed [rpm]	Torque [Nm]	Mechanical power [W] *(calculated therefrom)*
2	0	0.45	0.0
2	17	0.90	1.6
2	20	0.69	1.4
2	55	0.16	0.9
2	78	0.00	0.0
3	0	0.90	0.0
3	27	1.85	5.2
3	35	1.48	5.4
3	35	1.40	5.1
3	40	1.27	5.3
3	42	0.93	4.1
3	50	0.87	4.6
3	55	0.52	3.0
3	60	0.70	4.4
3	80	0.21	1.8
3	105	0.00	0.0
3	107	0.00	0.0
3	115	0.00	0.0
4	0	1.45	0.0
4	50	2.45	12.8
4	55	2.15	12.4
4	57	1.90	11.3
4	60	1.80	11.3
4	65	1.55	10.6
4	69	1.25	9.0
4	80	0.82	6.9
4	80	1.12	9.4
4	95	0.64	6.4
4	107	0.28	3.1
4	137	0.00	0.0

4	139	0.00	0.0
4	145	0.00	0.0
5	0	2.00	0.0
5	75	3.00	23.6
5	78	3.30	27.0
5	85	2.80	24.9
5	85	2.23	19.8
5	85	1.85	16.5
5	93	1.42	13.8
5	110	1.35	15.6
5	120	0.31	3.9
5	120	0.98	12.3
5	127	0.71	9.4
5	165	0.00	0.0
5	174	0.00	0.0
5	177	0.00	0.0
6	0	2.70	0.0
6	100	3.65	38.2
6	113	2.70	31.9
6	115	3.35	40.3
6	116	2.15	26.1
6	120	1.81	22.7
6	140	1.53	22.4
6	152	0.34	5.4
6	160	0.75	12.6
6	195	0.00	0.0
6	209	0.00	0.0
6	210	0.00	0.0
7	0	3.50	0.0
7	130	4.30	58.5
7	147	3.27	50.3
7	160	1.65	27.6
7	175	0.79	14.5

7	225	0.00	0.0
7	245	0.00	0.0
8	0	4.25	0.0
8	162	4.85	82.3
8	190	3.75	74.6
8	210	0.84	18.5
8	250	0.00	0.0
8	275	0.00	0.0

Fig. 15 and 16 are graphical representations with corresponding interpolated lines.

Fig. 15: torque vs. rotational speed characteristics, interpolation with average power coefficient (PC) 35 %

Torque [Nm] vs. rotational speed [rpm]; parameter wind speed [m/s]

Key to graph:

◆ 2 m/s measurement
▲ 3 m/s measurement
X 4 m/s measurement
+ 5 m/s measurement
− 6 m/s from measurement
■ 7 m/s from measurement
× 8 m/s from measurement
------- max. torque
- - - - ave. torque

Fig. 16: characteristics
Mech. power
Extrapolation in the maximum power range with average PC = 35 %

Mechanical power [W] vs. torque [rpm]; parameter wind speed [m/s]

Key to graph:

■ 2 m/s eddy current brake

× 3 m/s eddy current brake

• 4 m/s eddy current brake

– 5 m/s eddy current brake

◆ 6 m/s from eddy current brake

▲ 7 m/s from eddy current brake

x 8 m/s from eddy current brake

Since the dynamic measurements thus far have only been carried out with relatively weak braking forces, the interpolation outside the measurement range that has been established thus far is shown in dashed lines. In this context, it has been assumed that at the maximum power point a power coefficient of 35 % is achieved. From the dispersion of the result data, sufficiently precise calibration verification for the measurement technique used can provisionally be placed at approximately 30 – 40 %. Otherwise, the systematic errors in the measurement technique have to be additionally taken into account. The power coefficient can be determined more precisely if further measurements at higher braking forces are taken into account.

The turbine system according to the invention can also advantageously be used in water for obtaining energy from the flow of water, that is to say as a marine turbine system.

Fig. 17 to 26 are various perspective views of a wind generator according to the invention which has been improved further. Operation in practice has demonstrated that the wind generator operates with virtually no noise and very little vibration. Any compression oscillations are in the inaudible range below 20 Hz. The light and well-balanced construction of the rotating parts is responsible the observed lack of vibration. As a result, this wind generator is outstanding for use in urban areas and/or on buildings.

In a further embodiment, a grid mast construction, which is and/or can be used as a frame for the special accumulator and turbine mounting system, is provided above the rotary connection, which is fixed to a stationary mast (cf. Fig. 27a and section A-A in the form of Fig. 27b). The cavity inside the grid mast provides enough space for safely installing/fastening accumulators and for load control; at the same time, the cable lengths from the generator can be kept short so as to keep Ohmic losses low.

Since the lower region of the tower below the rotary connection is made from steel tubing, it forms a cavity which can be used for safely installing highly sensitive technology, since ventilation and/or heating and/or suitable air conditioning, particularly in relation to air humidity, can be provided.

The base part may be used in a configuration as a further energy store or as a water reservoir or oil store, and may be designed accordingly. Heat pumps (with heat pipes) may be integrated into the base part.

In the present invention, the turbine blades (air foils) are mounted on a plurality of milled support arms, which in turn are fastened to a rotary part on the shaft on both sides by two "support hearts" which are screwed together. This reduces the weight and makes it possible for the turbine to reach full speed more quickly (cf. Fig. 28).

In addition, the support hearts make it possible to replace the turbine blades individually by screwing. The very heavy fixed circular discs, which are entrained in rotation and are conventional in the Savonius turbine, are replaced with stationary grille face panels, which are additionally rounded for better wind introduction. As a result, the weight of the rotating parts and the losses from the Thom effect are greatly reduced. The wind energy can thus be harvested with a high level of efficiency.

The support hearts which are used according to the invention are much lighter. The grille face panels are held together by a mast, which is a functional replacement for the heavy frame construction conventional in the Savonius turbine.

It is advantageous to bring together a plurality of windtrackers to form a decentralised network-communicating energy supply system and other applications. It is therefore proposed to provide an arrangement of the turbine systems according to the invention and/or of the windtrackers along the traffic infrastructure, such as streets, motorways, railway lines and canals, which arrangement is additionally provided for telecommunications or for buffering current from the grid in times of low current uptake and/or for use as an advertising medium and/or as street lighting and/or for providing safety spaces.

List of reference numerals

1	radial turbine
2	radial turbine
3	wind splitter
5	steel mast
6	base plate
7	support plate
8	support plate
9	support plate
10	(rotary) bearing
11	(rotary) bearing
12	(rotary) bearing
13	(rotary) bearing
14	(rotary) bearing
15	longitudinal axis
16	turbine bearing
17	turbine bearing
18	turbine shaft
19	turbine bearing
20	turbine bearing
21	turbine bearing
22	turbine bearing
23	spacer collar
24	spacer collar
25	turbine blades
26	upper collar flange
27	guide flange
28	wind
29	modified deflector surface
30	concentration plate or concentration surface
31	Magnus effect
32	Coandă effect
33	Magnus/Coandă superposition

34 high lift
35 negative pressure
36 overpressure
37 thread direction breaks away

110 upper curve
111 curve
112 curve
113 curve

201 milled support arms
202 support hearts
203 turbine blades

301 external radius of the turbines or turbine blades
302 rounding of the concentration plate and/or wind guide plate
303 concentration plate and/or wind guide plate
304 grid mast
305 V-shaped wind splitter

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CLAIMS

1. A turbine system for wind and/or water power, comprising two radial turbines, wherein the radial turbines comprise a rotor which can rotate about a turbine shaft and which comprises one or more turbine blades, the turbine blades being orientated parallel to the rotor, the turbine blades being arranged within a cylindrical shell, which is arranged concentrically about the turbine shaft and has an external radius R1 and an internal radius R2, the radial turbines having upper ends and lower ends, wherein the internal radius is

$$R2 = f_1 \times R1$$

where f_1 = 0.19 to 0.32,

wherein each turbine blade has a first region which extends from the internal radius R2 to the external radius R1, is curved towards the turbine shaft, and has a radius of curvature

$$R3 = f_2 \times R1$$

where f_2 = 1.2 to 2.4, and

a second region, which is externally adjacent to the first region and having a radius of curvature R4, is positioned on the outside of the cylindrical shell, and has a curvature towards the turbine shaft, the curvature pointing to the same side as the curvature of the first region, the radius of curvature R4 of the second region being

$$R4 = f_3 \times R1$$

where $f_3 > 0.7$,

wherein the second region is of a width

$$B2 = f_8 \times R1$$

where f_8 = 0.11 to 0.19, and

wherein two radial turbines, orientated parallel side by side, are arranged with vertical rotation turbine shafts, are interconnected, and are pivotable about a pivot shaft parallel to the turbine shafts, the pivot shaft and a V-shaped wind splitter being positioned outside a line connecting the turbine shafts and both being on the same side of said line, the radial turbines having concentration plates and/or wind guide plates located at the upper ends and the lower ends of the radial turbines, and

the turbine blades are mounted on a plurality of milled support arms, which in turn are fastened to a rotary part on the turbine shaft,

wherein the wind splitter comprises a deflector surface orientated parallel to the rotor is arranged outside the cylindrical shell, and is of a width

$$B3 = f_9 \times R1$$

where $f_9 = 0.7$ to 2.5,

the deflector surface having an edge facing the turbine shaft,

the edge of the deflector surface being at a distance A2

$$A2 = f_6 \times R1$$

where $f_6 = 0.25$ to 0.55 from a first longitudinal section plane through the turbine shaft, and at a distance A1

$$A1 = f_5 \times R1$$

where $f_5 = 1.00$ to 1.10 from a second longitudinal section plane through the turbine shaft, the second longitudinal section plane being perpendicular to the first longitudinal section plane,

and wherein the deflector surface has an angle of incidence

$$\alpha = 40° \text{ to } 60°$$

with respect to the first longitudinal section plane.

2. The turbine system according to claim 1, wherein the total width B1 of the turbine blade is

$$B1 = f_7 \times R1$$

where $f_7 = 0.9$ to 1.1.

3. The turbine system according to claim 1, wherein a kinked edge is provided between the first and the second region of the turbine blade and the said kinked edge has a radius of curvature

$$R5 = f_4 \times R1$$

where $f_4 = 0.01$ to 0.08.

4. The turbine system according to claim 1, wherein the turbine shaft is in the form of an axle having a diameter

$$D1 = f_{10} \times R1$$

where $f_{10} = 0.03$ to 0.13.

5. The turbine system according to claim 1, wherein a generator is provided for generating current and the generator can be controlled so as to set the optimum tip speed ratio of the turbine.

6. The turbine system according to claim 1, wherein the wind and/or water generator rotates to the optimum wind or water flow direction automatically, without a motor-driven tracking means, without a control system, and without additional deflector surfaces.

7. The turbine system according to claim 1, wherein the distance between the V-shaped wind splitter and the turbines is adjustable.

8. The turbine system according to claim 1, wherein the pivot shaft comprises a rotary connection, and a grid mast, to which an accumulator system and/or a turbine support system can be fixed, is provided above the rotary connection.

9. The turbine system according to claim 1, wherein a means is provided for automatically moving the radial turbines closer together when a predetermined wind speed is reached.

10. The turbine system according to claim 1, wherein the radial turbines are divided into a plurality of individual turbines mounted individually along the turbine shaft.

11. The turbine system according to claim 1, wherein there is provided a rotary connection between the pivot shaft and the turbine shafts and a safety space, which is protected and earthed, is provided below the rotary connection for accommodating sensitive technological components.

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12. The turbine system according to claim 11, wherein the safety space comprises ventilation and/or heating and/or suitable air conditioning.

13. The turbine system according to claim 12, wherein the ventilation and/or heating and/or suitable air condition is in relation to air humidity.

14. The turbine system according to claim 1, wherein there is provided a base part and the base part can be used as a further energy store or as a water reservoir or oil store.

15. The turbine system according to claim 1, wherein there is provided a base part and heat pumps are integrated into the base part.

16. The turbine system according to claim 1, wherein the plurality of milled support arms are fastened at the bottom and at the top to the rotary part on the turbine shaft on both sides by two support hearts which are screwed together.

17. The turbine system according to claim 1, wherein the concentration plates and/or wind guide plates are rounded in the front region.

18. The turbine system according to claim 1, wherein LED elements are attached to the turbine blades and can be actuated as a function of the rotation so as to achieve advertising effects.

19. The turbine system according to claim 1, wherein the turbine system is provided along streets, motorways, railway lines and/or canals, and is additionally provided for telecommunications or for buffering current from the grid in times of low current uptake and/or for use as an advertising medium and/or as street lighting and/or for providing safety spaces.

Dennis Patrick Steel

Patent Attorneys for the Applicant/Nominated Person

SPRUSON & FERGUSON

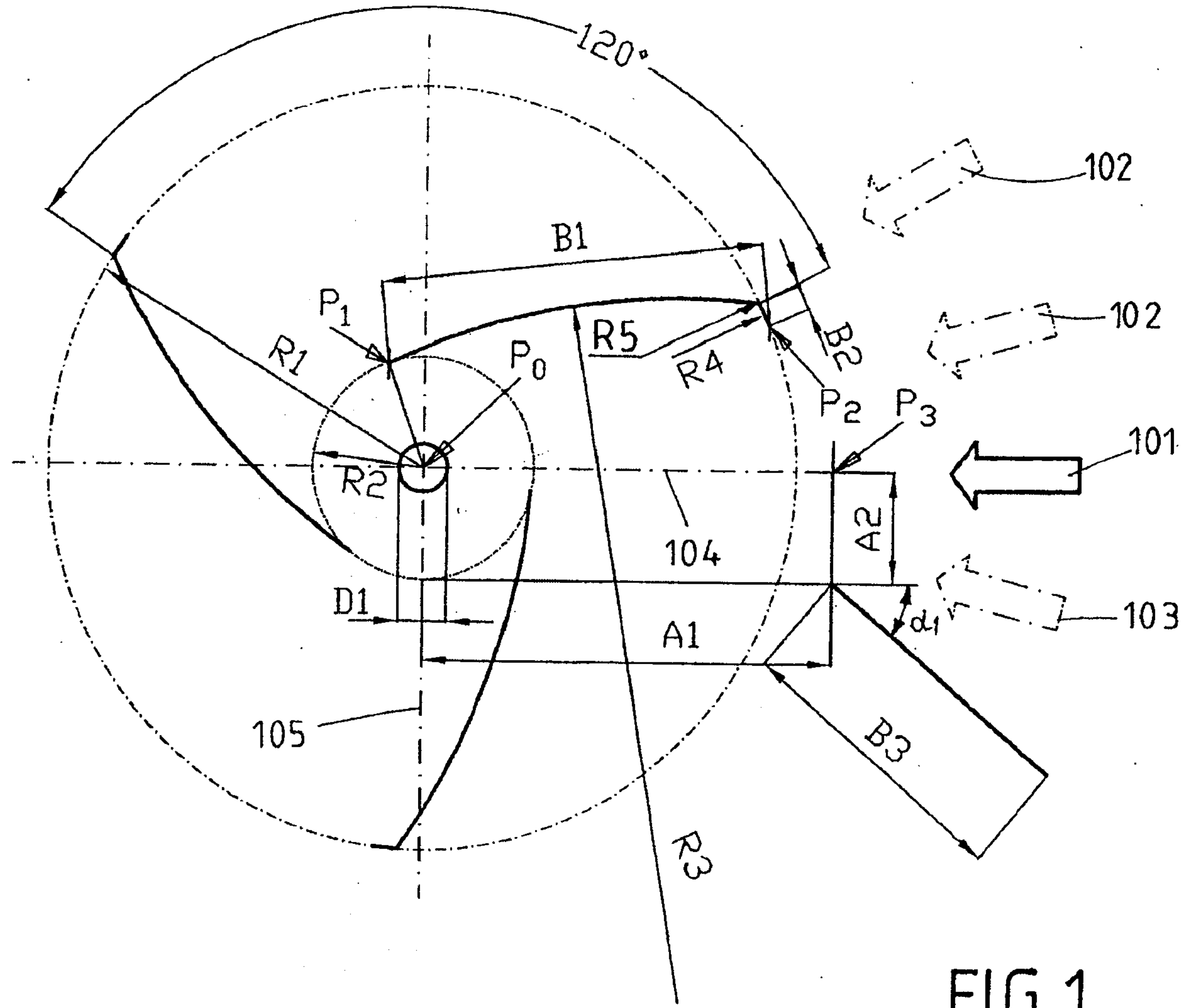
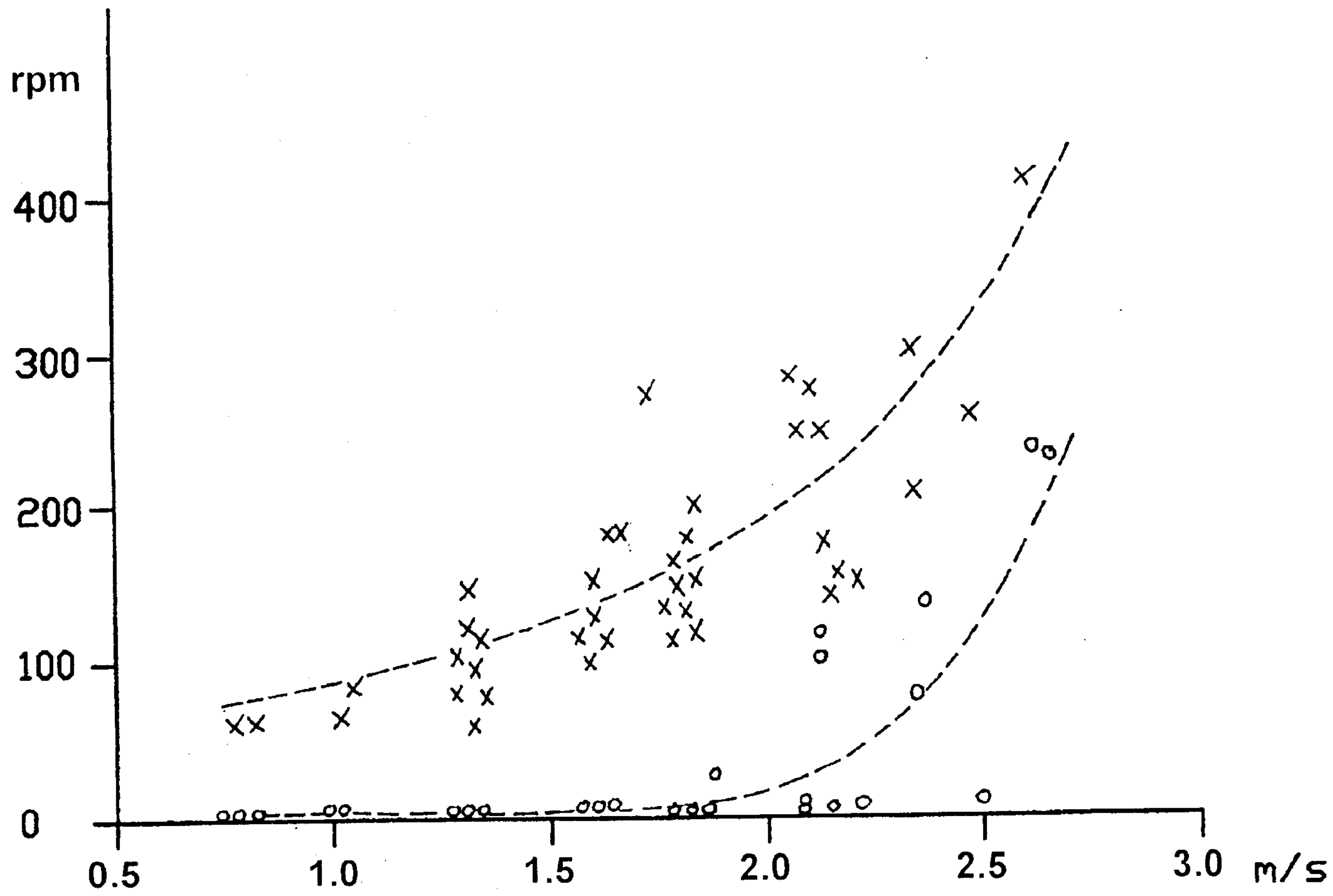

120°
102
B1
P1
R1
P0
R5
R4
B2
102
P2
P3
101
R2
A2
104
D1
A1
103
α1
105
B3
R3

FIG.1

FIG.2



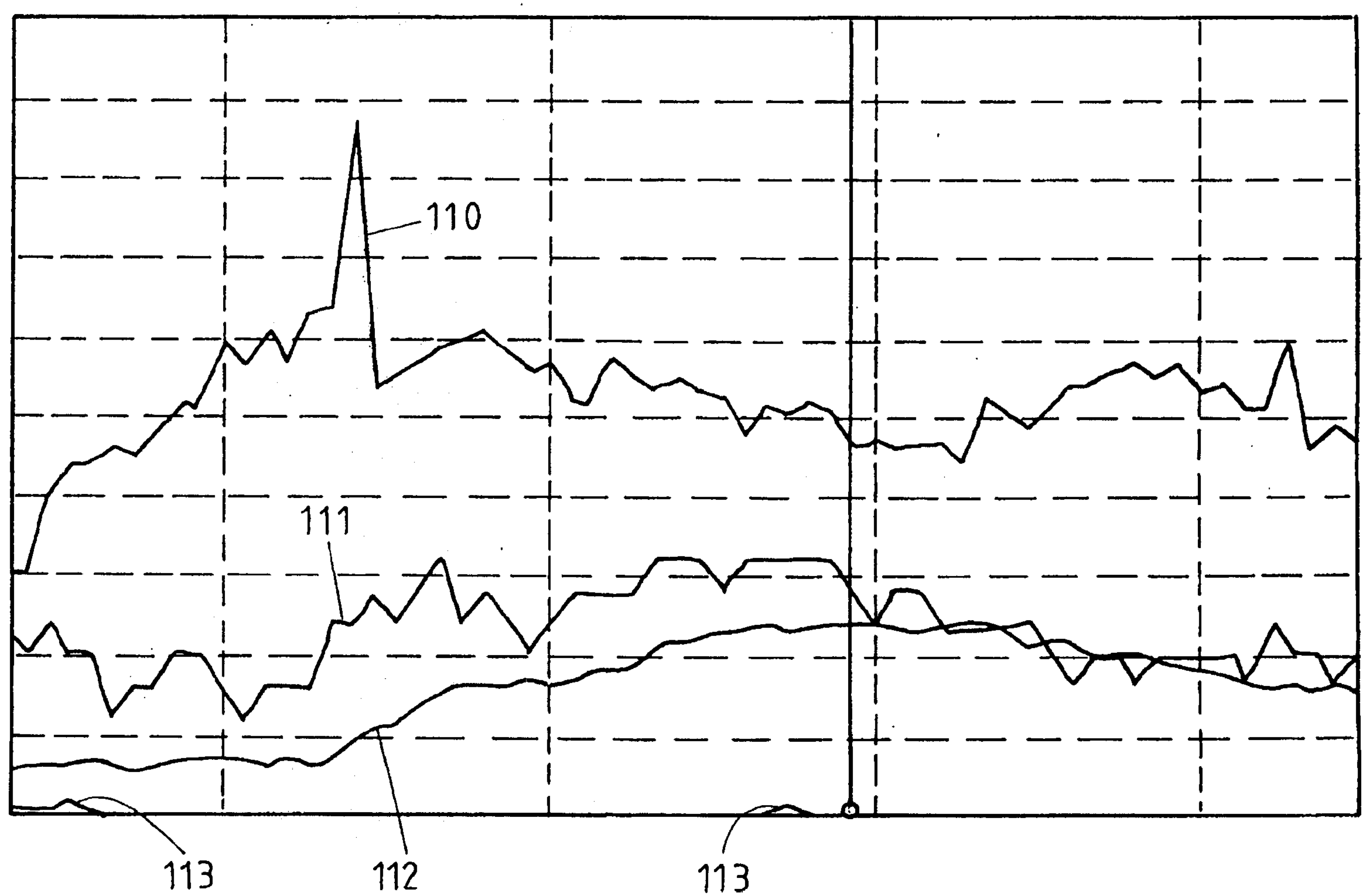


FIG.3

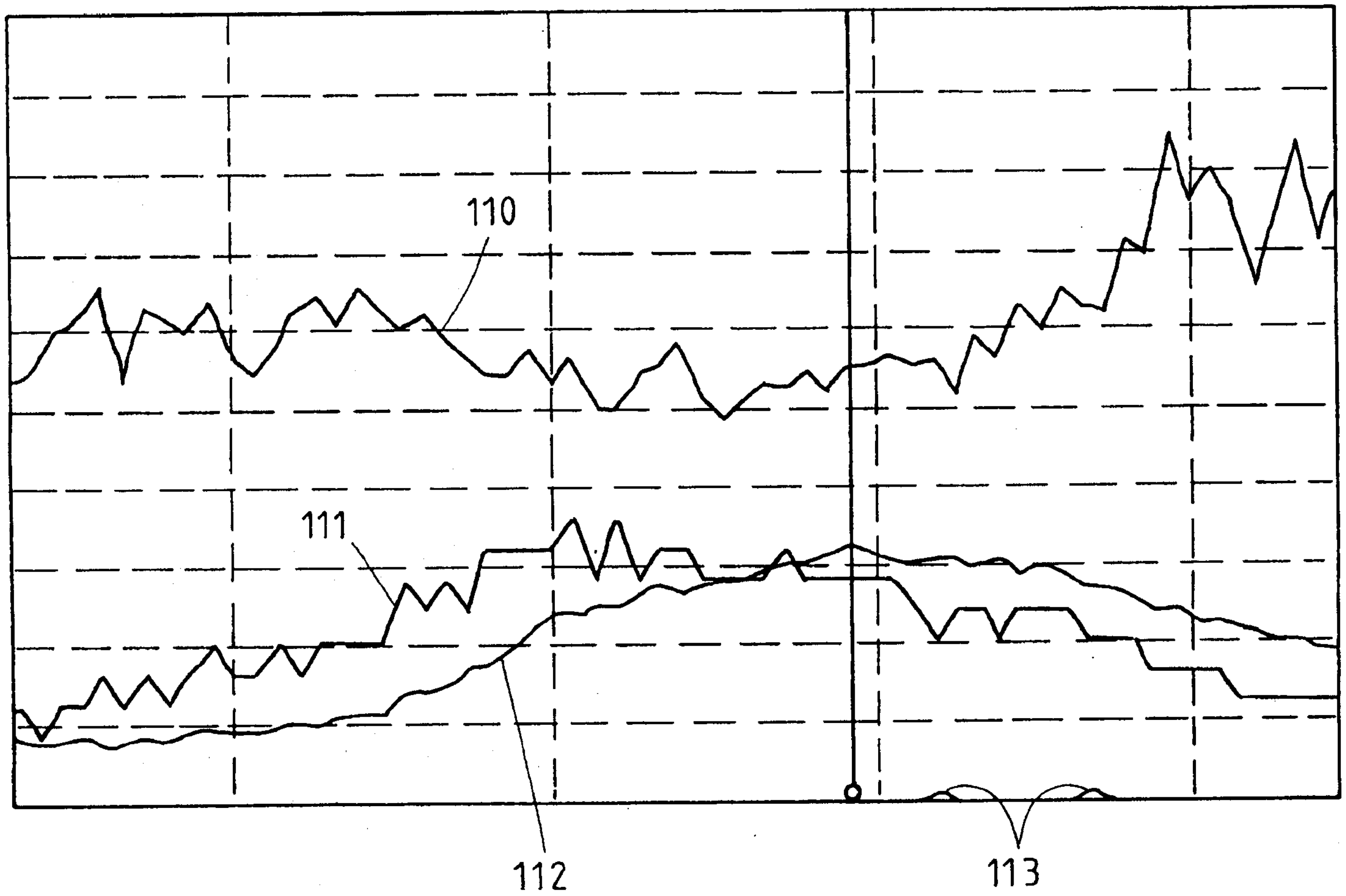


FIG.4

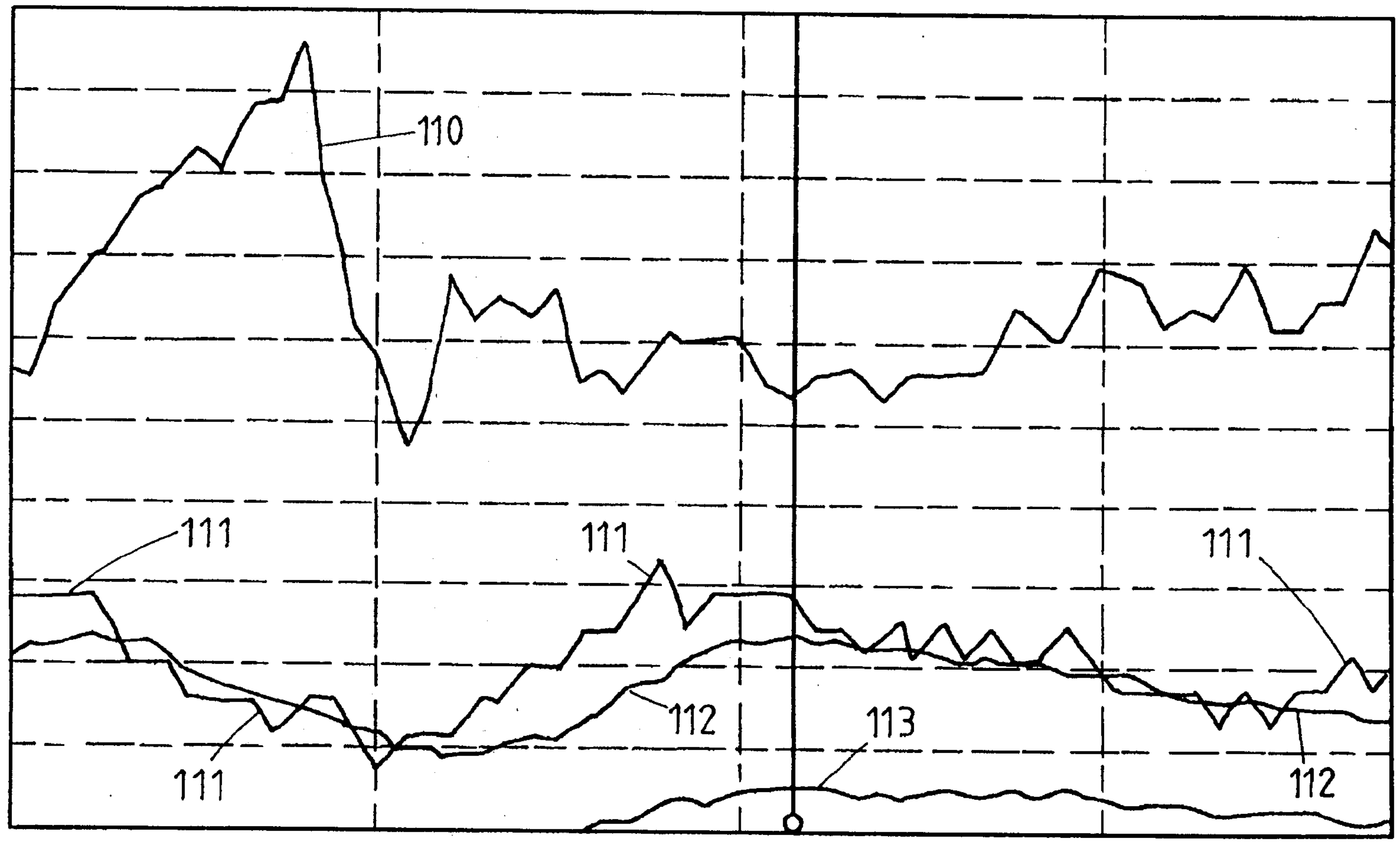


FIG.5

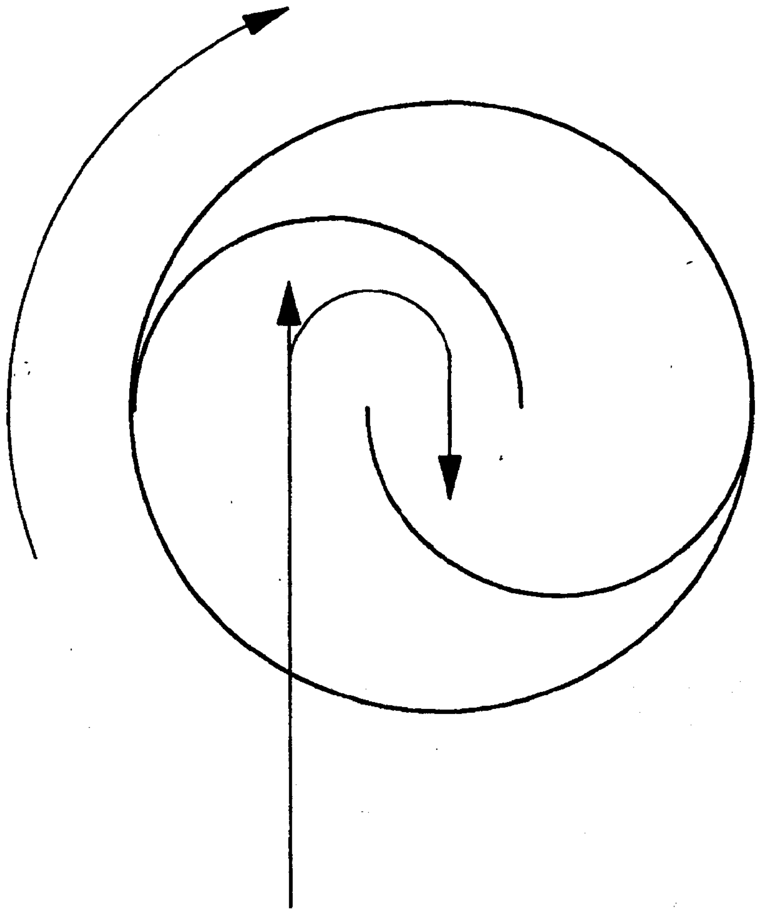


FIG.6

Prior art

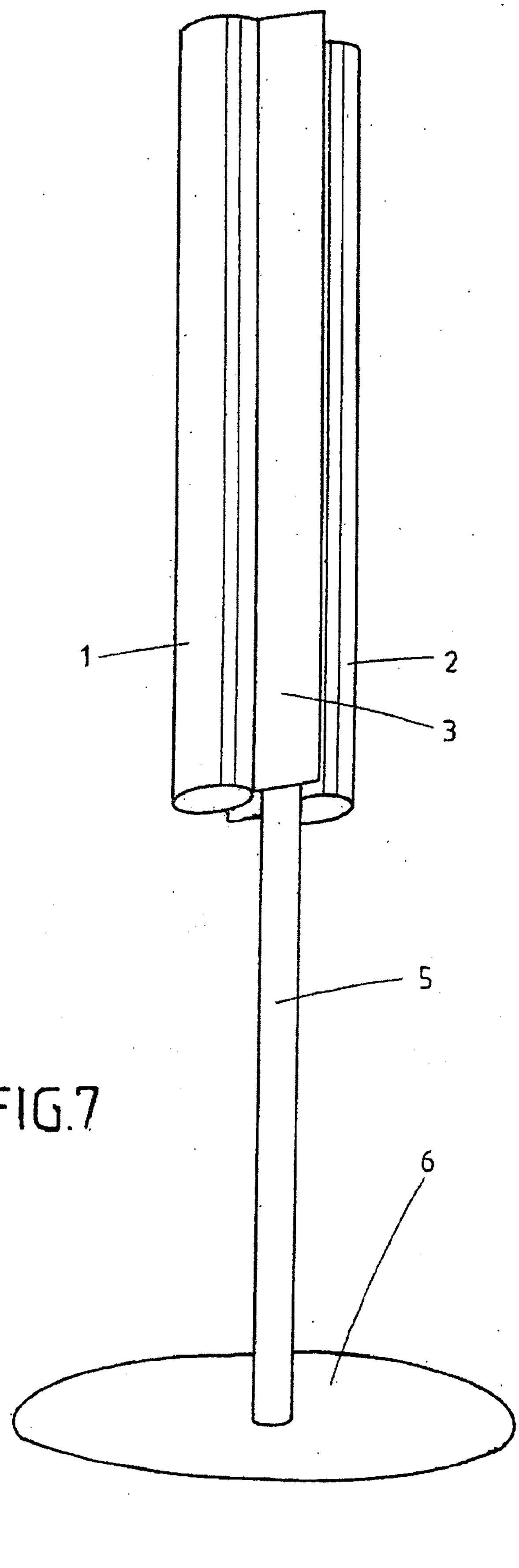


FIG.7

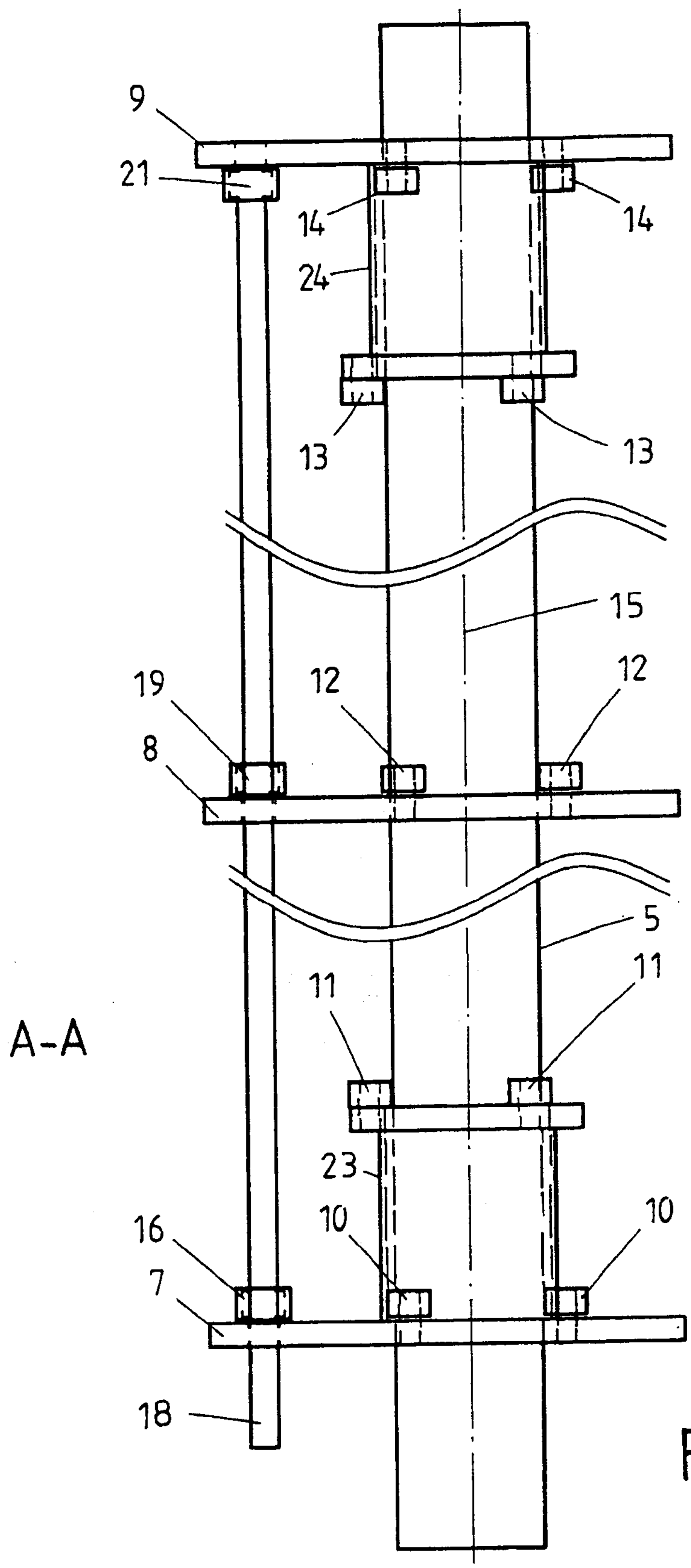


FIG.8

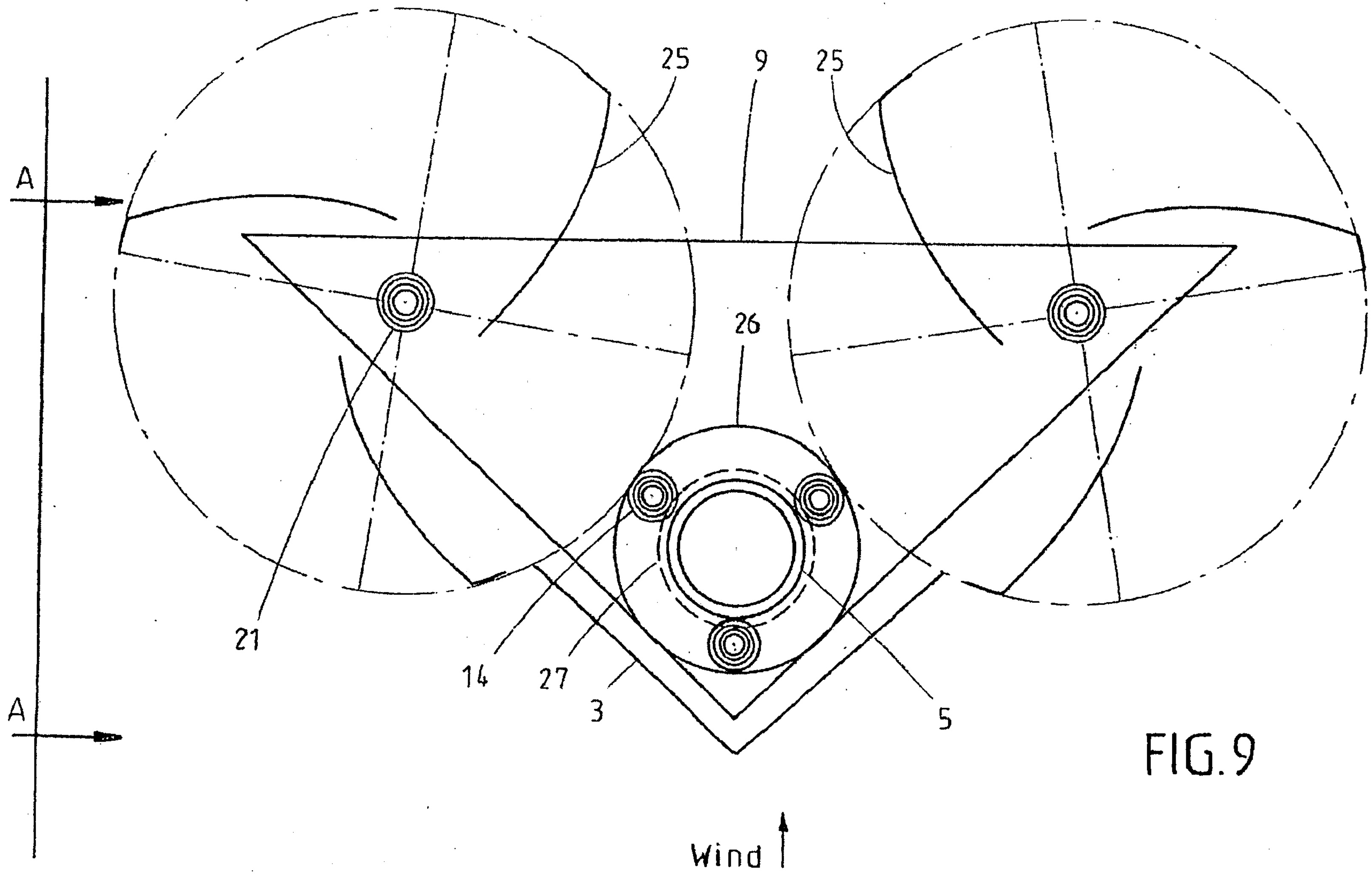


FIG.9

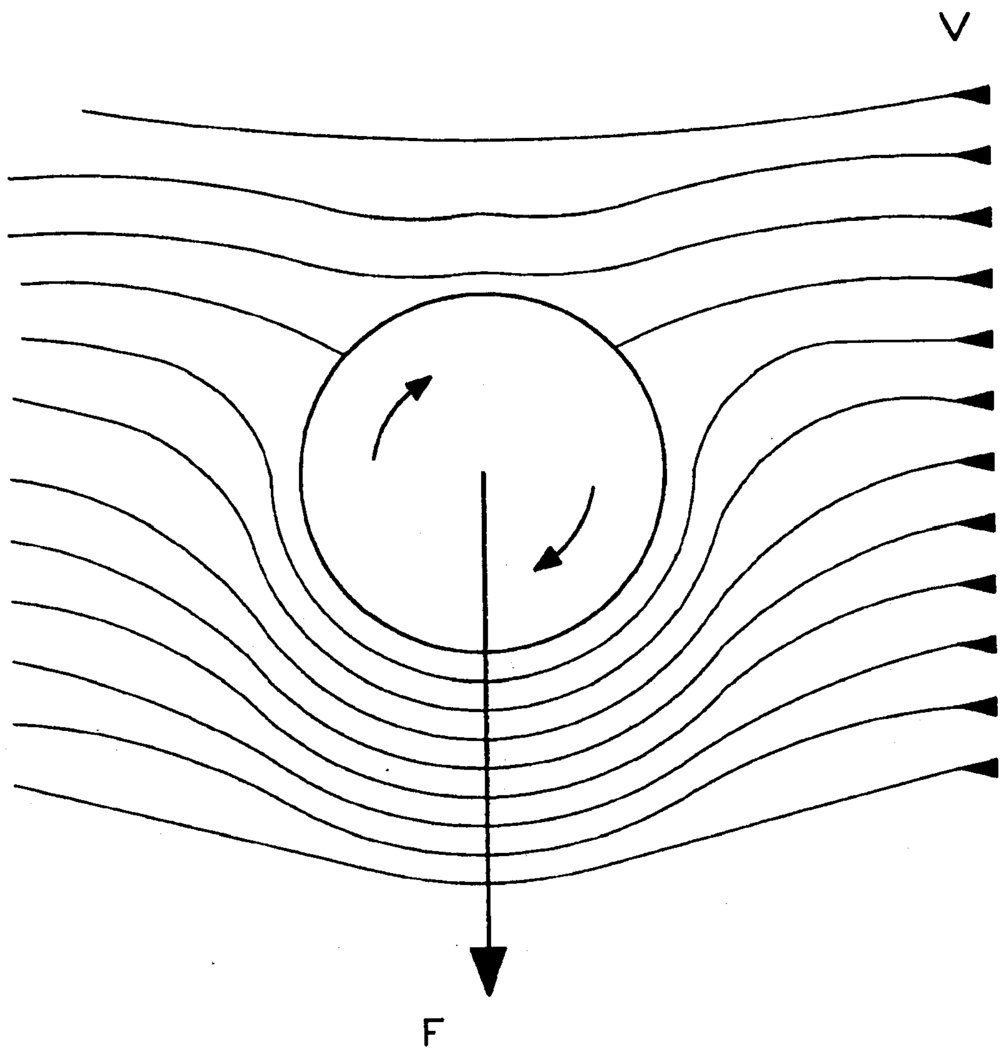


FIG.10

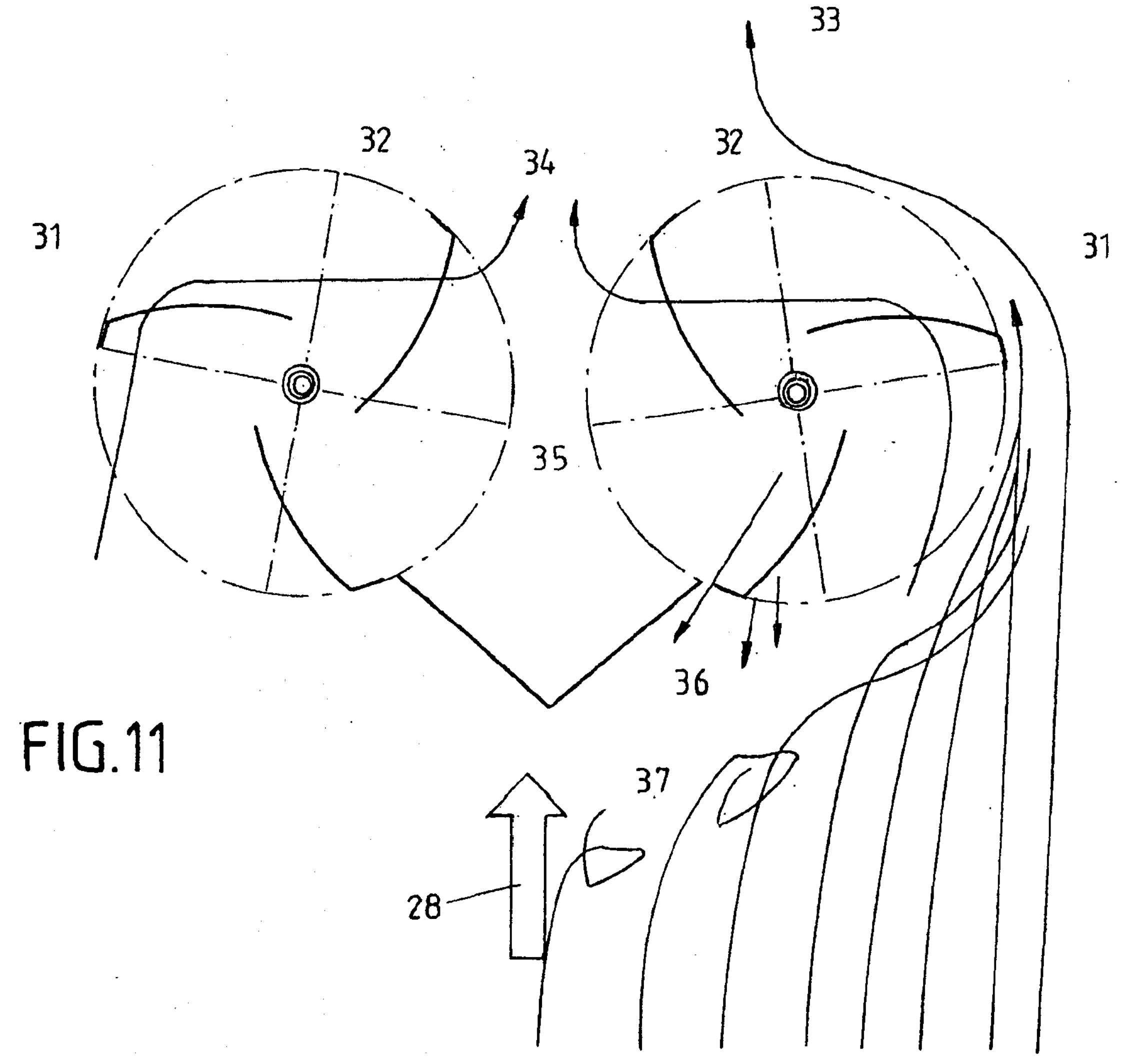


FIG.11

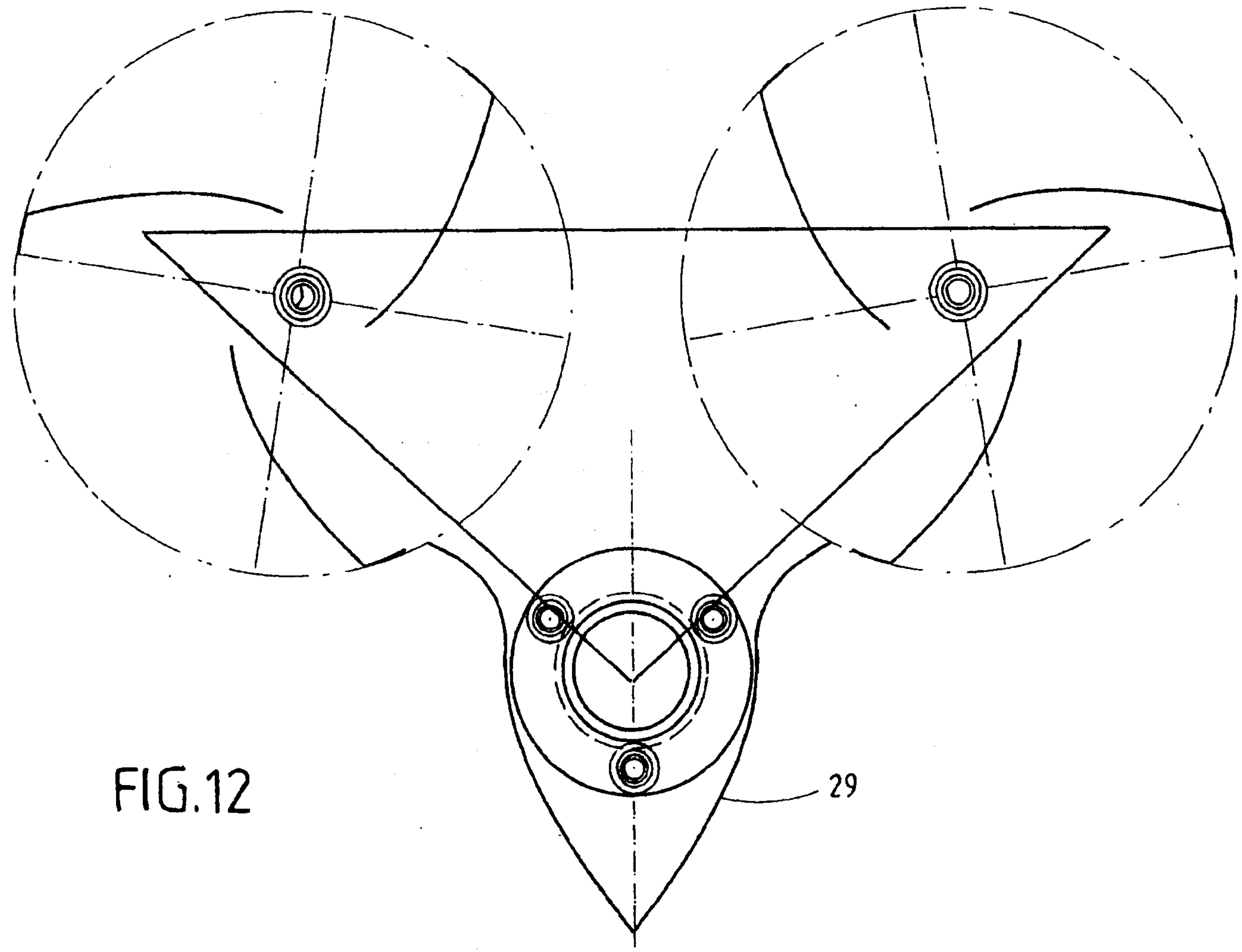


FIG.12

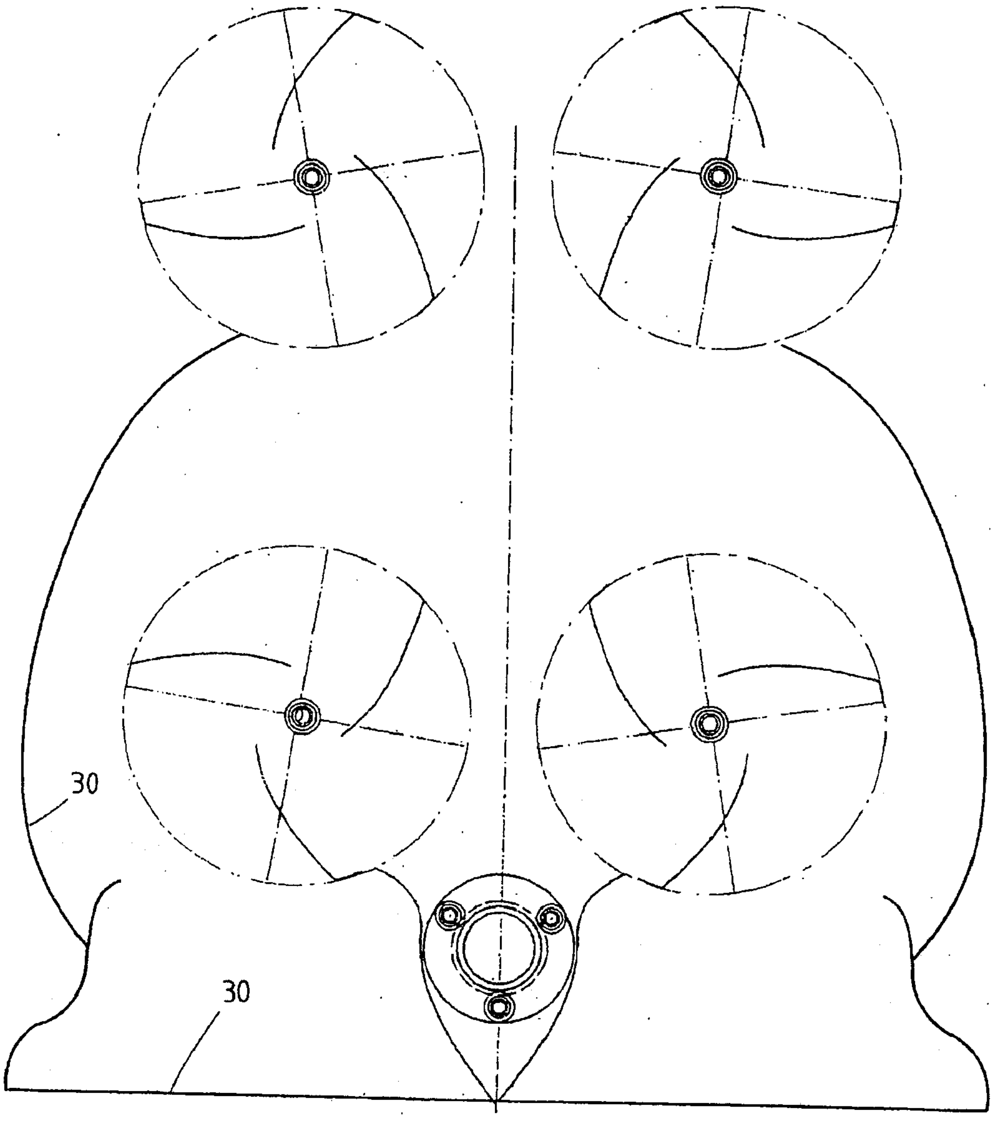


FIG. 13

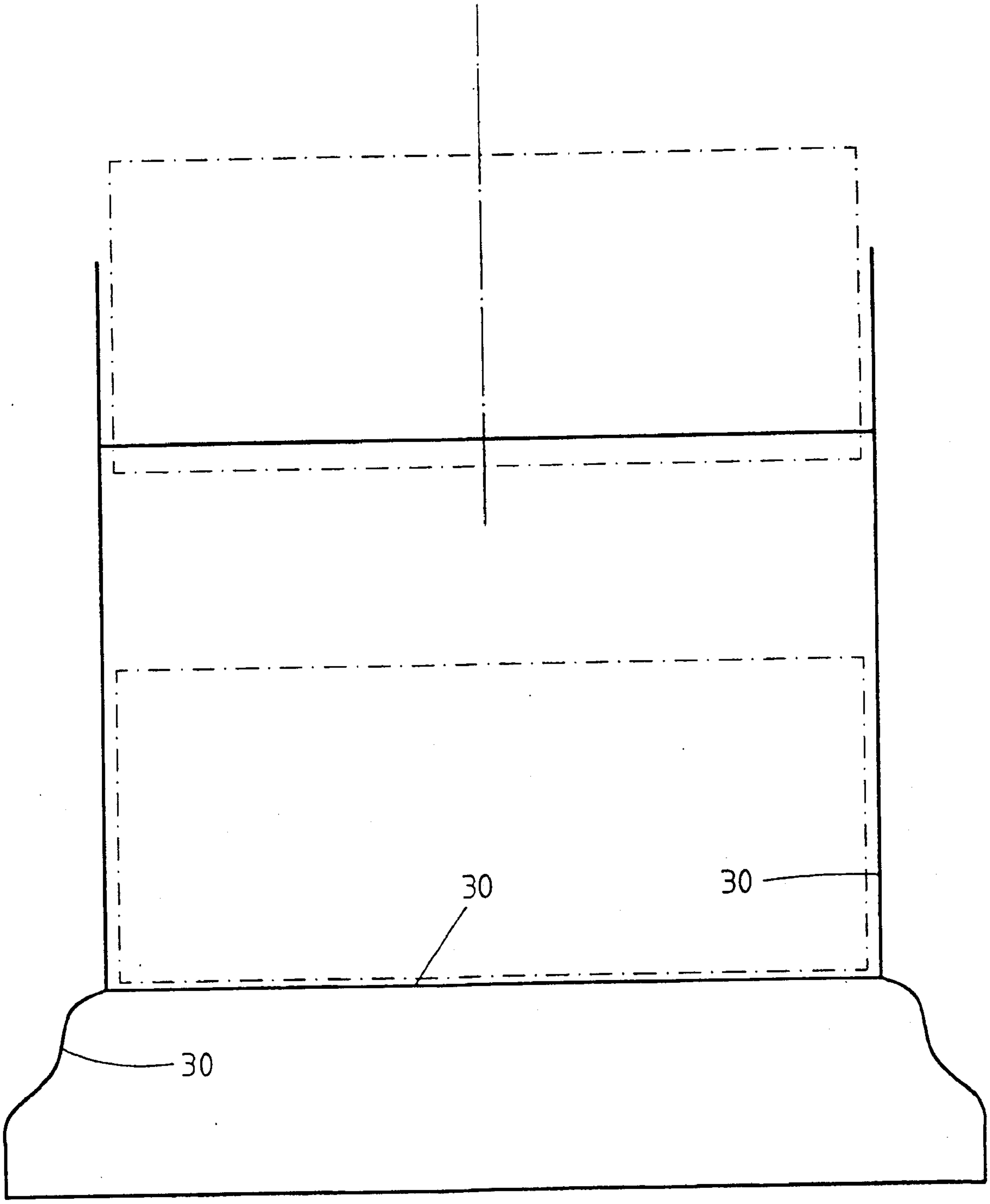


FIG.14

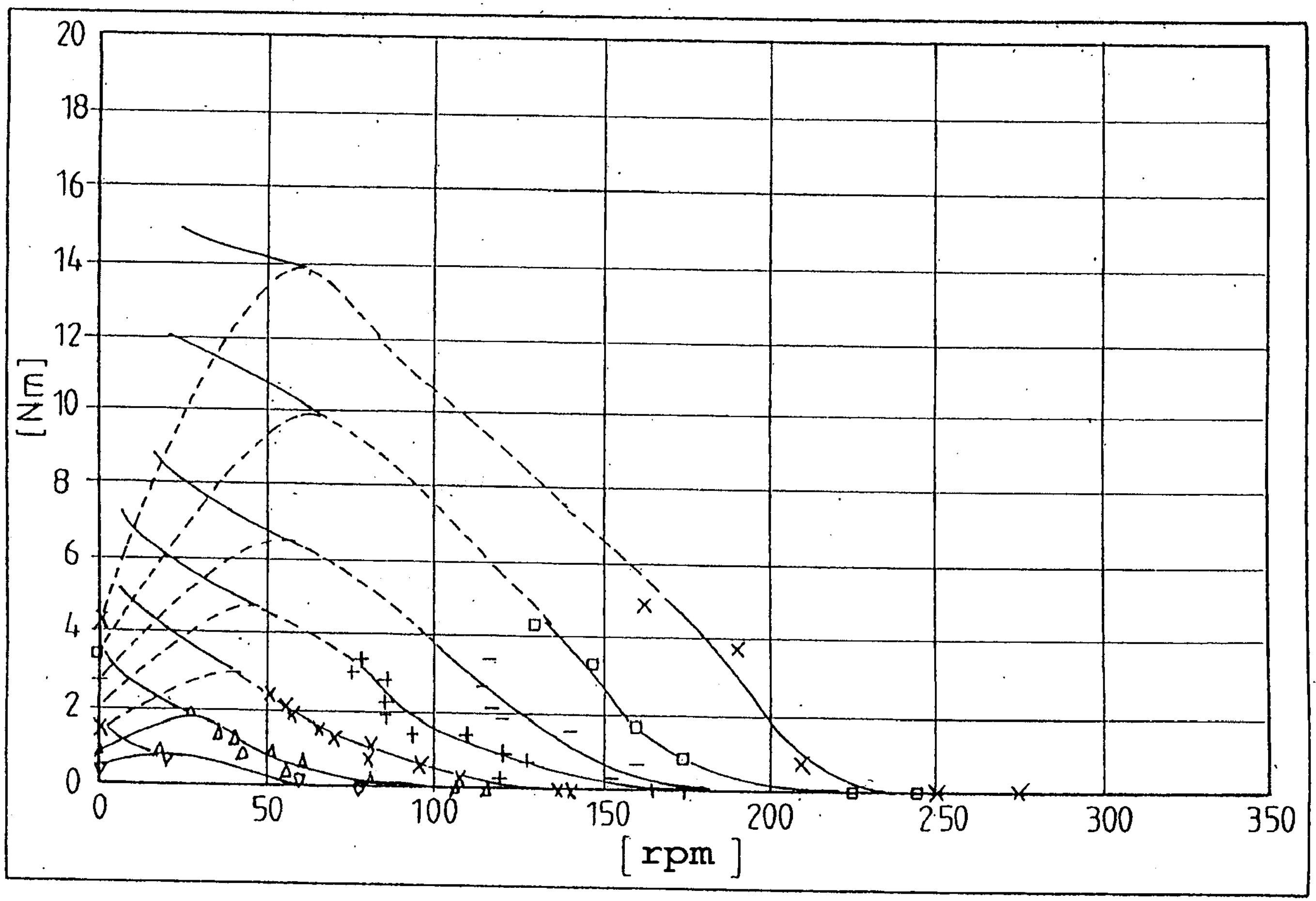


FIG.15

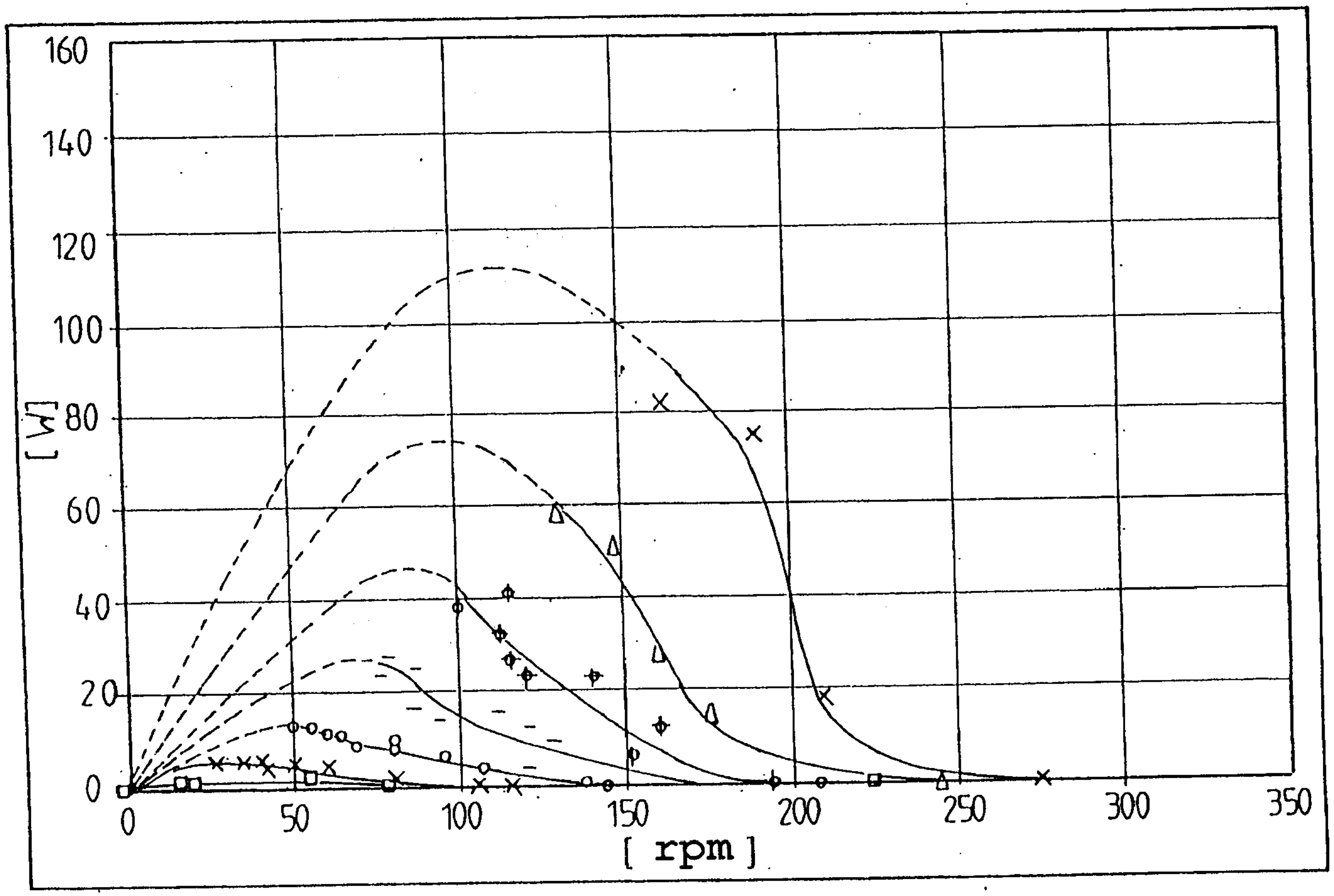


FIG. 16

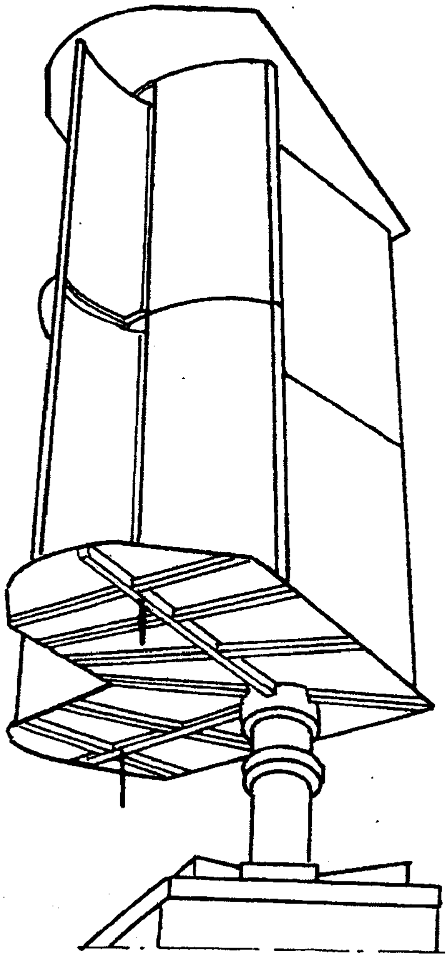


FIG. 17

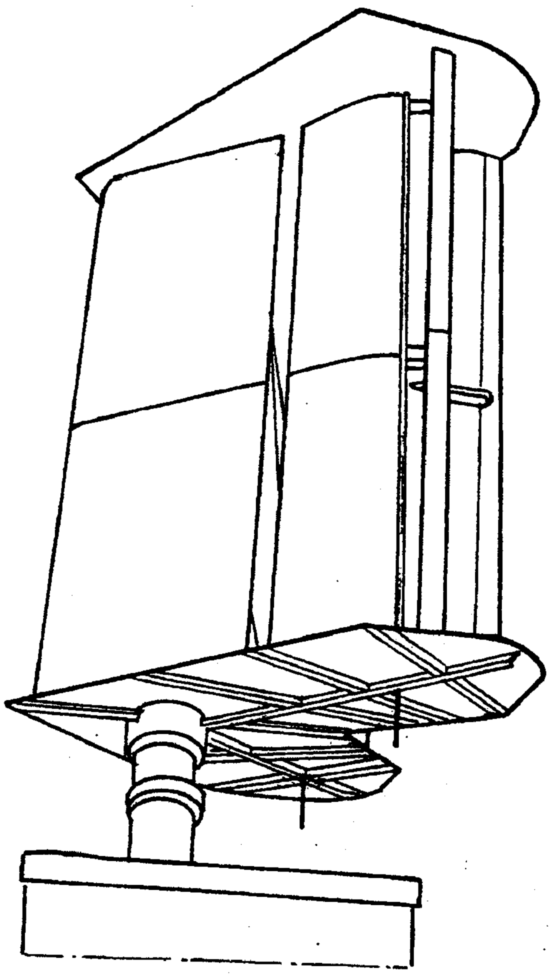


FIG. 18

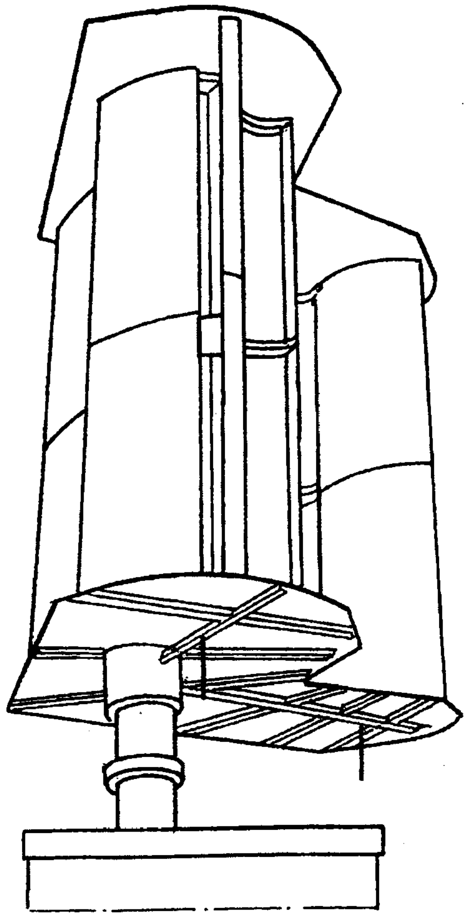


FIG.19

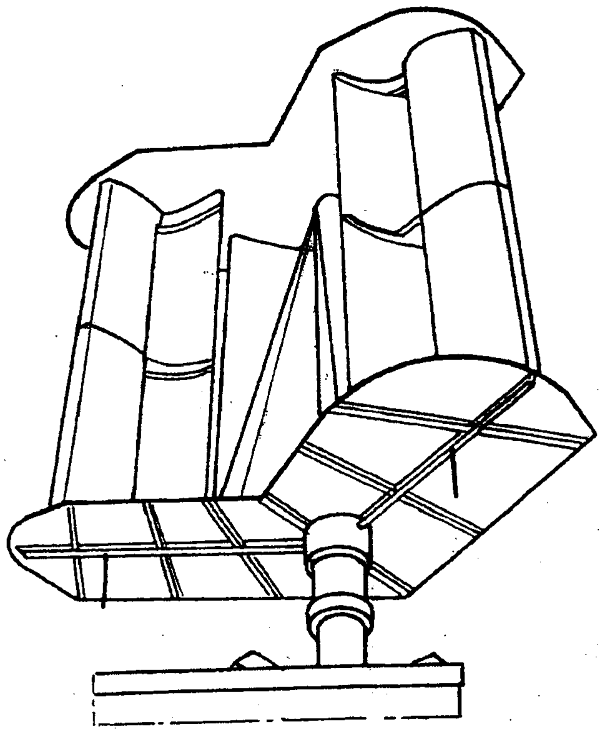


FIG.20

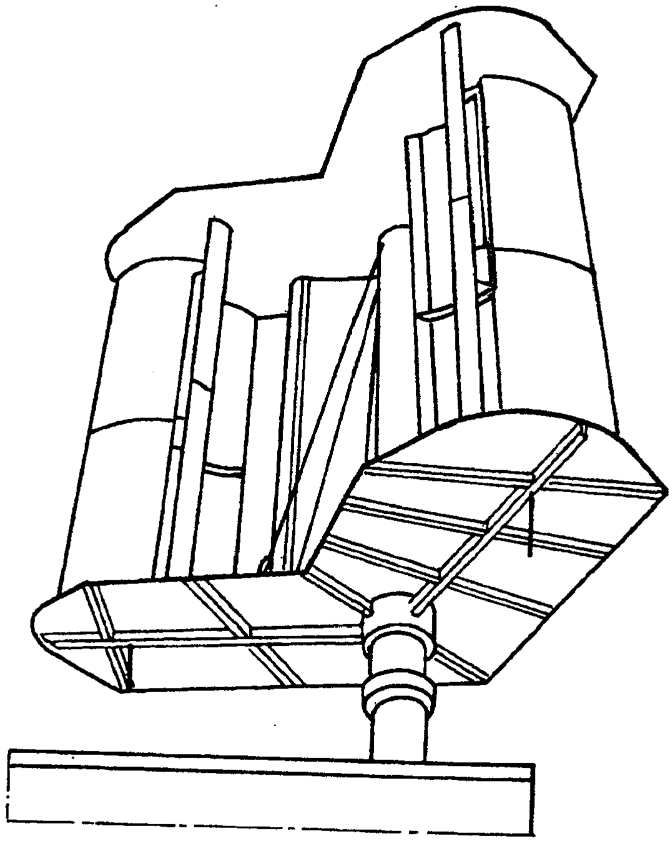


FIG. 21

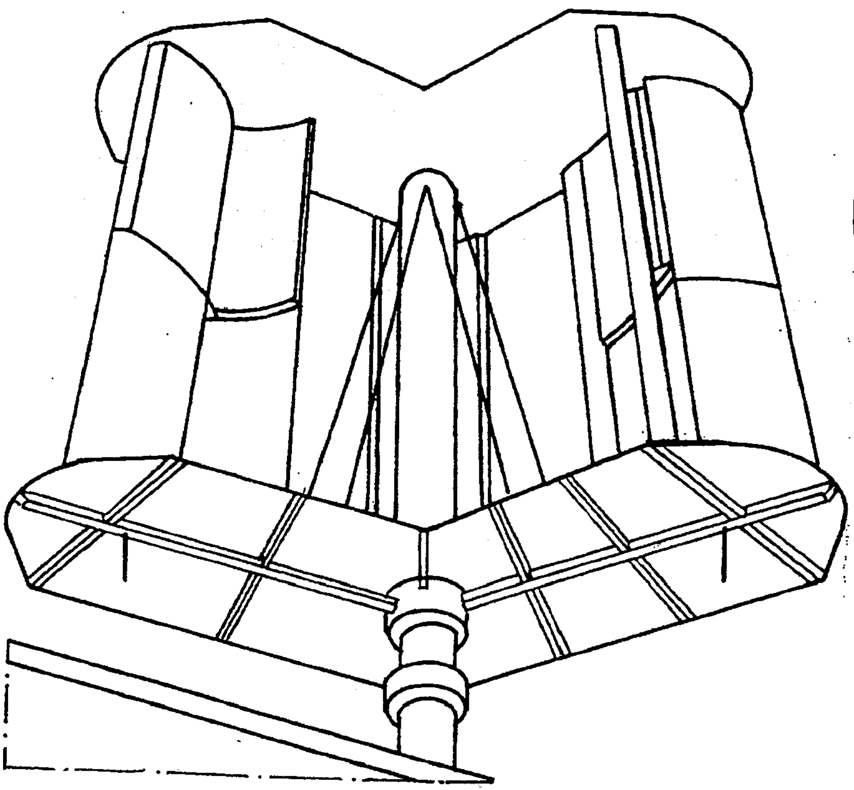


FIG.22

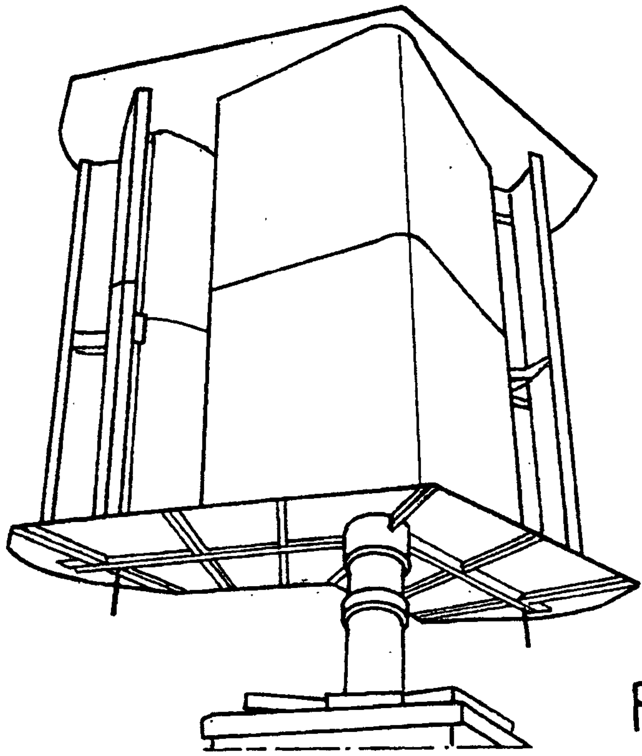


FIG. 23

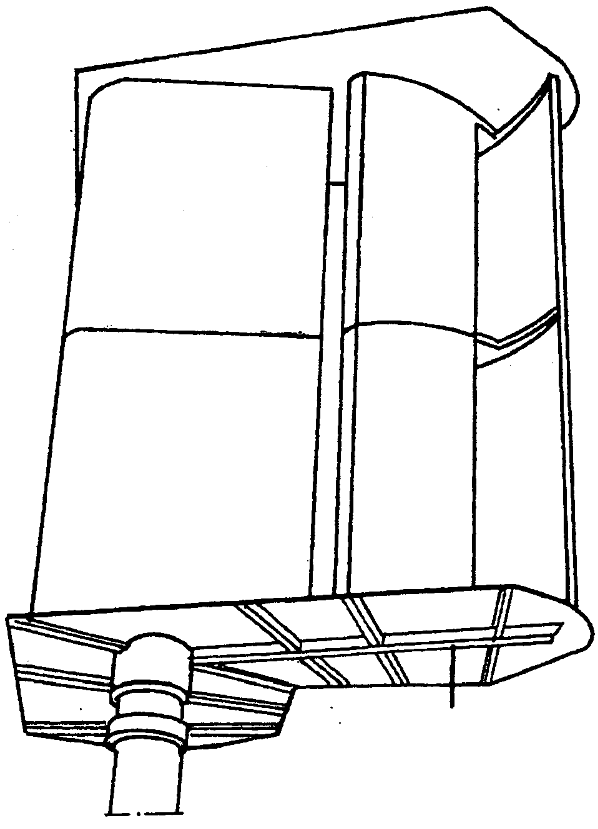


FIG.24

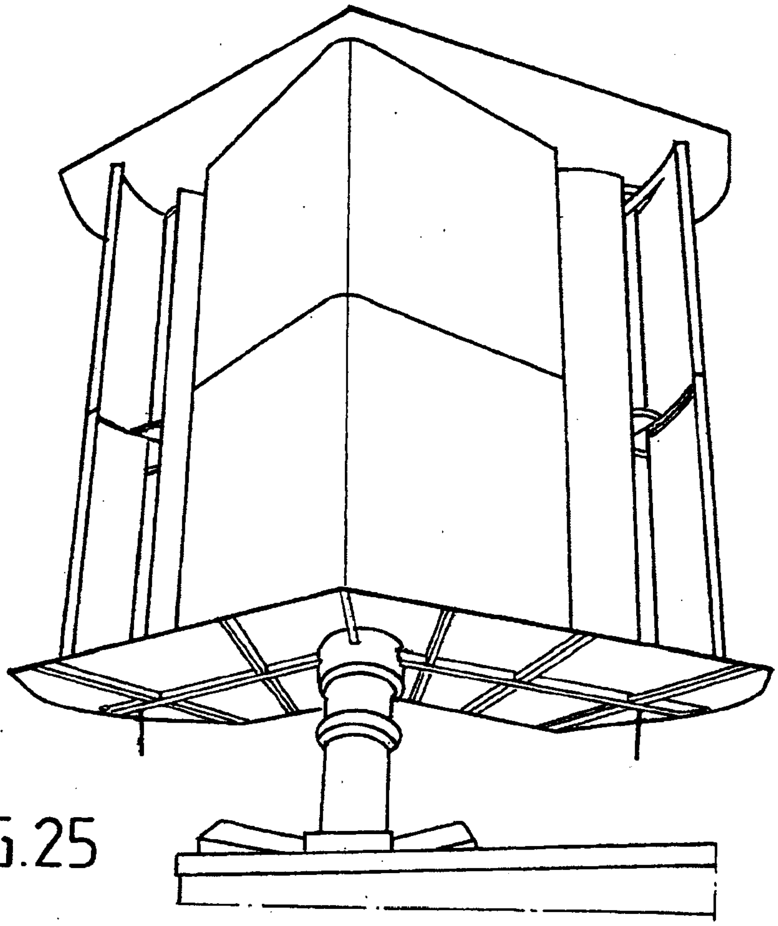


FIG.25

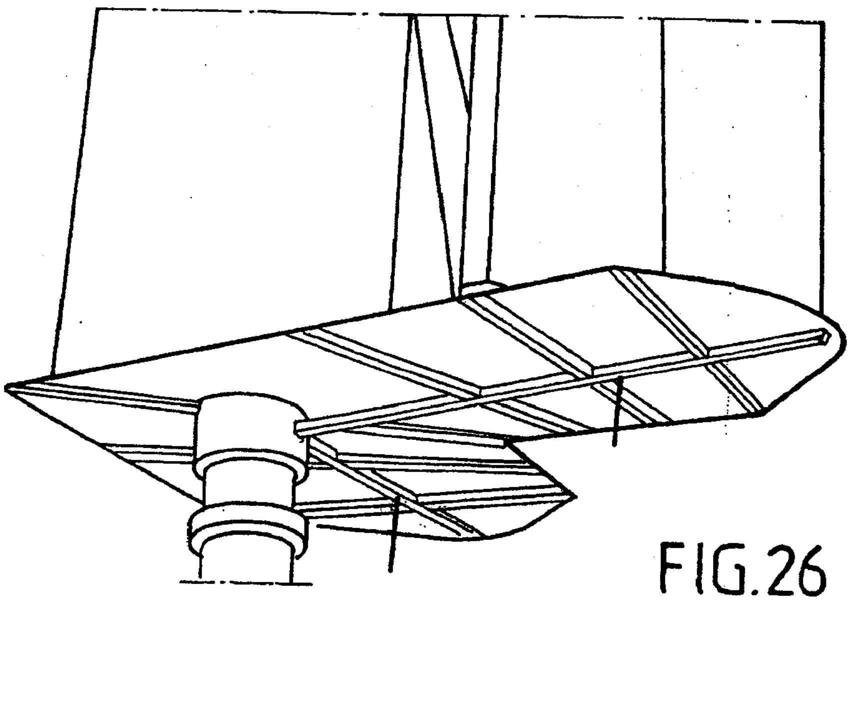


FIG.26

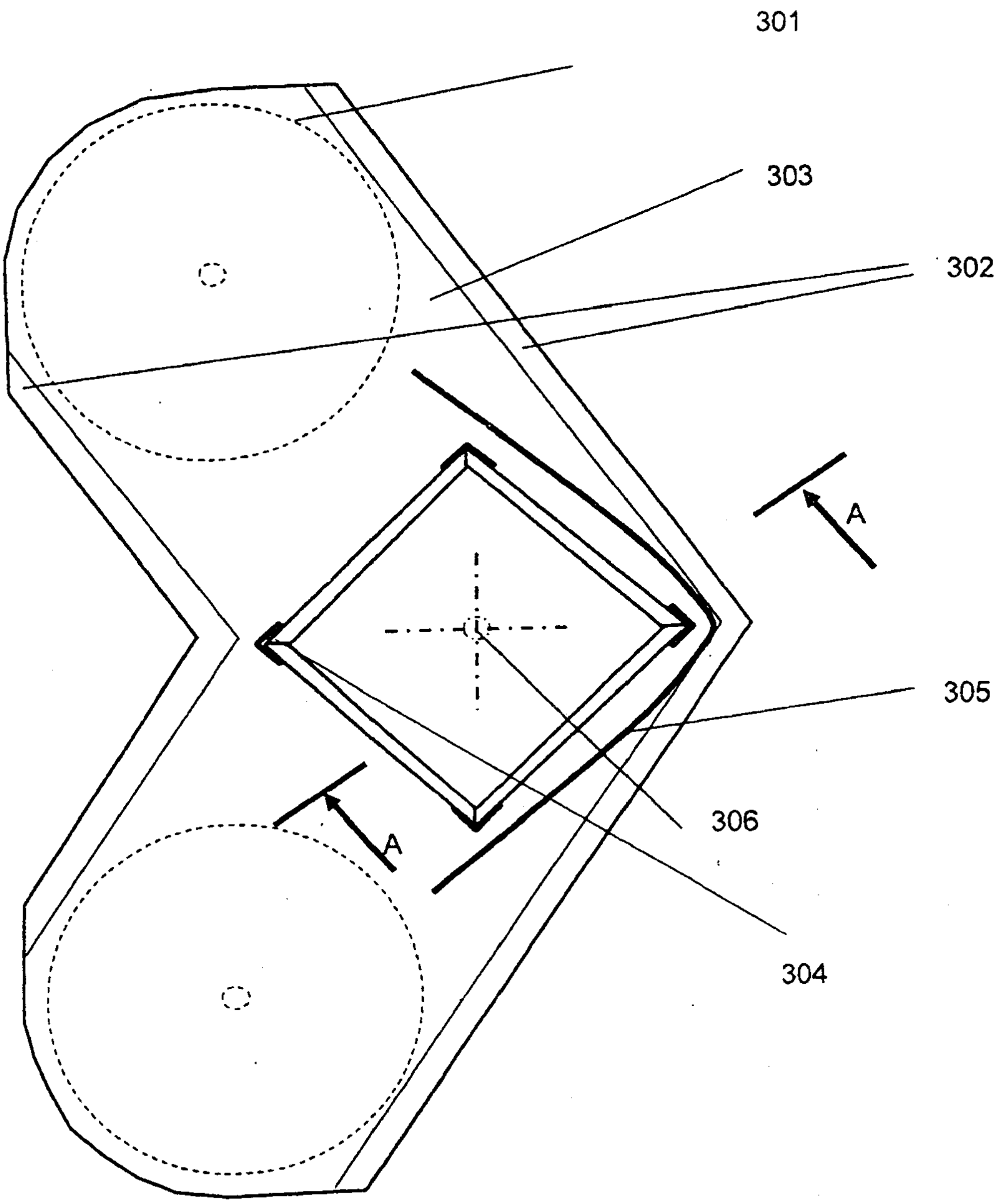


Fig. 27a

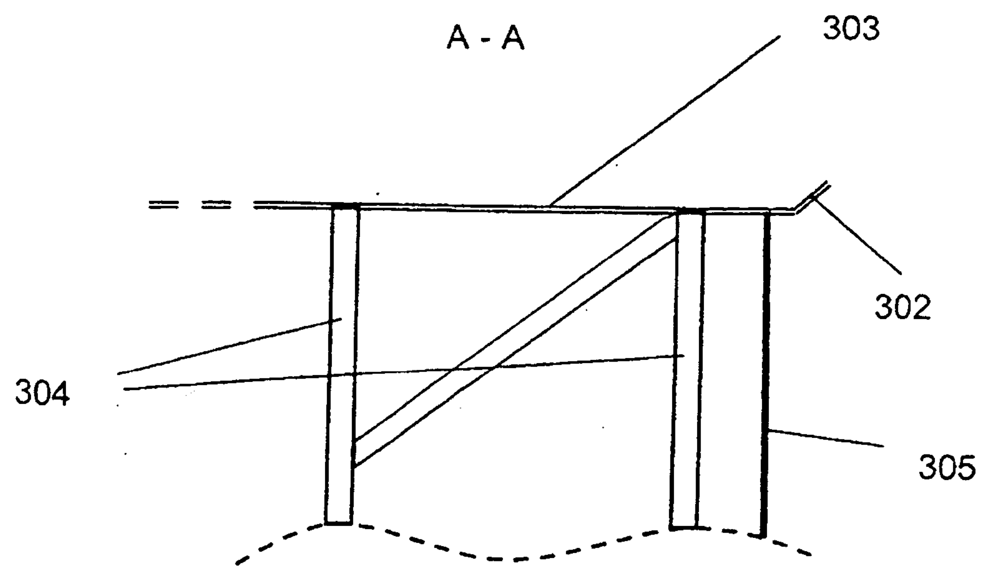


Fig. 27 b

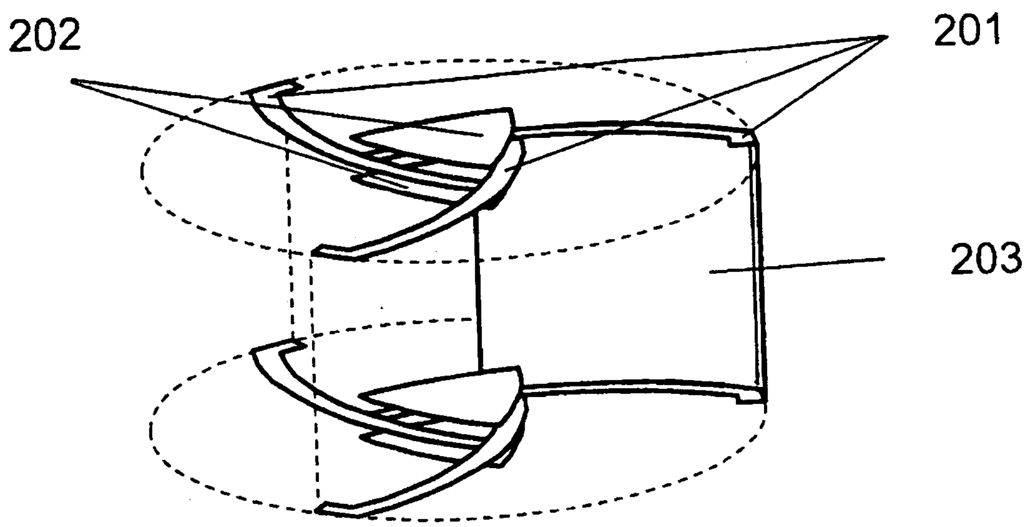


Figure 28