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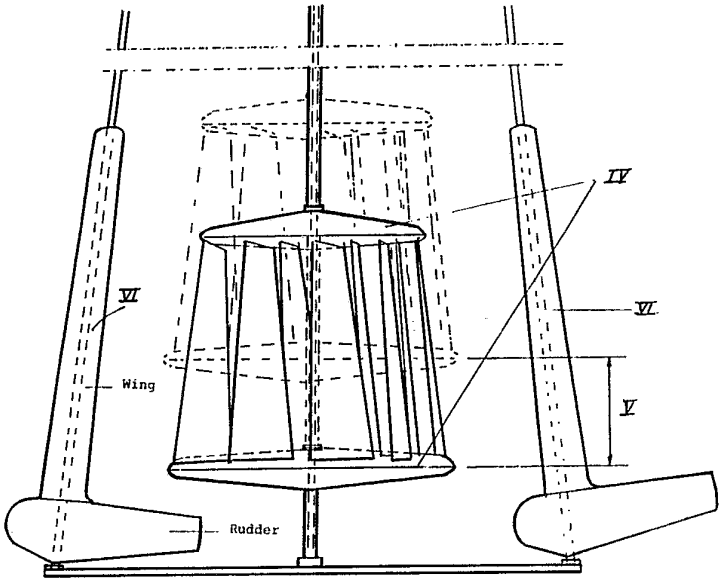

(57) Abstract

The invention refers to fluid-powered rotor to produce energy, especially from current flows, consisting of blades, running around the generatrix to a truncated cone and in its longitudinal direction, in two or three parallel ring systems inside each other. It is characteristic that the distance between two adjacent blades is less than the breadth of the respective blades, that at least one of the supports (top or base support) is open and permits communication between the inside of the rotor and its surrounding, and that the rotor has two or three separate parallel wing systems which are fitted so that the wings of the inner blades are fixed inside the openings of the outer blades and that the systems cooperate mechanically or hydraulically in the distribution of pressure between their blade systems in order to attain the maximum degree of effect and also that the blades are inclined at an angle between 20° and 35° in relation to the shaft of the rotor. The turbine can be raised or lowered along its shaft for different water levels in the same flow and it is fitted with angular wing or bow-shaped current direction intensifiers fitted in a variable number outside the generatrix of the turbine and at a variable distance from the turbine depending upon its size.

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FLUID-POWERED TURBINE WITH BUILT-IN FLOATING ELEMENTS AND CURRENT DIRECTION INTENSIFIERS

The fluid-powered turbine is specially, but not exclusively, intended to be driven by sea-currents (including tidal-currents), streams, rivers as well as other forms of flowing water. Various types of rotors and turbines are well known for producing inexpensive energy. There are mainly two types of contrivances of this kind: one where the turbine blades extend mainly at right-angles from the turbine shaft (propeller type), the other where the turbine blades run mainly parallel to the turbine shaft. There are also bow-shaped turbines.

In order to obtain useful power from these devices current speeds from about 1 knot (1,852 metres per hour) are required.

The present invention refers to the type of turbines having a vertical shaft and around this rotating and distributed blades in two or three separate rings counted from the base support of the rotor to its top support. By means of this invention, as defined in the distinctive parts of the claim to the patent, a fluid-powered conformed rotor or turbine is obtained. This is distinguished by high rotation speeds, displaying an effective torque already at current speeds of 1 knot independently of the direction of the current.

The invention is described in greater detail in the form of examples with reference to the drawings. Fig. 1 shows schematically a drawing of the connections of the blades and the pressure effect on each other in the outer ring of two or three separate systems. The distribution of the pressure takes

place with the help of mechanics or hydraulics. Fig. 2 shows schematically a device in accordance with the present invention, as seen from the side. Fig. 3 shows schematically a cut from above.

In accordance with the invention the rotor consists in principle of a shaft 1, which supports at the bottom a base support 2 and at the top a top support 3. Supports 2 and 3 take the form of a circular shaped plate or a wheel with spokes extending from the vertical shaft to the respective rings, whereby base support 2 has a larger diameter than top support 3 (conform).

Between the peripheral parts of the base support and the top support respecitvely the turbine blades extend in two or three separate systems inside each other, and to a number so that the distance between two adjacent blades is less than the breadth of the blade.

The blades can be of various materials such as stainless steel, aluminium alloy, brass or other suitable metal or reinforced plastics, etc.

In their turn the blades are movably fitted mechanically or hydraulically to rings of the base support and the top support respectively, in such a way that the blades communicate with each other's antipoles and thereby automatically assume the correct angle of action for maximum effect in relation to the flow of the stream. This is the principal novelty in the invention.

Since at least one of the supports, top or base support, is fixed to shaft 1, the turbine can for example drive a power transmission device (pressure pump, machine, generator, etc; not shown on the drawing) either at the base or at the top.

Seen as a whole the blades with base and top supports respectively form a truncated cone, the casing of which should make up an angle α to the shaft of approximately 20° - 35°, preferably 27° -28°, which has proved to be an optimal angle area. Greater or smaller angles reduce the rotation speed of the rotor.

In the case of flow pressure a higher pressure is formed in the accepted manner on the front side of the blade and this causes the turbine to rotate. On account of the venturi effect between the blades the flow there increases its velocity, thereby reducing the dynamic pressure. The flow leaves the device through the open support instrument 2 while inside the turbine during rotation a continuous negative pressure is formed and this is greater than the negative pressure on the lee side of the conformed turbine.

Because the movable mechanically or hydraulically fixed blades in the two or three separate ring systems always take up the correct angle of action to the pressure flow (smaller or greater angles respectively) there is no braking effect as the blades rotating against the direction of flow take up the minimum possible angle of resistance. From this it follows that the speed of rotation is high in relation to the flow of the stream. Due to the fact that the speed of the blades is greater at the base of the turbine and with respect to the inclination of the blades, the front side of the blade should for aerodynamic reasons be thicker at the attachment of the top support than at the base support attachment.

In general it is the case that the higher the speed of the flow, the more ductile the blades should be in order to attain a high degree of efficiency. By making the top support and the base support pivotable relatively in relation to each other the top support, for example, can be made freely pivotable on the shaft and then it is

automatically possible to attain this effect since the top support with a smaller diameter than that of the base support together with the other blade parts have less mass than the blade parts of the base support, the upper part of the turbine will rotate faster than the lower. This results in a certain amount of angular tilting between the top and base supports respectively with consequent tightening (stiffening) of the moving blades. But the tightening in any case is affected by the respective antipoles of the blades in relation to the different distributions of pressure of the current flow on the rotor blades.

The principal novel feature within the scope of the invention is to be found in the communication of the different blades with each other. One example is the way the blades located on the pressure side of the current flow communicate and distribute pressure mechanically and hydraulically to both the blades located on the lee side as well as to those which rotate against the direction of the flow. Thus the pressure is distributed in such a way that the blades always assume the correct angle of action in relation to the current flow and thereby the rotor achieves a higher rotation speed with less resistance and superior performance than those of previously known designs.

The second part of the invention is concerned with an installation for water turbines with floating elements and current direction intensifier and is a further development of the turbine described above. Priority is therefore asserted from the earlier Swedish Patent Application No. 9002676-6.

The invention refers to an installation with an enclosed fluid-powered turbine designed with floating elements to reduce the weight of the turbine and pliability, which can be elevated and lowered on the shaft of the rotor so that it can follow the currents, for example in the case of tidal flows and different water levels in rivers, streams and other flows, (Fig. 4). In addition the installation is provided with a current direction intensifier to affect the current flow in a changed angle of direction towards the turbine and to obtain greater power (Fig. 5). In addition reference is made to the earlier Swedish Patent Application No. 9002676-6 as well as to what is stated under Item 1.

This invention involving a turbine fitted with floating elements has a vertical shaft around which rotate dispersed blades in two or three separate rings reckoned from the base support to the top support of the rotor. The floating elements are designed so as to function simultaneously as base and top supports for the rotating blades in the rotor. Thanks to the invention as specifically defined in the patent claims a fluid-powered rotor or turbine is obtained having floating elements in its base and top supports respectively. The purpose of the floating elements is to reduce the relative weight of the rotor in relation to that of the current flow (the weight of the displaced water). The turbine itself can be raised or lowered on the shaft of the rotor in relation to the different levels of the flow (e.g. tidal water currents) and the turbine itself is characterized by high speed of rotation.

At a certain distance from the generatrix of the turbine there are a numer of blades, so-called current direction intensifiers suitably fitted to the upright members of the installation support in order to change the angle of the flow towards the rotor a ell as to increase still further the capacity of the turbine. These current direction

intensifiers are shaped like an extended wing with a rudder below. The wings are at an angle in relation to the rudder section. The angle between the wing and the rudder sections can be greater or smaller depending on the distance to the active blades of the water turbine. The angle of the current direction intensifiers is always dependent on the distance to the rotor and also on the size of the turbine. The current direction intensifiers always function whatever the direction of the flow around 360° . They can also be operated manually (pneumatically), but this does not need to be the case. These current direction distributors have a wing section in order to change the angle of approach of the flow towards the most active blades of the turbine in the rotation direction of the turbine. The blades also create a certain vacuum in the flow which these turbine blades have in relation to the direction of the current.

The current direction intensifiers are also equipped with a rudder section characterized by a larger surface and volume in relation to the wing section. The rudder section is therefore aimed at providing ductability (balance and stability) and has a much smaller approach angle in relation to the current flow. In addition the rudder section is located below the area which affects the current flow of the turbine and consequently it does not affect the performance of the turbine.

The floating capacity of the turbine can be designed to ensure that its upper part is always to be located at the water surface or close to it irrespective of tidal water differences in the case of high and low tide respectively or other differences in level in streams, rivers and other watercourses.

Most known sea currents, including tidal currents, are strongest at the surface and gradually diminish with the depth, with the exception however, of currents affected by differences in temperature. In such cases the currents can flow at different depths. Floating elements are therefore in combination with a turbine highly adaptable for obtaining energy from various sea currents, streams, rivers and other forms of flowing water when, for example, the tide changes direction at intervals at the same time as the tide rises and falls.

Another function makes it possible to regulate the floating capacity of the water turbine by means if its ability to rise and fall in relation to the position of the currents with respect to the water surface. The rise and fall are governed manually or pneumatically from the machine room of the installation by means of pressure tanks inside the floating elements of the turbine. This pneumatic transfer takes place through the outer shaft of the turbine. which is hollow but fixed to the upper part of the turbine. The rotor shaft consists of two shafts, one of which is fixed and extends from the installation through the turbine to the base of the shaft. The outer shaft, which also conveys the power energy to the machine room of the installation is fixed and fastened to the top of the turbine and runs parallel to the inner shaft like a pipe up to the installation machine room. This shaft is adjustable and can be raised or lowered respectively, following the floating turbine at different water levels and flows. The transfer of power takes place through the upper part of the movable shaft which is provided with longitudinal cogs or pneumatics.

The turbine installation can be erected in a tower of the type oil well derrick or it can also float attached to a buoy or pontoon or some other floating device which, by means of cables and wires, is anchored to the bottom of the sea, lake or river.

The invention is described in greater detail in the form of examples with reference to the drawings. Fig. 1 illustrates schematically an installation with a turbine which, by means of floating elements, can be raised and lowered respectively on its shaft. Fig. 2 illustrates schematically the current direction intensifiers which change the approach direction of the current flow to the turbine. Fig. 3 is a schematic sketch of the installation in a section seen from above.

In accordance with the invention the floating elements, which are built-in and connected in the turbine, consist in principle of one, two or more pressure-controlled pressure chambers and water tanks which, with pneumatically raising and lowering air pressure, control the rising and falling of the turbine as well as regulate the position of the turbine in relation to the strength of the current flow. The floating elements and the turbine are regarded as a single unit.

The floating elements and the current direction intensifiers can be made of various materials such as rust-resistant sheet metal, stainless sheet metal, aluminium alloy, brass or other suitable metal or reinforced plastic or newly invented strong material.

The turbine can be connected to a generator, pump or other means of conversion for the transmission of energy produced by the rotor. The transport of energy from the installation to the mainland can take place in various ways, by means of transport via electric cables, on the lazer principle through transmission and conversion of electric power into lazer via glass fibre cable or by pneumatics through pipes or also, for example, by oil or fluid pressure in pipe systems for a permanent installation ashore.

The installation as such, with extension, can also be utilized in a process for the production of hydrogen fuel (the water gas process). In this process the turbine functions as a motor which produces power which is transferred by electric generators, so that it is possible by means of the water gas process to make hydrogen gas H^2. It is also possible to produce hydrogen gas by means of an electrical catalytic process with the aid of, for example, zinc z^n or other catalytic metal. Methanol and hydrogen chloride, ammonia and chlorine can also be produced. The installation can even be used for the production of drinking water and distilled water, but in the main the turbine with its floating elements is primarily intended to produce energy from hydropower.

Fig. 1
shows schematically an outline over the connection of the blades and their pressure influence to one another by help from mechanics or hydraulics within the separate rings.

Blade A gives pressure influence to the blades B and C. Blade D gives pressure influence to the blades C and E. Blade F gives pressure influence to the blades G and H. Blade I gives pressure influence to the blades H and E. Blade J gives pressure influence to the blades D and B and so on. One of the blades in the turbin gives always pressure to two opposite blades. This system always functions no matter how many turbin blades, for instance 3, 4, 5, 6, 7, 8 och 10 blades and others, which are mounted in the turbin.

1. is the exterior vertically adjustable axle.

Fig. 2
shows schematically a turbin seen side-face.

Fig. 3
shows schematically a turbin with three separate systems seen from above.

Fig. 4
IV shows schematically floats and floating elements.
V shows raising and lowering of the floating elements.
VI shows current direction intensifiers.

Fig. 5
shows schematically current direction intensifiers seen from above, side-face and from the front.

Fig. 6
shows schematically a turbin in a cross-section with floating elements .

IV seen from above.

VI shows current direction intensifiers.

The whole turbin system can be mounted in a fixed construction or built in a pontoon or a ring formed current intensifier VII.

PATENT CLAIMS

1. a) Fluid-powered rotor for the production of energy from current flows consisting of blades, running around the generatrix to a truncated cone and in the longitudinal direction, in two or three mechancially or hydraulically communicating systems, standing parallel at an angle to the extension of the rotor shaft, which with the larger limitation area of one of the cones forming the first base support and with the smaller limitation area of one of the cones forming the top support are connected to the shaft of the rotor (1) coinciding with the shaft of the truncated cone, c h a r a c t e r i z e d by the distances between two adjacent blades (4,5;45) being less than the breadth of the respective blades and furthermore that the blades of the inner rings, also standing parallel in relation to those of the outer rings and fitted so that the inner blades are movably fixed in the openings between two movably fixed blades in the outer ring, and communicating mechanically or hydraulically with each other to take up the correct action angle to the current flow, from which it follows that all the blades fitted inside the cone mechanically or hydraulically affect each other in order to extract the maximum effect from the flow in addition to taking up the correct action angle.

b) The rotor according to Claim 1 a) is c h a r a c t e r i z e d by the angle being between 20 and 35 .

c) The rotor according to Claim 1 a) or b) is c h a r a c t e r i z e d by the respective blade having the form of a wing-shaped blade or other form of blade along its leading edge seen in the movement direction of the

blades, fixed between an upper and a lower ring-shaped support and that the base edge of the wing is mechanically or hydraulically fitted in communication with the other blades fitted inside the cone.

d) The rotor according to any of the preceding claims is c h a r a c t e r i z e d by the rotor having two or three wing systems, standing parallel inside each other, which systems mechanically or hydraulically affect each other to obtain the maximum effect when the blades in the respective rings always take up the correct action angle in relation to the flow.

e) The rotor according to any of the preceding claims is c h a r a c t e r i z e d by the possibility of connecting the rotor to a pump, machine or generator in order to produce energy.

2. a) Floating fluid-powered turbine in combination with one or more floating elements for the floating capacity of the turbine for the production of energy from current flows consisting of blades, running around the generatrix to a truncated cone and in the longitudinal direction, in two or three mechanically or hydraulically communicating systems, standing parallel at an angle to the extension of the turbine shaft, which with the larger limitation area of one of the cones forming the first base support and also floating element and with the smaller limitation area of one of the cones forming the top support and also the floating element are connected to the main shaft of the turbine (1), (ref. Part 1 and Swedish Patenet Application No. 9002676-6), and that the turbine with floating elements can be raised or lowered by means of pneumatic effects on the pressure chambers in the floating elements; further

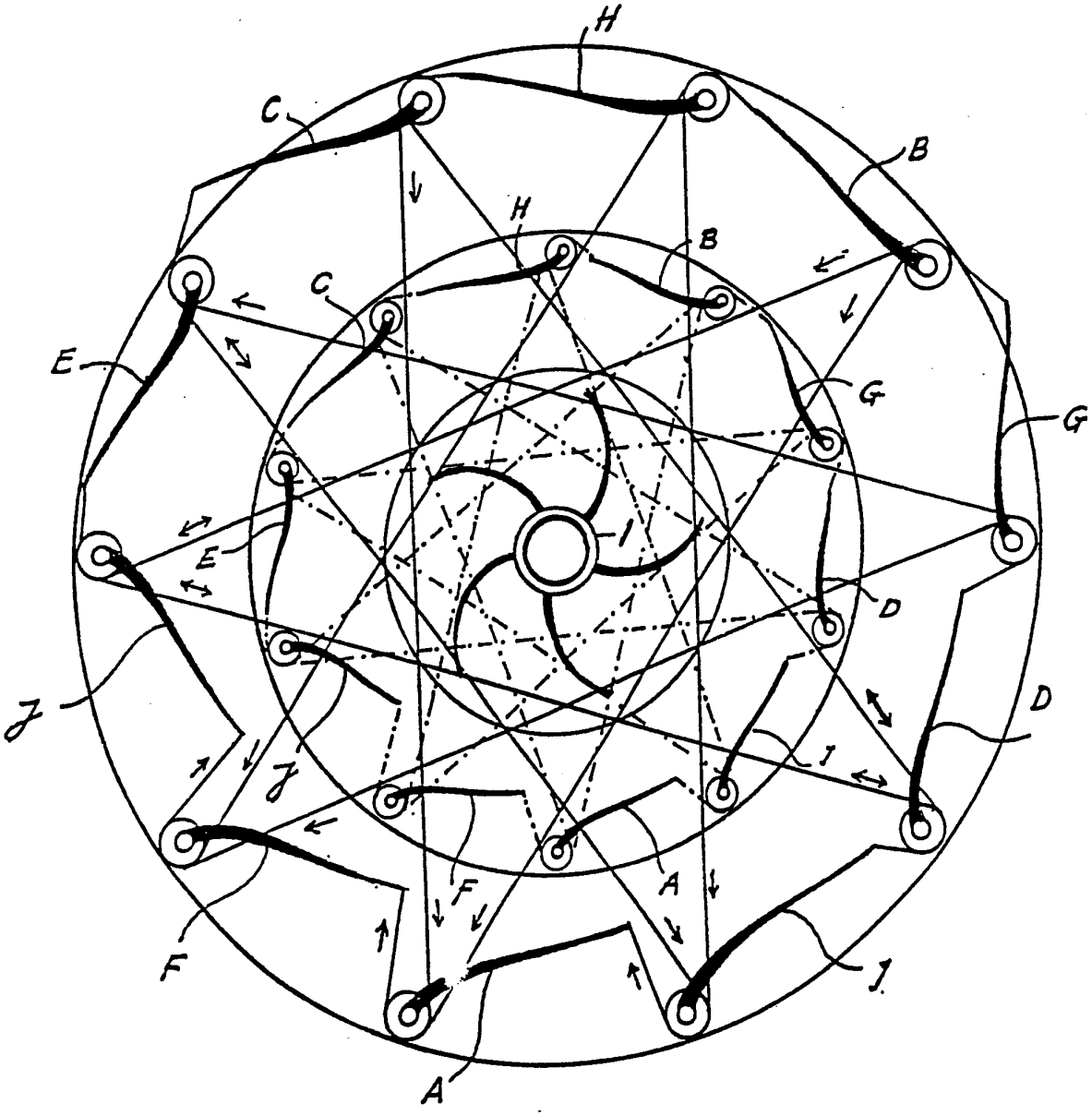
the current direction intensifiers fitted around the generatrix consisting of a variable number of wing-shaped blades with rudder fitted to the support of the turbine installation outside the generatrix of the turbine and in its longitudinal direction in order to change the angle of approach of the current flow towards the turbine as well as to raise the performance of the turbine, is c h a r a c t e r i z e d by the turbine together with the floating elements forming a single unit which can be kept floating.

b) The turbine according to Claim 2 a) is c h a r a c t e r i z e d by the possibility of raising or lowering on the turbine shaft (2) and that it follows the water levels of the differens watercources.

c) The turbine according to Claims 2 a) and b) is c h a r a c t e r i z e d by the possibility of raising or lowering the turbine by means of pneumatically operating compression tanks for the intake and release of water (3).

d) The turbine according to any of the preceding claims is c h a r a c t e r i z e d by a current direction intensifiers (3) fitted at a varying distance outside the generatrix of the turbine, its purpose being to change the angle of approach of the current flow towards the turbine.

FIG. 1



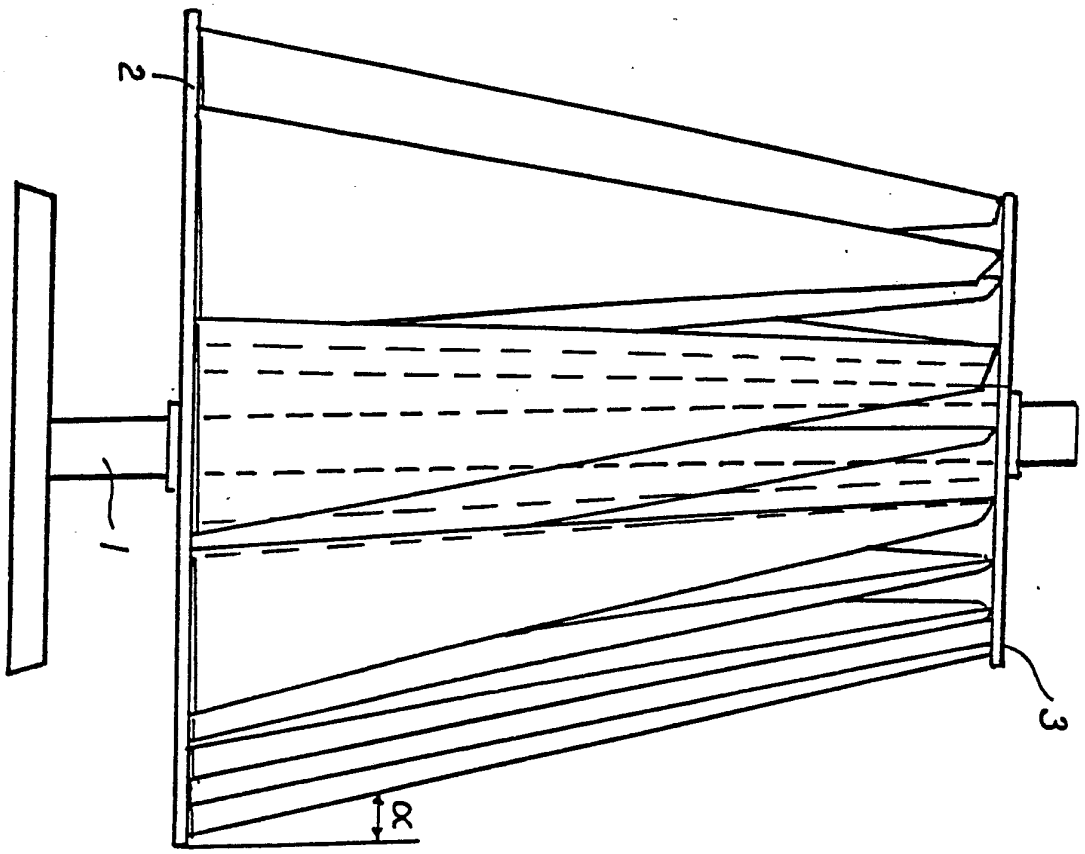


FIG. 2

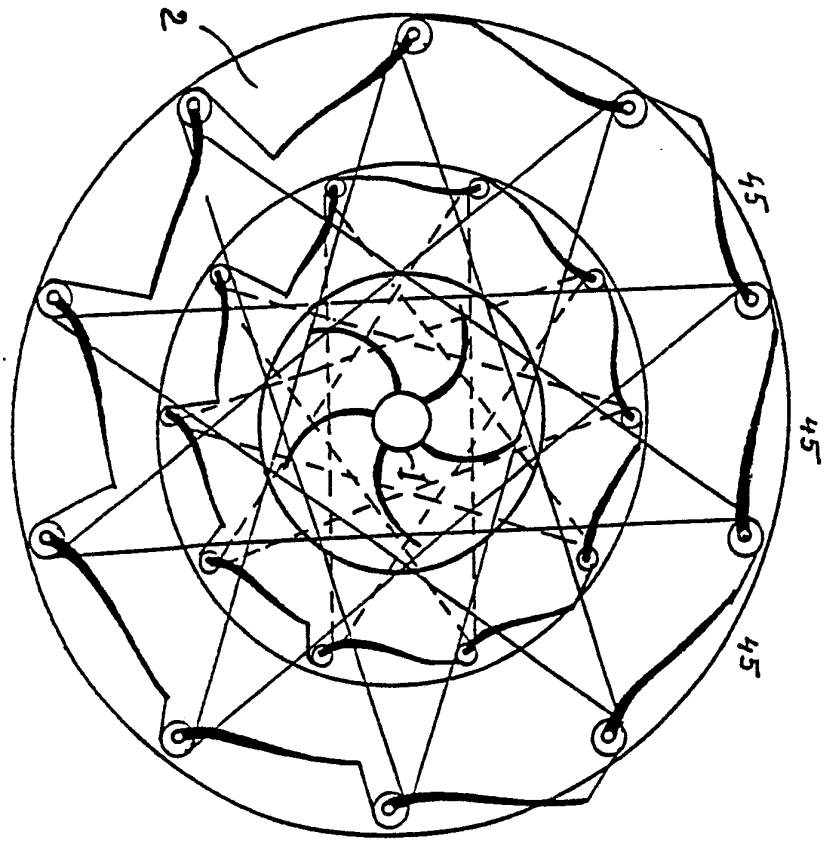


FIG. 3

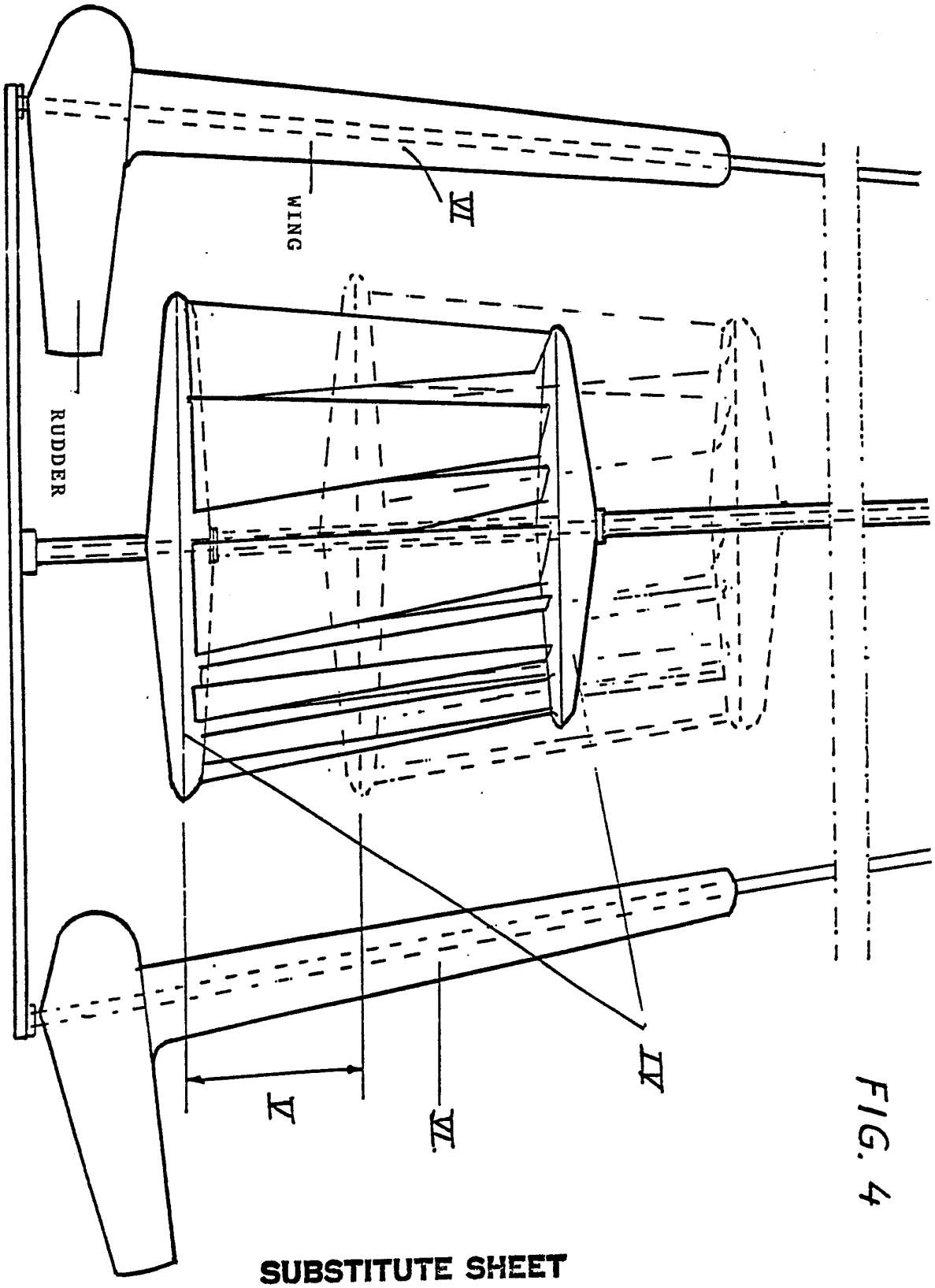


FIG. 4

FIG. 5

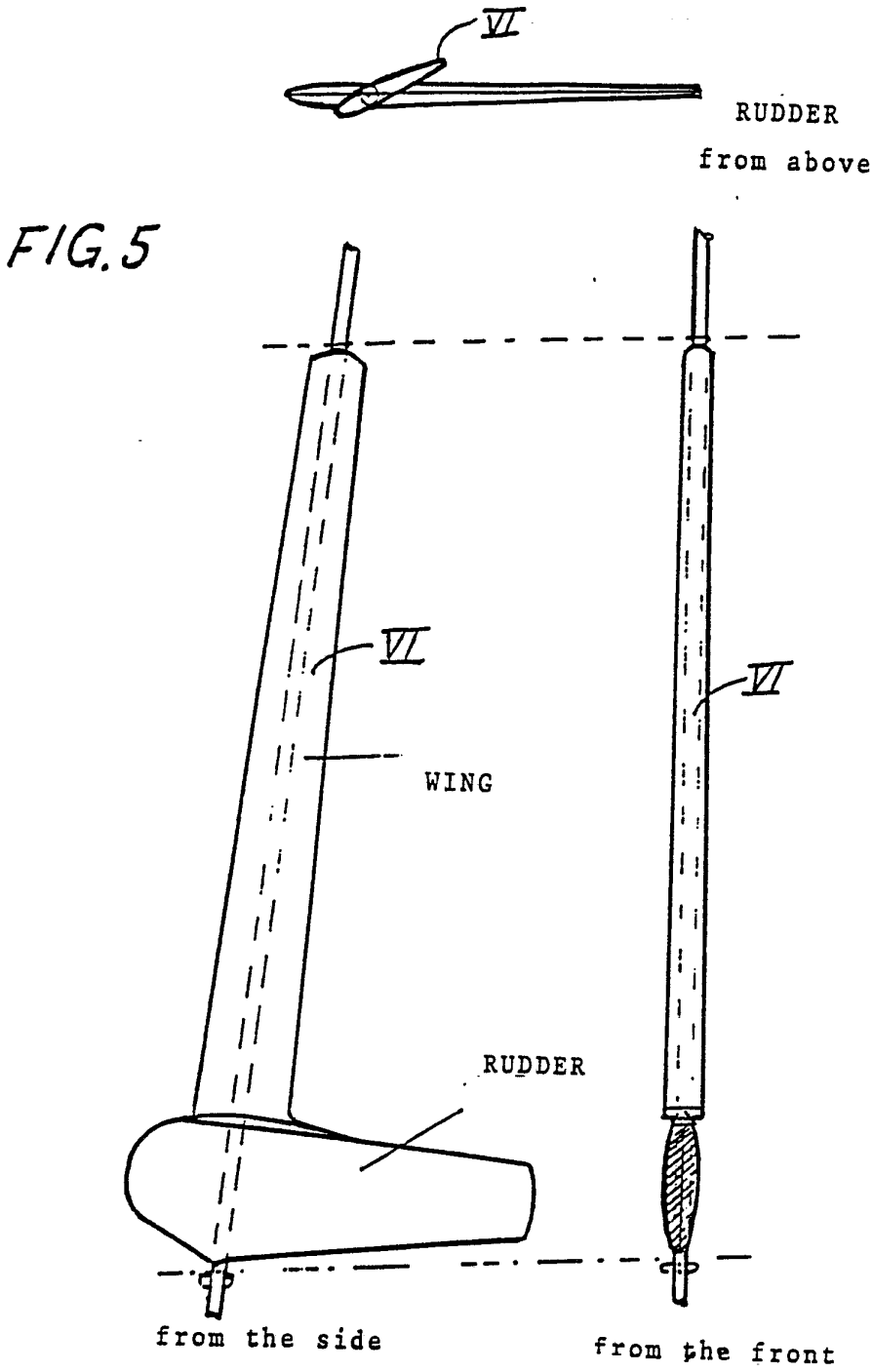
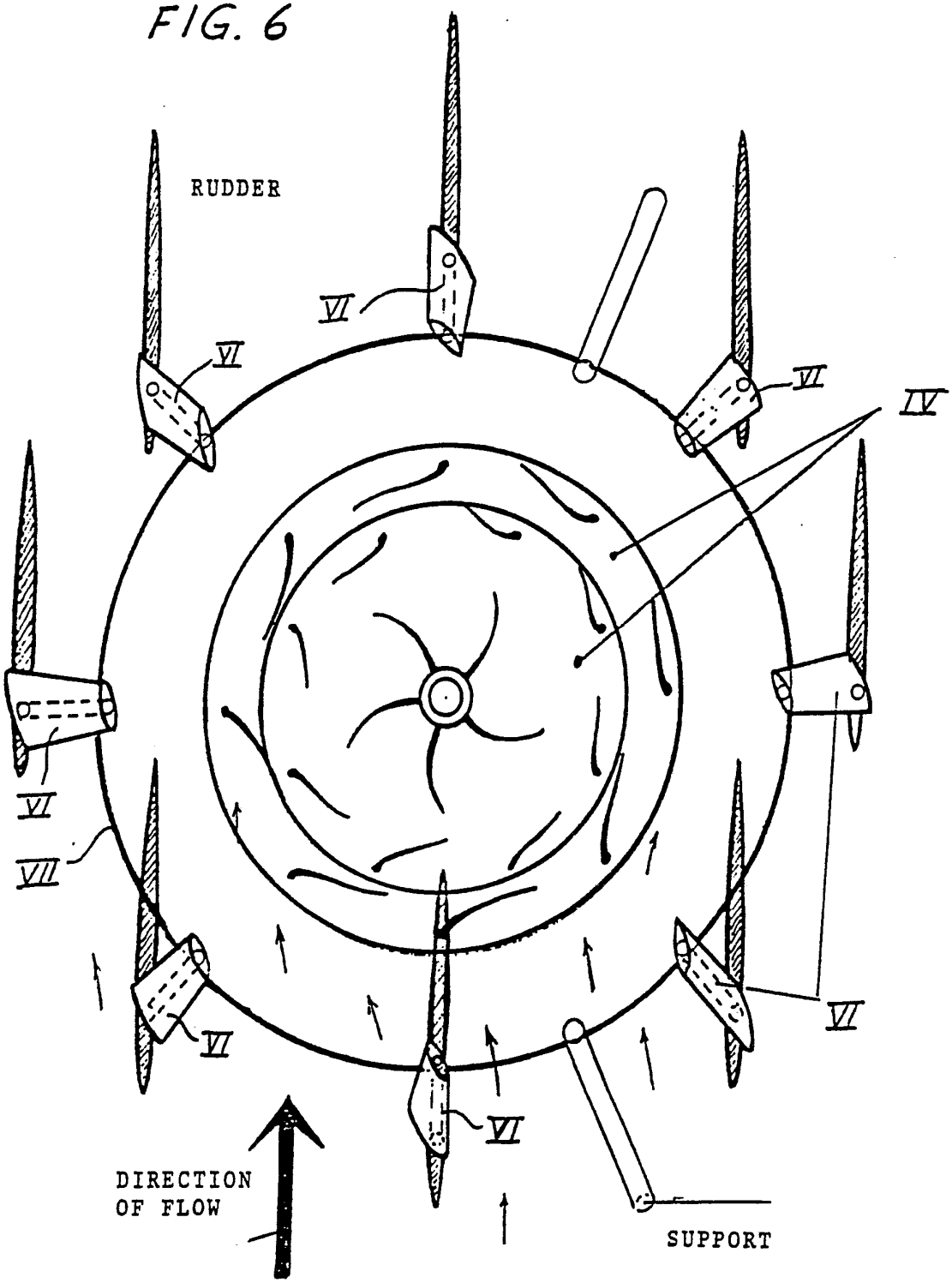

VI
RUDDER
from above
VI
VI
WING
RUDDER
from the side
from the front

FIG. 6



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00007

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: F 03 B 3/00, 13/26

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	F 03 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	WO, A1, 82/02747 (LUNDQVIST, ANDERS) 19 August 1982, see the whole document --	
A	WO, A3, 86/01563 (JÄCKEL, ERNST) 13 March 1986, see the whole document --	
A	WO, A1, 88/04362 (PEDERSEN, HANS, MARIUS) 16 June 1988, see the whole document --	
A	DE, A1, 3801673 (BUTTLER, ERNST) 29 September 1988, see the whole document --	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
2nd May 1991	1991 -05- 07
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	P-O Warnbo

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4686376 (RETZ) 11 August 1987, see the whole document --	
A	US, A, 3928771 (STRAUMSNES) 23 December 1975, see the whole document --	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 91/00007

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A1- 82/02747	82-08-19	NONE	
WO-A3- 86/01563	86-03-13	NONE	
WO-A1- 88/04362	88-06-16	NONE	
DE-A1- 3801673	88-09-29	NONE	
US-A- 4686376	87-08-11	NONE	
US-A- 3928771	75-12-23	NONE	