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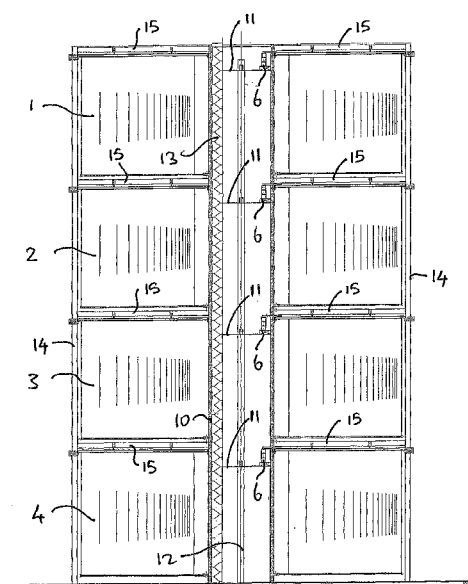


Fig 1

(57) Abstract: A shaftless wind turbine includes a vertical structure in which is located a wind driven rotor (1, 2, 3, 4). The vertical structure has a plurality of columns (14) located about an outer circumference and a hollow circular core (10) located concentrically with the outer circumference. The rotor (1, 2, 3, 4) comprises a plurality of wind engaging blades (22) located between the columns (14) and the core (10) of the vertical structure for rotation about the core (10) by action of wind blowing into the vertical structure.

SHAFTLESS VERTICAL AXIS WIND CAGE TURBINE

Background to the invention

5 1. Field of the Invention

The current invention relates to wind turbines and more particularly to vertical axis wind turbines.

2. Background Information

10 With the continuing increase in demand for energy, especially in developing countries, and a realisation that traditional fossil fuel supplies are limited there is increasing interest in new and improved ways to harness renewable energy sources such as sunlight, wind, rain (water), tides and geothermal heat, which are naturally replenished. Hydro-electricity generation has been a mainstay of renewable energy for many decades. However, with
15 greater importance being placed on the environmental impact of damming waterways and the realisation that clean fresh drinking water is an important commodity hydro-generation schemes are becoming less desirable. Attention has now turned to wind as a source of future large scale electricity generation.

20 Wind turbines can be characterised as either horizontal axis or vertical axis turbines. Horizontal axis turbines typically comprise a tower with a large fan-like blade rotating around a horizontal axis much like a windmill. Hitherto the largest horizontal axis wind turbines are about the height of a 40-storey building and have a blade diameter of approximately 126 metres. In order to produce sufficient electricity for supply to a public
25 electricity network horizontal axis wind turbines are located in large wind farms that can comprise hundreds of wind turbines spread over a large area. Although they use an abundant renewable energy source these wind farms occupy large areas of land and are unsightly.

30 Vertical axis wind turbines have a main rotor shaft extending vertically. The main advantage of vertical axis turbines is that the generator and gearbox can be placed at the bottom of the shaft near the ground meaning that the tower does not need to support this

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weight. Additionally, a vertical shaft wind turbine can accept wind from any direction and does not need to turn to capture the wind. However, there is a significant amount of lateral force applied to the vertical shaft and turbine structure due to the larger surface area that vertical axis turbines presents to the wind. Thus, there is theoretically a size limit on
5 vertical axis wind turbines known hitherto. Additionally, because they turn vertically with the wind part of the rotor is moving with the wind a diametrically opposite part of the rotor is moving towards the wind and must counter the oncoming force of the wind.

It is an object of the present invention to provide a vertical axis wind turbine that can be
10 made to a larger scale than wind turbines known hitherto in order to greater harness wind energy. It is another object of the present invention to provide a vertical axis wind turbine that overcomes or at least ameliorates disadvantages with known wind turbines, or at least to provide the public with the useful alternative.

15 Summary of the Invention

According to a first aspect the invention there is provided a shaftless wind turbine comprising

a vertical structure having a plurality of columns located about an outer
20 circumference and a hollow circular core located concentrically with the outer circumference, and

a rotor comprising a plurality of wind engaging blades located between the columns and core of the structure for rotation about the core by action of wind blowing into the structure.

25 Preferably, the shaftless wind turbine further comprises two or more rotors located one above the other between the columns and core for independent rotation about the core.

Preferably, each one of the rotors is mechanically connected with an electric generator.

30 Preferably, there is a generator driven by each one of the rotors.

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Preferably, the generator is located within the hollow core.

Preferably, the shaftless wind turbine further comprises an annular support beam concentric with the core and the rotor is suspended from the annular support beam.

5

Preferably, the annular support beam comprises a first annular support beam located at the core and a second annular support beam located at the circumference of the structure, and the rotor is suspended between the first and second annular support beams.

10 Preferably, the rotor comprises an annular frame located between the columns and core for rotation about the core, and wherein the plurality of blades are located on the annular frame.

15 Preferably, the rotor comprises an upper annular frame and a lower annular frame, and the blades comprise semi-ridged sails supported between the upper and lower frames.

Preferably, the shaftless wind turbine further comprises an annular support beam concentric with the core and the upper annular frame is suspended from the annular support beam.

20

Preferably, the annular support beam comprises a first annular support beam located at the core and a second annular support beam located at the circumference of the structure, wherein the upper annular frame is suspended between the first and second annular support beams.

25

Preferably, the shaftless wind turbine further comprises a vertically extending shield located at the outer circumference of the support structure for rotation about support structure outer circumference.

30 Preferably, the shield has a circumferential span of between 54 and 90 degrees of the support structure outer circumference.

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Preferably, the shield has a circumferential span of 60 degrees of the support structure outer circumference.

Further aspects of the invention will become apparent from the following description.

5

Brief Description of the Drawings

An exemplary form of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which:

10

Figure 1a is a section elevation view of a multi-stage wind turbine according to the invention,

Figure 1b is a pictorial view of a rotor space frame of the wind turbine,

15

Figure 1c is a pictorial view of a blade of the wind turbine,

Figure 1d is a pictorial view of a skeleton frame of the blade of Fig. 1c,

20

Figure 2 is a section plan view of the top of a single stage of the wind turbine,

Figure 3 is a section plan view of the bottom of a single stage of the turbine,

Figure 4 is a section elevation view through one stage of the wind turbine,

25

Figure 5a is an enlarged section elevation view of one half of a rotor frame of the wind turbine,

Figure 5b is a detail of an intermediate support by which the rotor is suspended,

30

Figure 6 is a section elevation view of transmission and generation components of the wind turbine,

Figure 7 is a section plan view of the top of a single-stage of an alternative embodiment of a wind turbine according to the invention,

- 5 Figure 8 is a section elevation view through the bottom of a single-stage of the alternative embodiment wind turbine,

Figures 9-13 illustrate respective embodiments of a wind shield that can be used with either embodiment of the wind turbine.

10

Description of the Exemplary Embodiments

The invention will now be described as practiced in a large size, i.e. tall building sized, vertical axis multi-stage wind turbine. The design of the wind turbine is such that it can be made to a very large size and in particular much larger than known wind turbines.

15 Hitherto the largest wind turbines are horizontal shaft wind turbines having a blade diameter of up to 126 metres. By large scale the inventors intend that a wind turbine according to the invention could have a diameter, or width, at its base of up to 300 metres and a vertical height up to 500 metres or higher. This is, however, not intended to limit the use or functionality of the invention and a skilled addressee will appreciate that principles of the invention can be applied to a wind turbine of any size.

20

Because a wind turbine according to the invention can be made to such a large scale it can capture a large area of wind at greater heights where wind velocity is higher. The kinetic energy (KE) of air is given by $\frac{1}{2}mv^2$ where mass (m) is related to the area and the velocity of the air. Being up to 300 metres wide the wind turbine presents a large blade area to the wind. Being able to reach heights of 500 or more metres means that the wind turbine is exposed to winds of higher velocity and thus a wind turbine according to the invention is able to tap greater energy potential of the wind.

25

30 Construction of a wind turbine of the size referred to above may use well known building construction and large scale engineering techniques. Numerous tall building of up to 500 or more metres have been constructed in most countries of the world and the building and

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construction techniques for such structures are easily within the know-how of the skilled addressee. The individual structural elements and features of the wind turbine described herein lend themselves to such known construction techniques.

- 5 The apparatus of the preferred embodiment is “multi-stage” in that a plurality of independent turbines, each with a respective rotor, are stacked vertically about a common rotational axis. Each turbine is mechanically linked with its own generator. As the vertical wind turbine may extend to a height of several hundred metres it may experience different wind directions and velocities at different levels through its height. Each turbine
10 is free to rotate in response to the wind that it experiences independently of a generator at a different level which may be experiencing different wind conditions. However, this is not essential to the invention and the wind turbine may be made to have just a single rotor.

A wind turbine according to the invention is shaftless. In this document “shaftless” refers
15 to the fact that each rotor of the wind turbine is a freely rotating structure. There is no shaft coaxial with the rotor to transmit torque to a generator, as is the case in conventional rotating electrical machines and known vertical and horizontal shaft wind turbines.

The term “cage” is used herein to refer to components, including the rotor frame 100 and
20 the structure for supporting the rotors, which have a cage-like form.

Referring initially to Figure 1, therein is depicted a sectional elevation view of a shaftless vertical multi-stage wind turbine according to the invention. Although not critical to the invention in terms of scale, the substantially cylindrical structure has a diameter at its base
25 of 300 metres and a height of up to 500 metres. The wind turbine comprises three basic functional parts, namely a vertical supporting structure, at least one wind driven rotor located within the structure and a generator driven by the rotor for the generation of electricity. In the illustrated embodiment there are four independently rotating rotors 1, 2, 3, 4. The rotors are stacked vertically one above the other and are each linked with a
30 respective one of four power transmission and generation units 6 within a core 10 of the structure.

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The main cage or vertical supporting structure is essentially an open rotunda building having a central circular hollow core 10. The core is constructed using known building construction techniques and gives the structure the strength to withstand large lateral forces. Within the core 10 there is at least one transverse supporting structure or floor 11 for each rotor 1, 2, 3, 4 of the turbine. Each floor is located near the top of its respective rotor and provides space for a machine room to house the electrical generator 6 and associated equipment. Access to each floor is provided by an elevator 12 together with a staircase 13 as are well-known in the building construction art. Located at the outer circumference of the structure are a plurality of vertical outer columns 14 encircling the core. The columns 14 form the outer boundary of the cage structure, which is substantially open to allow wind to blow through the structure. Each transverse supporting structure or floor 11 includes a radial beams 15 extending between the core 10 and each column 14. The core structure is capped with a roof (not shown) that is either flat, pitched or domed.

Each stage of the structure includes a rotor 1, 2, 3, 4 located within the rotunda and which is freely rotatable about the core 10 and having a generally annular form to extend between the core 10 and the outer columns 14. Each rotor includes a rigid space frame 100 having and coaxial upper and lower ring members 101, 102 centrally located in respective upper and lower planar lattice frameworks 40, 41 which are hexagonal and parallel to one another. The frameworks 40, 41 are joined by vertical bars and diagonal bracing. The rigid rotor frame 100 carries a plurality of blade skeletons 21 which are located non-radially between the inner circumference and the outer circumference of the rotor frame. The blade skeletons 21 support light weight flexible tensioned fabric panels forming wind engaging blades or sails 22. The sails 22 have a constant arcuate profile in a transverse plane and are elongated axially to extend between the upper and lower frameworks 40, 41. The sail fabric may be any one of a number of high strength lightweight fabrics that are known in, for example, the yachting industry.

The rotor cage or frame 100, blade skeletons 21 and light weight fabric sails 22 form a rigid relatively lightweight rotor which is suspended from its upper end within the rotunda between the core 10 and outer columns 14. As will be discussed in more detail later, the sails 22 do not extend from the outer circumference of the rotor all the way to the inner

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circumference. Indeed, in the preferred embodiment the sails 22 extend from the outer circumference of the rotor towards but not all of the way to the inner circumference of the rotor. This allows the wind to pass between the blades 22 and the core 10 of the building to engage subsequent sails in the rotor. The blade skeletons 21 located within the rotor
5 frame provide a support structure for the flexible wind sails 22. The skeletons hold the wind sails in a substantially curved shape to create high and low pressure zones on either side of the sail 22 as wind passes around the sail 22. The lower pressure zone is on the leading face of the sail 22, where the wind velocity is increase relative to the training face, helping to turn the rotor.

10

Referring to Figures 1b and 2, the upper rotor framework 40 includes an inner gear ring 25 internally of and coaxial with the upper ring 101. A plurality of radial rotor bars 27 extend between the upper ring 101 and apexes of the hexagonal sides. Edge bars 28 extend along each of the six sides of the frameworks 40, between the outer ends of the radial rotor bars
15 27 and inner transverse bars 29 extend between points towards the proximal end of radial bars 27 to form two concentric rings of transverse bracing between the radial bars 27. The lower annular rotor framework 41 has a similar structure to the upper annular rotor framework 40. A plurality of vertical bars are provided between radial bars 27, 31 on the upper and lower frameworks 40, 41 and are stiffened by diagonal bracing. Bracing is also
20 provided diagonally between the upper and lower frame radial bars 27, 31 and outer and inner transverse bars 27, 29, 32.

25

Referring specifically to Figures 4 , 5a and 5b, in which the rotational support of the rotor of the first embodiment is more clearly shown, at the upper part of each stage of the turbine there are inner and outer annular roller track beams 42, 43. The inner roller track
beam 42 is located around the outer periphery of the structure core 10 and fixed thereto. The outer roller track beam 43 is located adjacent the periphery of the structure and is held in place by fixing at circumferential points to the vertical outer columns 14 of the structure. The inner gear ring 25 fixed inside the upper ring 101 is engaged with drive
30 gear 52 mounted to rotate about an upright axis. The bearing 105 mounted upon the core 10 supports the rotor at its generally uppermost radially-inner end, taking the axial or vertical loads (but may optionally also the transverse or radial loads). The locating ring 44

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is received in an annular recess in the beam 42. Optionally low friction rollers between the locating ring 44 and annular recess may provide the necessary transverse or radial location of the rotor. In a like manner the weight of generally uppermost radially-outer end of the rotor is supported upon the annular track beam 43.

5 . Fixed at circumferentially spaced positions on the ring 102 of the lower framework 41 are rollers 45 bearing against the outer periphery of the core 10, thereby providing transverse support of the lower part of the rotor. In this manner the self-weight of the rotor largely produces tensile loads in the members joining the frameworks 40, 41 for a structurally more favourable loading regime.

10

As mentioned earlier in the discussion, the preferred embodiment of the invention may be up to 300 metres in diameter. If the core 10 and outer columns 14 combined accounted for, say 15 metres of the diameter then the radial distance between the inner gear ring 25 and outer circumference ring 26 of the rotor upper frame will be approximately 90 metres.

15 In such cases the structure is provided with intermediate supports between the radially inner and outer ends in the form of concentric annular suspension track beams 46, 47 located between the inner core 10 and outer columns 14. The beams 46, 46 are assembled from two members each having an upright web 106a and lower flange 106b symmetrically arranged with the flanges 106b spaced apart. Rollers 108 received in the beam are
20 supported in pairs, a roller of each pair supported upon a respective flange with a suspension member joining the rollers 108 and extending between the flanges 106b to engage the upper framework 40.

Adjacent the rotor gear ring 25 of each stage of the turbine there is an opening 51 in the
25 wall of the structure core 10 leading to a machine room in which a generator 6 is located. In practice other openings or access ways are provided through the core wall into the rotor area for construction and maintenance but these are not critical to the present invention and are not discussed. Located in the wall opening 51 adjacent the rotor gear ring 25 is a generator drive gear 52 that engages with the inner periphery of the rotor gear ring 25.
30 The generator drive gear 52 is attached to a shaft that drives gear set 53, 54 which in turn drives the generator 6 within the machine room either directly or via a gear box, for example a variable speed gear box for maintaining a constant output speed for various

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input speeds. Thus rotation of the rotor drives the generator in the machine room and produces electricity.

Figures 7 and 8 depict an alternative embodiment of the invention in which a second plurality of vertical columns 70 are provided spaced apart in a circle concentric with, and outwardly spaced from the core 10. The second plurality of columns 70 at the inner circumference define a rotor volume between the inner columns 70 and the plurality of outer columns 14. In practice the inner columns 70 are positioned at a location adjacent where the inner edge of the wind sails would be. The inner gear ring 71 of the rotor frame is positioned about the inner circumferential columns 70. An inner roller track bearing is provided about the inner columns 70 so that the rotor is freely rotational within the rotor volume defined between the inner columns 70 and the outer columns 14. The wind sails span the full radial dimension of the rotor and wind can pass between the inner columns 70 and the core 10 to impact on other sails 22 in the rotor. Because the span of the rotor is shorter there is no need for intermediary annular suspension beams in this embodiment. The transmission and generator equipment 6 is moved outside of core 10 to the inner circumferential columns 70 for engaging the rotor gear ring 71. The transmission and generator equipment 6 may be suspended from frame between the inner column 70 or a concrete floor slab may be provided between adjacent columns 70 and the core 10 to support the transmission and generator equipment 6. Access to such a machine slab is via the core 10.

When wind blows through the columns of the outer facade of the structure it impacts upon the rotor sails and turns the rotors thereby generating electricity. Because the structure is very tall, circa 400-500 metres, wind direction and velocity can change up to structure. Therefore, the wind turbine is provided with a plurality of stages each comprising a rotor and a generator arrangement as herein before described stacked vertically. The rotors are independently rotatable and can respond to wind speed and direction at their particular level within the structure.

In a drag-type turbine of the type described herein, blades are simultaneously advancing in the wind direction, and retreating opposite to the wind direction respectively. To address

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the losses caused by the advancing blades the wind turbine of the invention is provided with shields to deflect wind away from the advancing blades adjacent the leading edge of the rotor. The shields comprise a continuous cover or barrier extending around part of the outer circumference of the structure in order to protect those sails moving towards the wind direction from being effected by the wind. Each shield may have a circumferential span of between 30 and 90 degrees measured in a transverse plane with respect to the axis of the rotor and extend vertically through the full height of each rotor or stage of the wind turbine, with shields being stacked vertically like the rotor. Each shield is mounted on a rotary track running around the outside of the structure so that the shield may be moved around the circumference of the structure to accommodate changes in wind direction. The shields include rollers and driving motors to drive the shields around the roller track to different circumferential locations of the structure. The position of a shield can be automatically controlled by a computer or logic controller receiving input from a wind direction indicator. Fine tuning of the position of each shield can be achieved via an air pressure sensor behind the shield with the controller using wind direction for cause positioning of the shield and air pressure information to fine tune the position of the shield. The shield at different stages, heights, can be rotated independently to accommodate different wind directions at different levels of the structure. In the plan views depicted in Figure 2, 3, 7 and 8 the shields are identified by reference numeral 80. The shields provide the same purpose and function in both embodiments of the invention the effect of the shields is illustrated with reference to Figure 9 depicting the second embodiment of the invention. As wind, depicted by black arrows extending upwardly from the bottom of the drawing, meets the shielded area of the structure it is diverted around the circumference of the structure as depicted by arrow 81. The airflow accelerates as it moves around the shield relative to air that passes into the structure. This creates a low pressure area across the shield. A venturi effect draws air through a vertical opening 82 in the shield creating a low pressure area depicted by reference letter A at the back of the wind sail passing behind the shield. The shields not only prevent the wind impacting the advancing blades to slow the rotor, but by creating a low pressure zone in front of the advancing blades they aid in rotation of the rotor.

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Various example of shield arrangements are depicted in Figures 9-13. In the first embodiment depicted in Figure 9 the shield is simply a curved plate complementary to the generally cylindrical outer face of the apparatus and extending through 60 degrees of the circumference of the structure with its trailing edge 83 forming a small aerofoil tapering radially outwardly to a sharp upright edge. By simply deflecting the wind the shield accelerates the wind drawing air out from behind the shield and creating a low pressure zone behind the shield. In Figure 10 the shield is provided with a vertically extending ridge 84 at its leading edge. This ridge 84 helps split airflow passing through the turbine structure and around the outside of the shield reducing turbulence at the leading edge of the shield which may affect passing wind sails. In Figure 11 the ridge 84 is extended to a slot 82 elongated vertically and extending transversely in a radially inward direction from a trailing edge of the ridge toward a cylindrical section of the shield. Air can be drawn from behind the shield through the slot by venturi effect to reduce drag on the advancing blades. In the Figure 12 the portion of the shield following the ridge 84 is formed by vertical slats 85 creating a louver with a plurality of openings through which air is drawn to further improve the low pressure zone behind the shield. Figure 13 the trailing edge of the shield is shortened so that the shield spends only 30 degrees of the circumference of the structure with the trailing surface being curved to deflect airflow away from the structure. Deflection of airflow around the structure is sufficient to create a low pressure zone behind the shield and aid rotation of the rotor. The shield is also more light weight and more easily moved around the circumference of the structure.

There has been described herein an embodiment of a shaftless vertical wind turbine according to the invention. Various features and elements of the structure, rotors, gearing and generation system and shields has been described which are known in the art to have structural or functional equivalents. It is envisage that those in the art will readily see how such functional or structural equivalents can be incorporated into the invention and so the particular embodiment described herein is not intended to limit the use or function of the invention. Although the preferred embodiment described herein a drag-type turbine, it will be understood that the invention is equally applicable to a lift-type turbine, or a hybrid type.

Claims

1. A shaftless wind turbine comprising
a vertical structure having a plurality of columns located about an outer
5 circumference and a hollow circular core located concentrically with the outer
circumference, and
a rotor comprising a plurality of wind engaging blades located between the
columns and core of the structure for rotation about the core by action of wind blowing
into the structure.

10

2. The shaftless wind turbine of claim 1 further comprising two or more rotors located
one above the other between the columns and core for independent rotation about the core.

15

3. The shaftless wind turbine of claims 1 or 2 wherein each one of the rotors is
mechanically connected with an electric generator.

4. The shaftless wind turbine of claim 3 wherein there is a generator driven by each
one of the rotors.

20

5. The shaftless wind generator of claim 3 wherein the generator is located within the
hollow core.

25

6. The shaftless wind turbine of any preceding claim further comprising an annular
support beam concentric with the core and the rotor is suspended from the annular support
beam.

30

7. The shaftless wind turbine of any preceding claim wherein the annular support
beam comprises a first annular support beam located at the core and a second annular
support beam located at the circumference of the structure, and the rotor is suspended
between the first and second annular support beams.

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8. The shaftless wind turbine of any preceding claim wherein the rotor comprises an annular frame located between the columns and core for rotation about the core, and wherein the plurality of blades are located on the annular frame.

5 9. The shaftless wind turbine of any preceding claim wherein the rotor comprises an upper annular frame and a lower annular frame, and the blades comprise semi-ridged sails supported between the upper and lower frames.

10 10. The shaftless wind turbine of claim 9 further comprising an annular support beam concentric with the core and the upper annular frame is suspended from the annular support beam.

15 11. The shaftless wind turbine of claim 10 wherein the annular support beam comprises a first annular support beam located at the core and a second annular support beam located at the circumference of the structure, wherein the upper annular frame is suspended between the first and second annular support beams.

20 12. The shaftless vertical wind turbine of any preceding claim further comprising a vertically extending shield located at the outer circumference of the support structure for rotation about support structure outer circumference.

25 13. The shaftless vertical wind turbine of any preceding claim wherein the shield has a circumferential span of between 54 and 90 degrees of the support structure outer circumference.

14. The shaftless vertical wind turbine of any preceding claim wherein the shield has a circumferential span of 60 degrees of the support structure outer circumference.

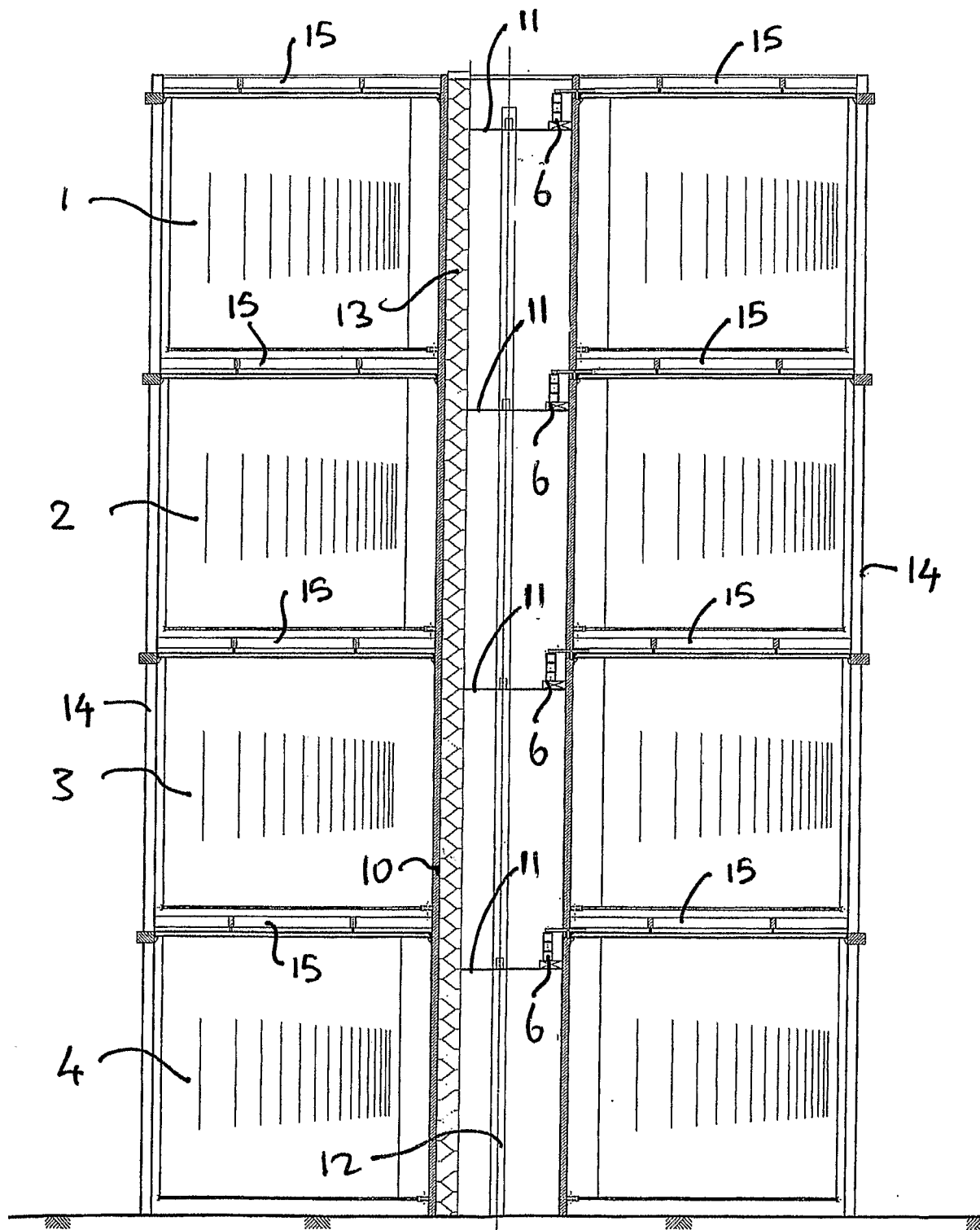


Fig 1

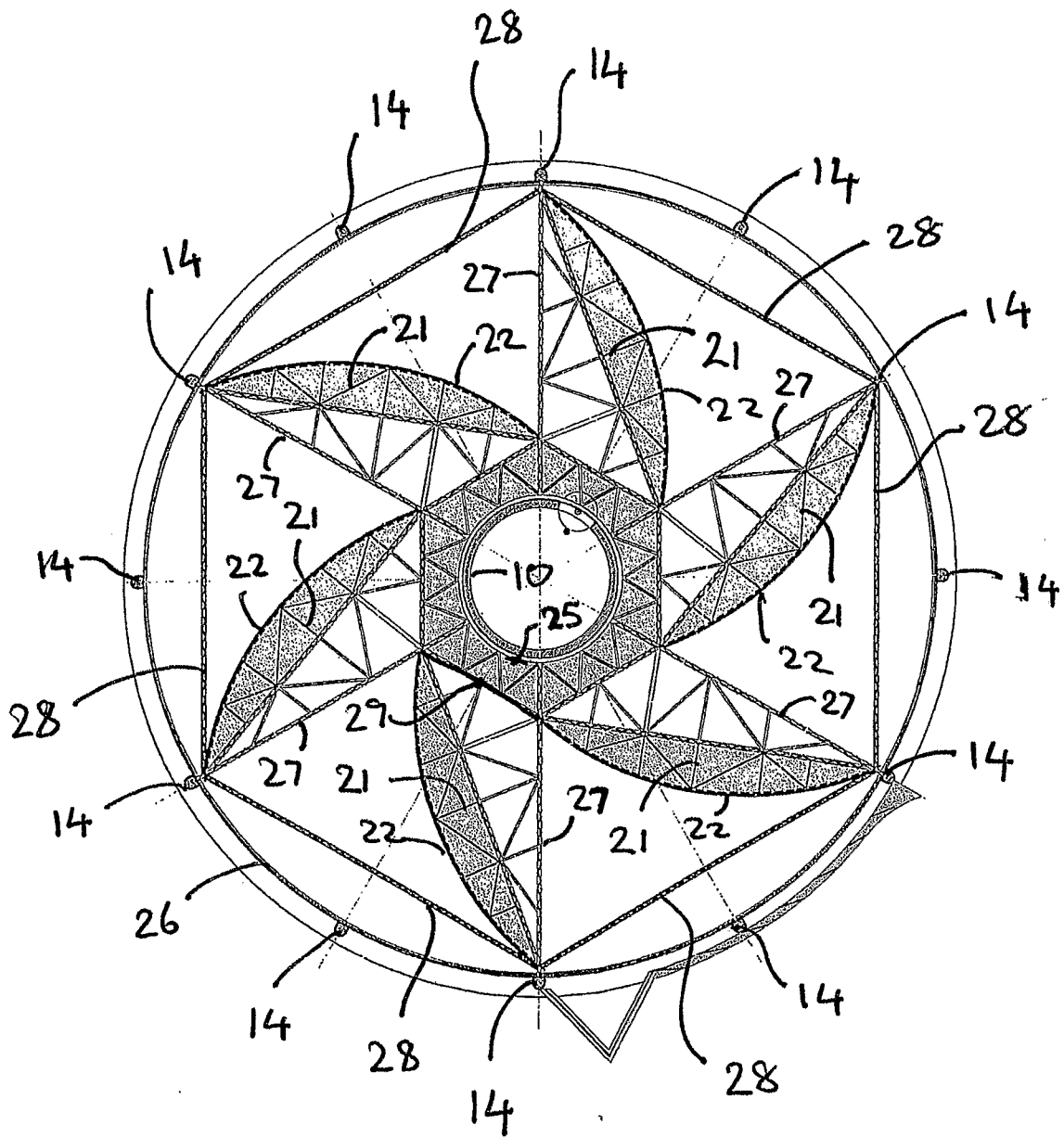


Fig 2

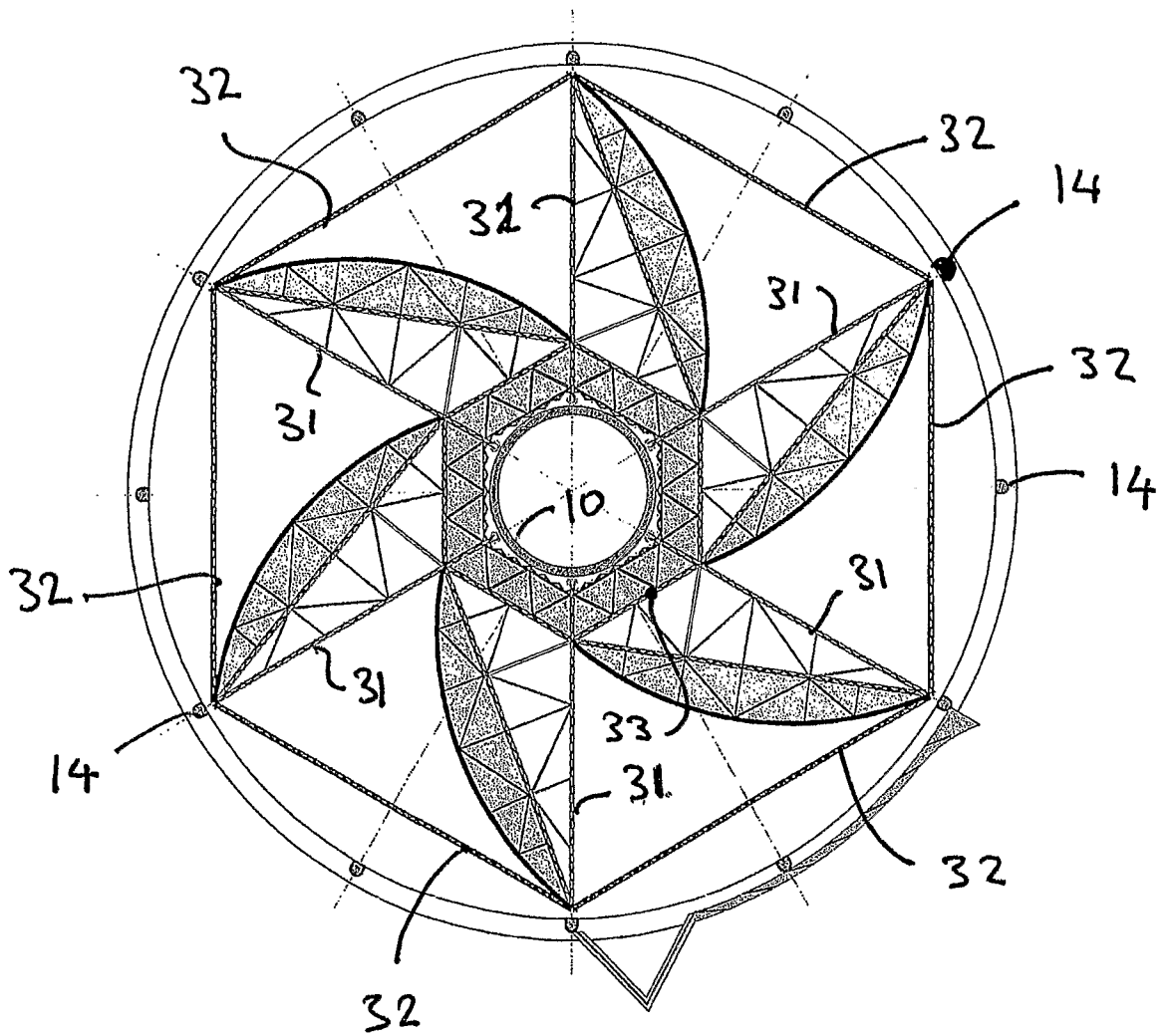


Fig 3

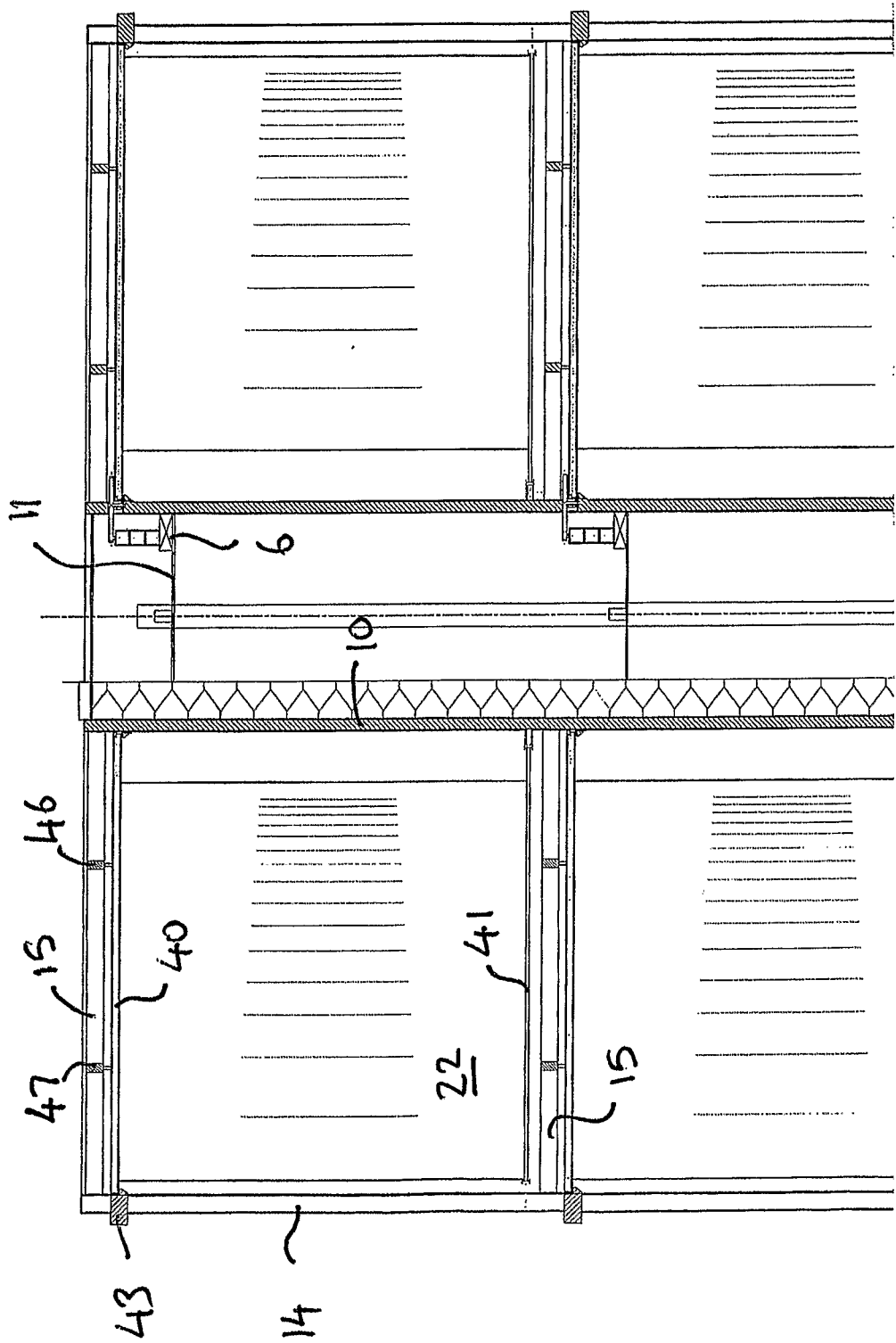


Fig 4

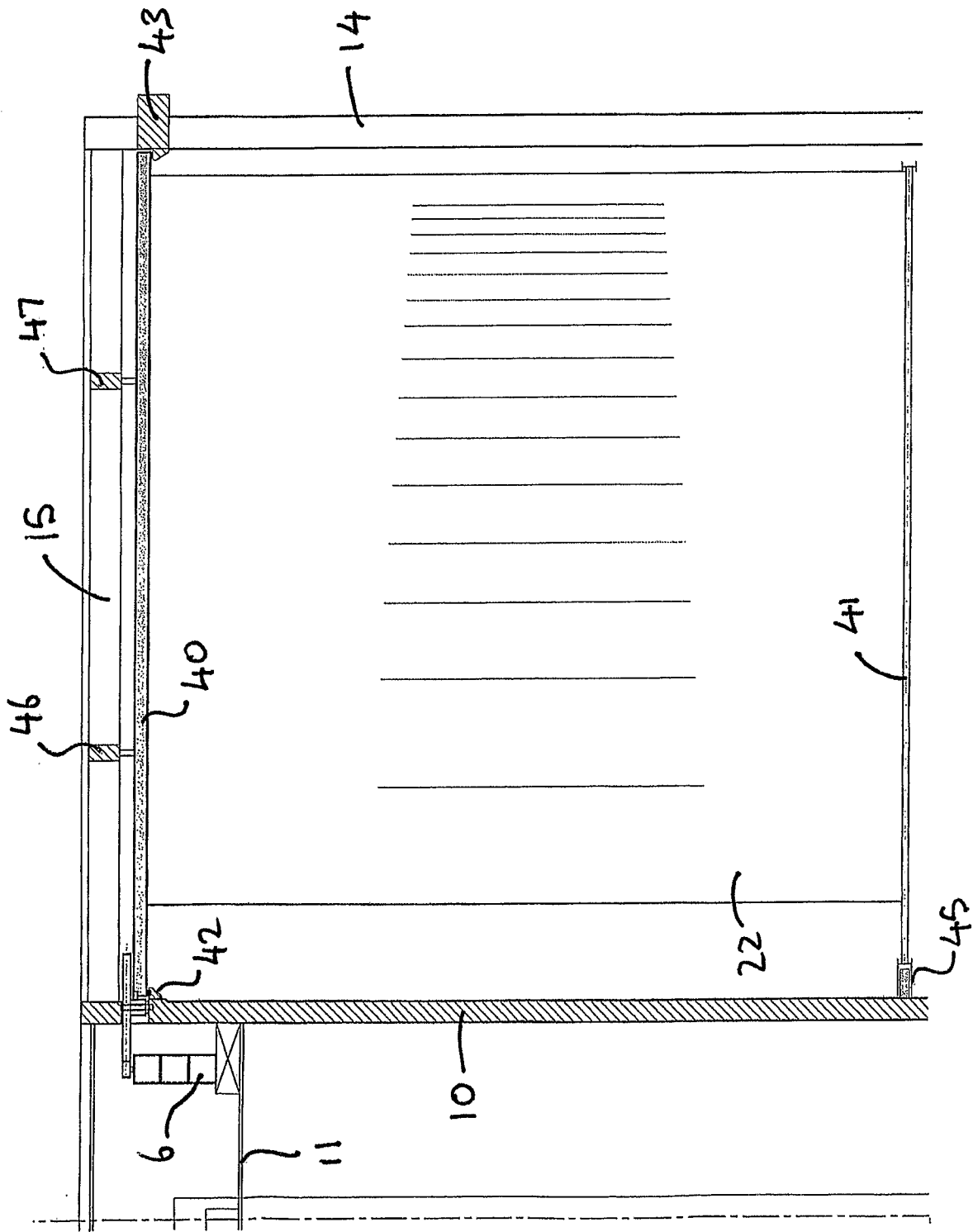


Fig 5

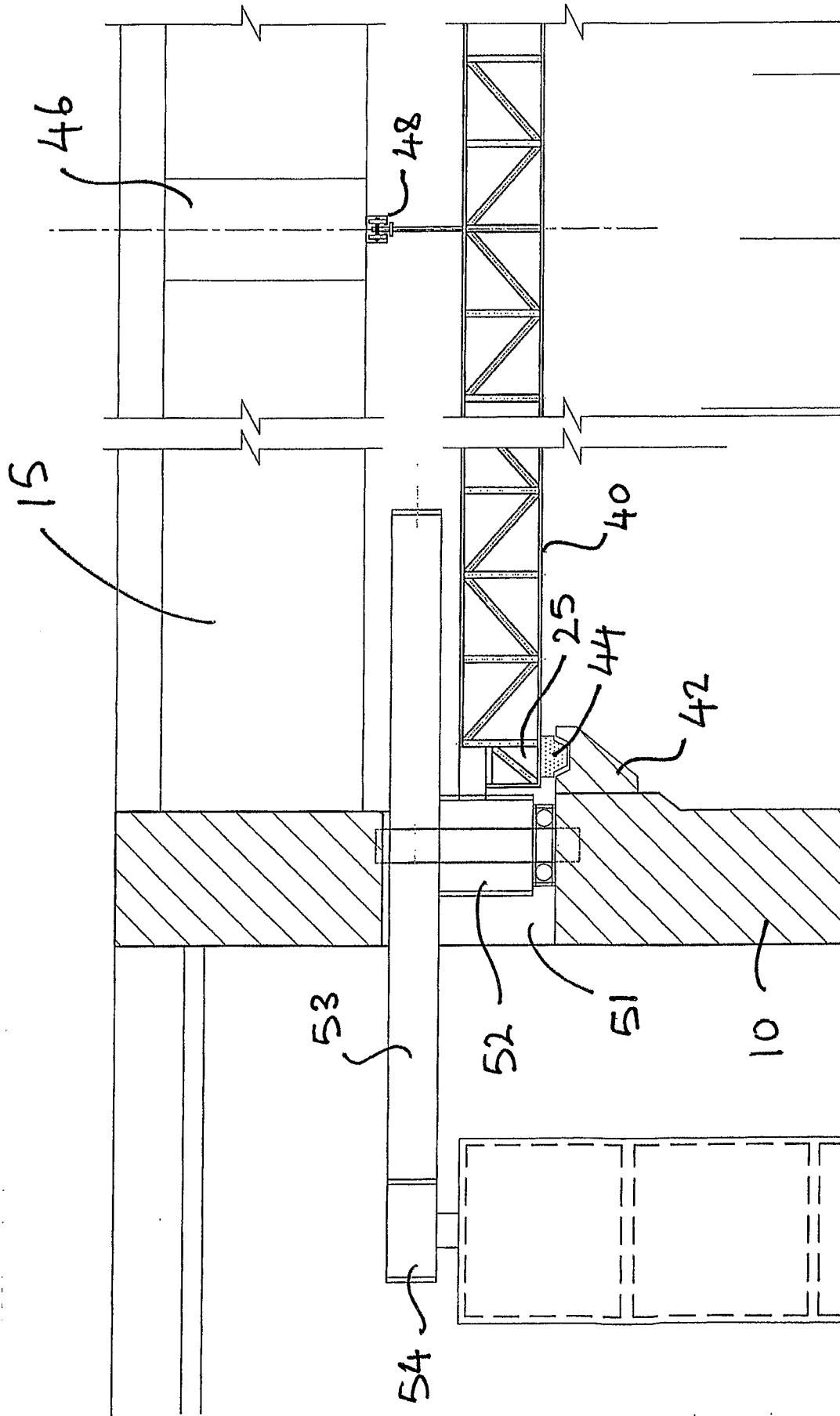


Fig 6

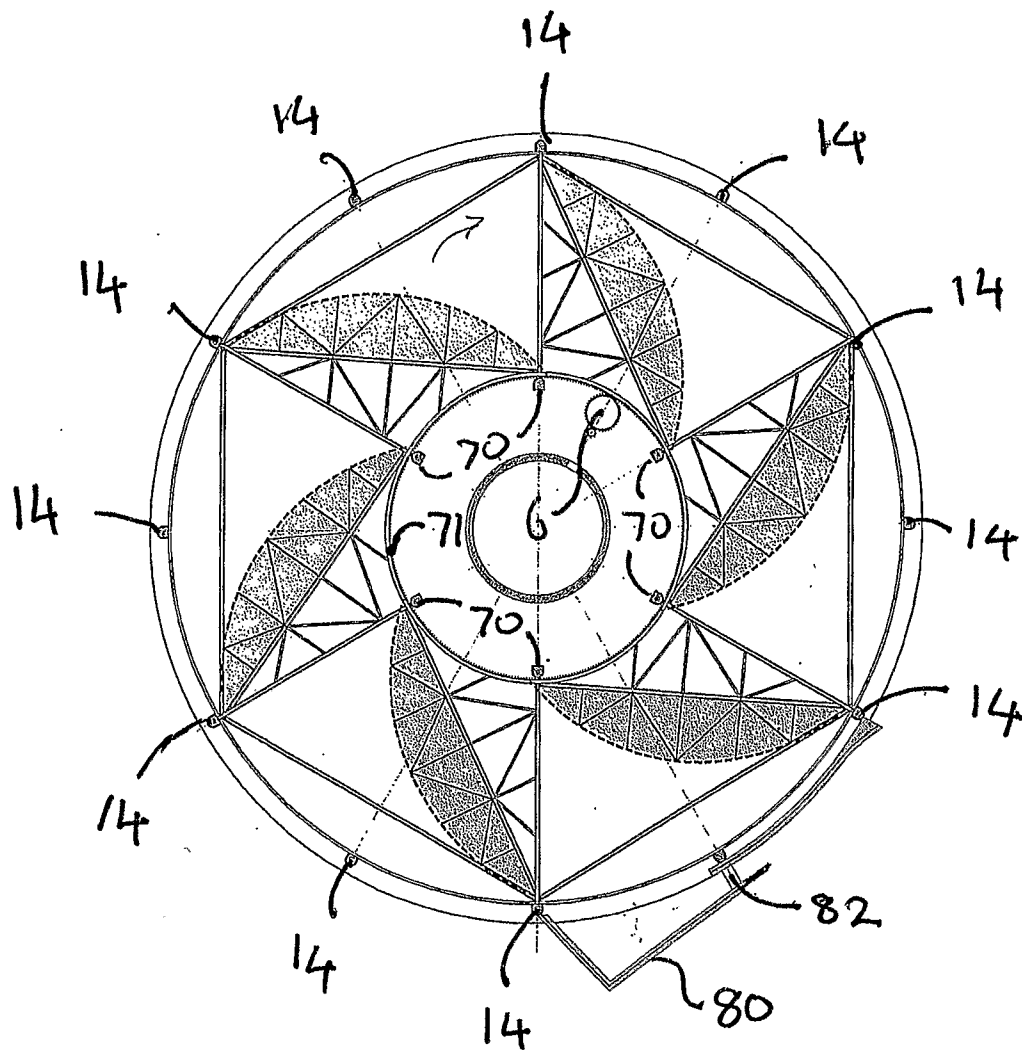


Fig 7

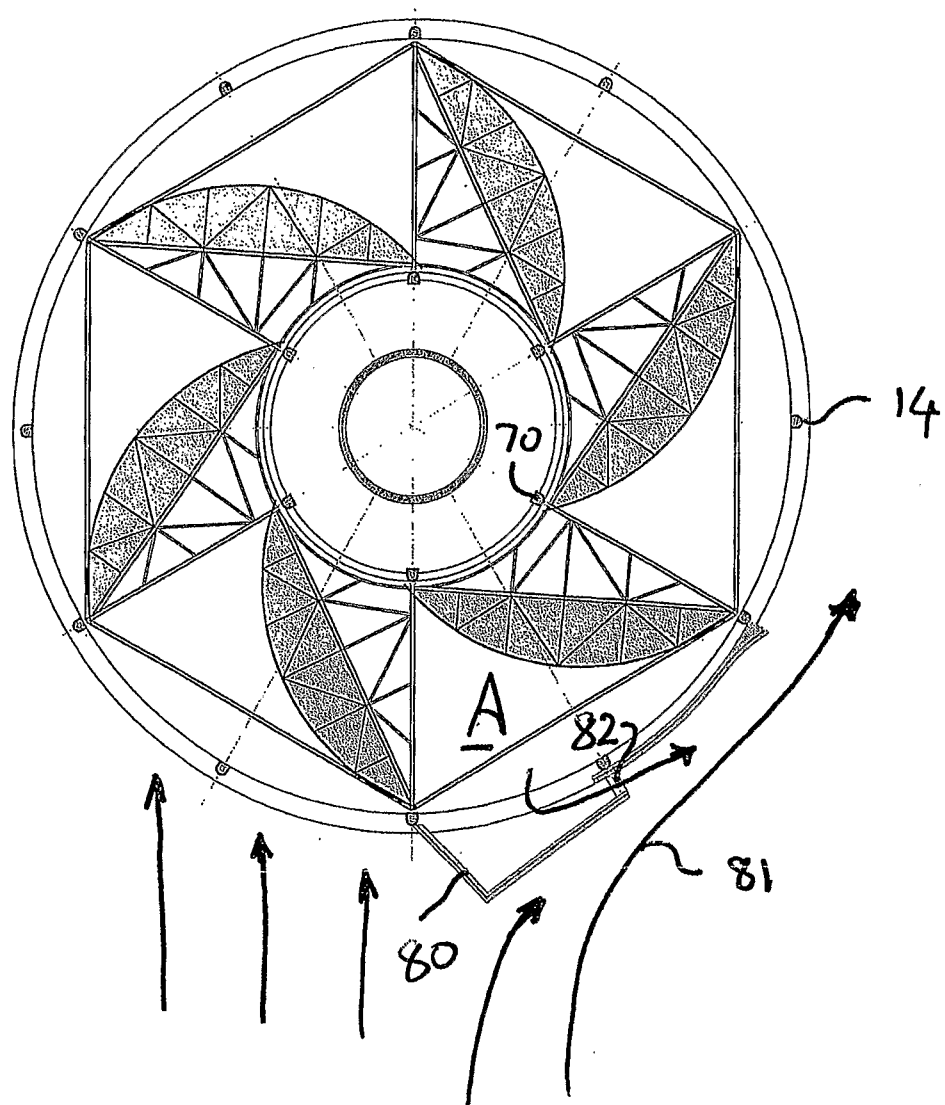
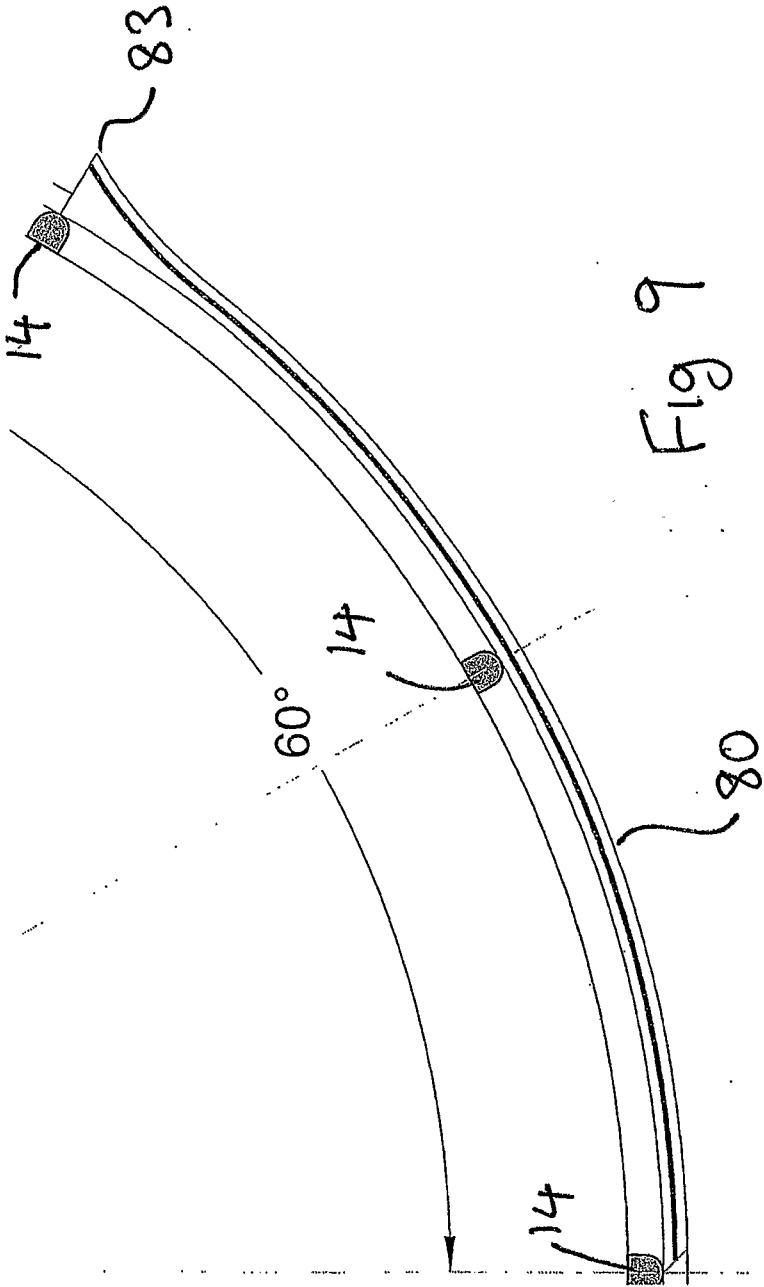
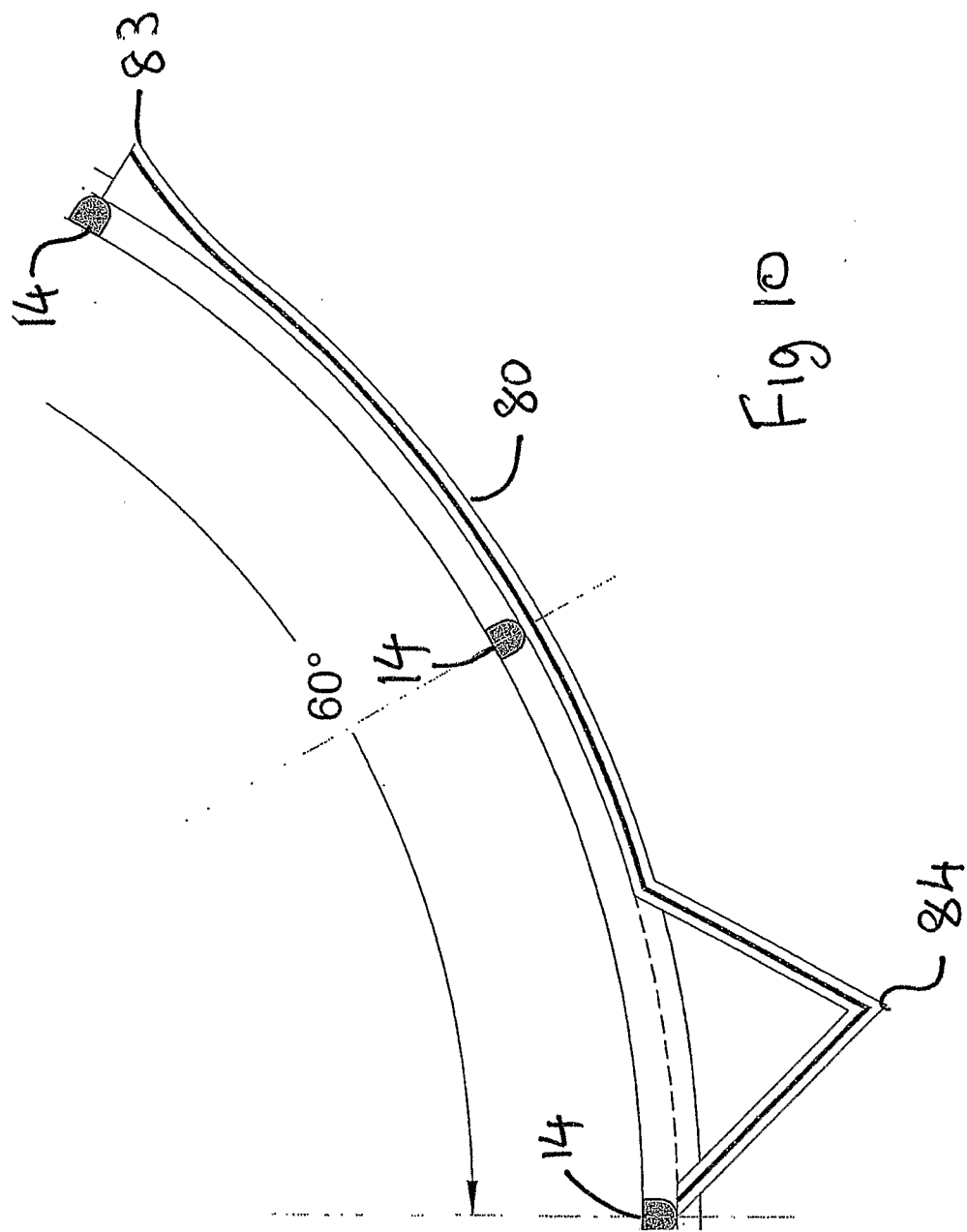
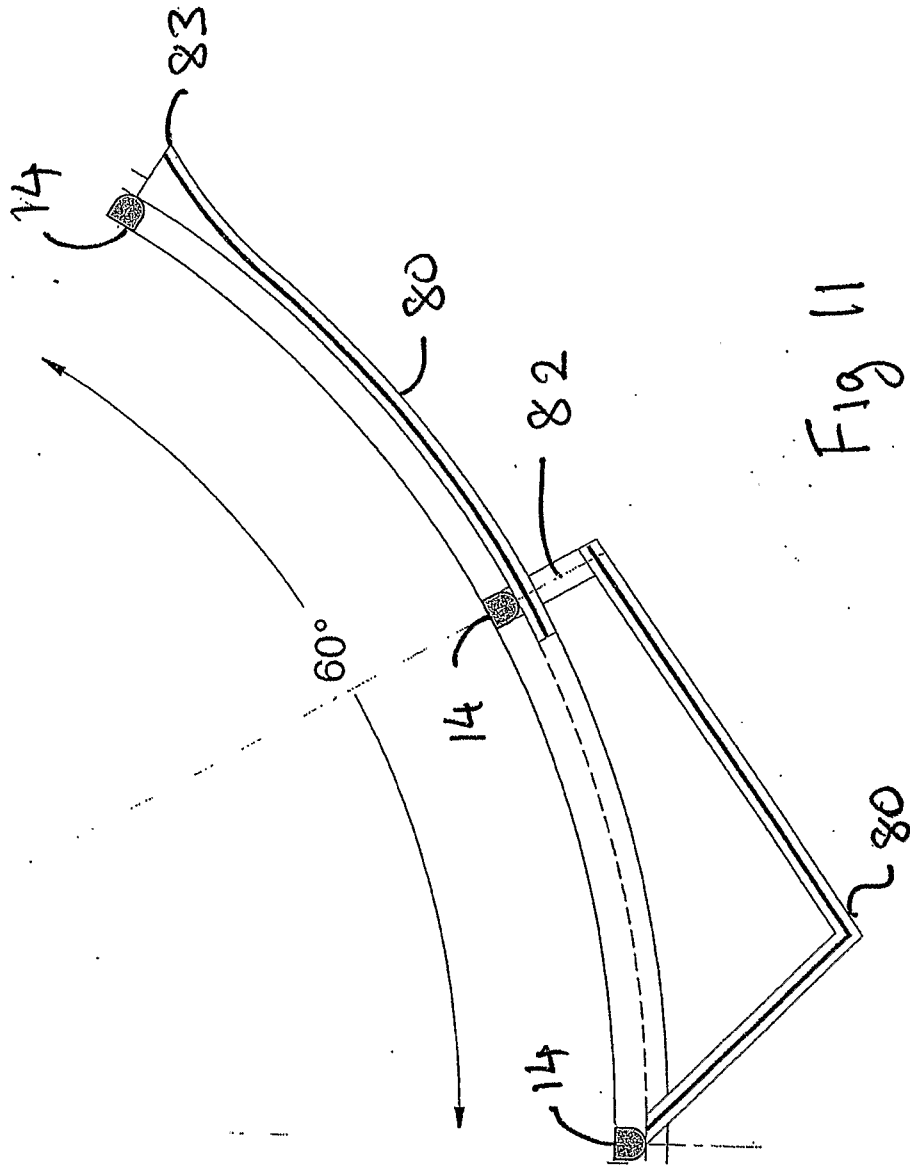


Fig 8







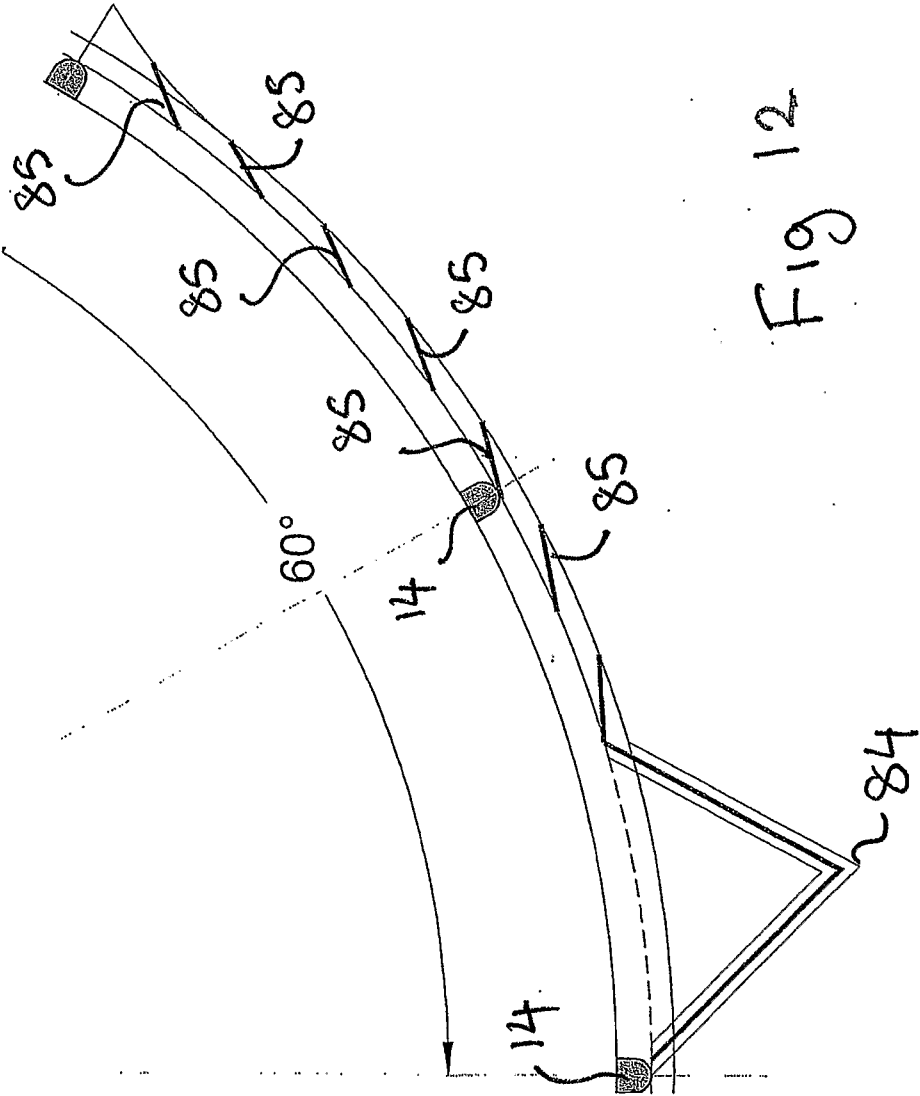
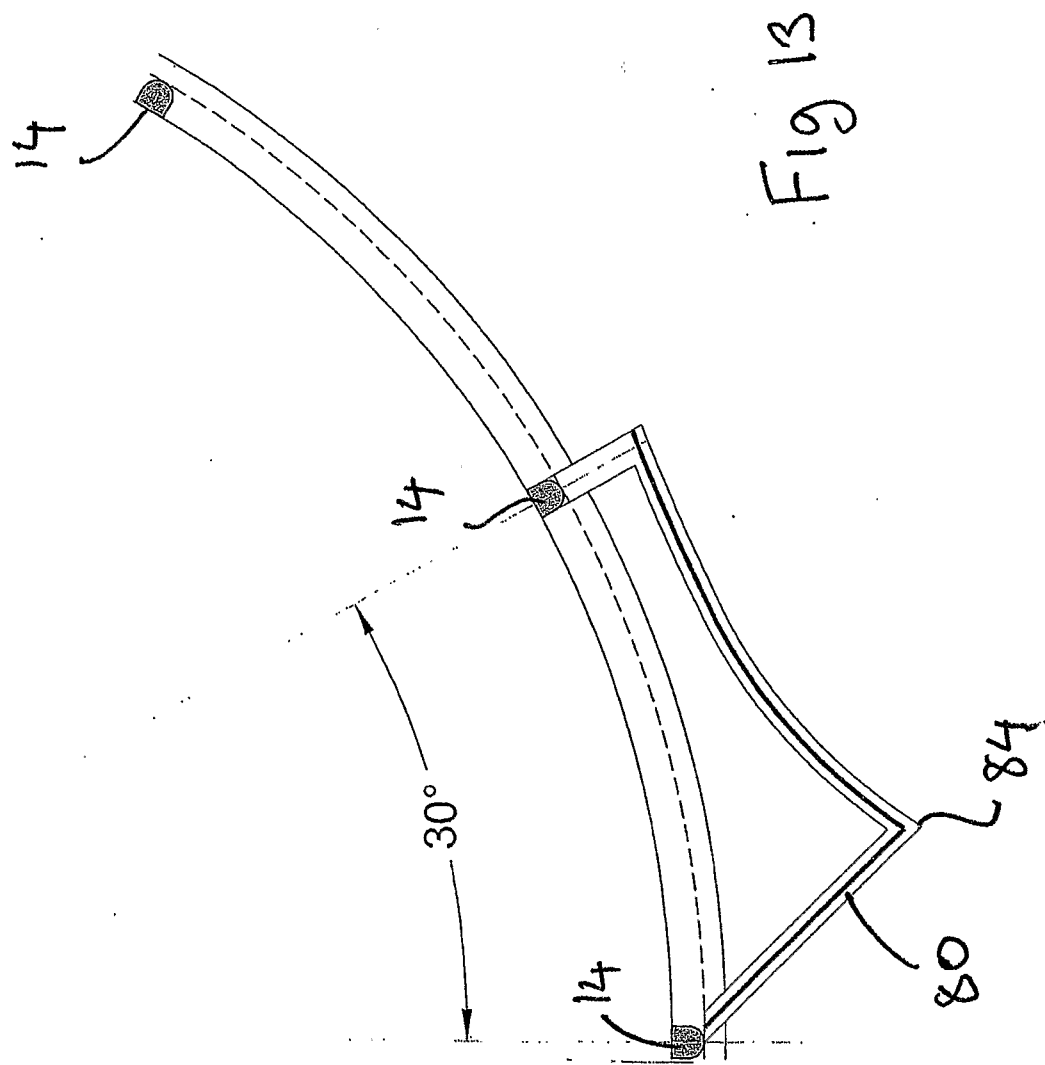


Fig 12



INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2008/003518

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, PAJ, CNPAT: column, beam, hollow, rotor, blade, vane, core, sail, canvas, rail, guide, suspend, hang, circumference

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP7174068A (NAGAMINE MASAhide) 11 Jul. 1995 (11.07.1995) see paragraphs 0008-0015 of the description, figures 1-2	1
Y		2-6, 8-10, 12-14
Y	DE202005009164U1 (MP NEWCO GMBH et al.) 26 Oct. 2006 (26.10.2006) see paragraphs 0056-0076 of the description, figures 1-17	2-6, 8-10
Y	FR2390595A1 (BINDER ADAM) 08 Dec. 1978 (08.12.1978) see figures 1-2	12-14
Y	CN2386208Y (JIN, Hongcai) 05 Jul. 2000 (05.07.2000) see page 1, lines 29-32 of the description, figures 1-2	12-14
A	JP2005076624A (KANAI YOSHIO) 24 Mar. 2005 (24.03.2005) see the whole document	1-14
A	DE202006013779U1 (AEROVIGOR HUNGARIA KFT) 24 Jan. 2008 (24.01.2008) see the whole document	1-14
A	US6242818B1 (Ronald H. Smedley) 05 Jun. 2001 (05.06.2001) see the whole document	1-14

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 08 Jun. 2009 (08.06.2009)	Date of mailing of the international search report 02 Jul. 2009 (02.07.2009)
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Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer WANG Qinghua Telephone No. (86-10)62085252
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2008/003518

Continuation of: second sheet A. CLASSIFICATION OF SUBJECT MATTER

F03D3/02 (2006.01) i

F03D3/06 (2006.01) i

F03D5/04 (2006.01) n

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2008/003518

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP7174068A	11.07.1995	NONE	
DE202005009164U1	26.10.2006	NONE	
FR2390595A1	08.12.1978	FR2390595B1	29.01.1982
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		WO2008028675A3	12.06.2008
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		AU1607301A	30.05.2001