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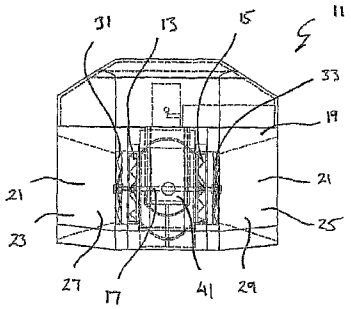
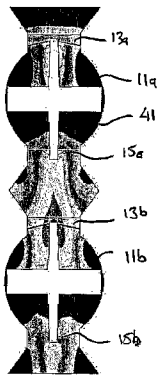




(57) **Abstract:** A turbine unit (11) adapted to be placed in a flowing fluid. The turbine unit (11) comprises a first turbine set (13) and a second turbine set (15) mounted within a passage (21) of a housing (19). The first turbine blade set (13) and a second turbine blade set (15) are set in opposed relation such that in operation a region between the two turbine blade sets (13, 15) has a lower pressure than the fluid pressure at an opening of the passage (21). The turbine unit (11) being used to generate power. The turbine units (Figures 8 to 11) can be abutted with each other such that they define a passage and each turbine unit comprises a driving turbine blade set before fluid passes to a pumping turbine blade set.

WO 2008/043131 A1

Turbine Unit and Assembly

Field of the Invention

The present invention generally relates to a turbine assembly. In particular the invention relates to a turbine assembly powered by a flowing fluid.

Background Art

As the demand on earths diminishing fossil fuels increases, research and development of alternative sources of energy is rapidly expanding. To date nuclear energy and renewable energy sources are dominant when considering alternative energy sources.

In relation to nuclear energy there are many significant disadvantages in the use of this fuel: waste disposal/storage, establishment costs and risk of accident, to name but a few.

In relation to renewable energy, such as wind, solar, and wave energy, the cost associated with the establishment of a sufficiently sized plant to harness the energy is, to date, a relatively expensive alternative. Furthermore, the plant only generates energy from these sources if these sources are present. As this is not always the case, the plant may lay idle, unable to produce any energy until the wind blows, the sun is present or the swell improves. As a result, these sources are only used to supplement energy supplied through conventional means.

Another problem with renewable energy alternatives is that the plant required to harness the energy is often unsightly and requires a large area of land or fluid body area.

The preceding discussion of the background to the invention is intended only to facilitate an understanding of the present invention. It should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was part of the common general knowledge as at the priority date of the application.

It is an object of this invention to provide a turbine assembly which ameliorates or overcomes one or more of the disadvantages of the prior art or which provides a useful alternative.

Disclosure of the Invention

The present invention provides a turbine unit adapted to be placed in a flowing fluid, the turbine unit comprises a first turbine blade set and a second turbine blade set mounted within a passage of a housing, the first turbine blade set and second turbine blade set being in opposed relation such that in operation a region between the two turbine blade sets has a lower pressure than the fluid pressure at an opening of the passage, wherein the turbine unit is used to generate power.

Preferably the first turbine blade set and second blade set are in spaced apart relation. .

Preferably the first turbine blade set and second blade set are positioned in opposed direction to each other. That is to say the blades are reversed relative to each other.

Each blade set may be connected to a generator such that movement of each blade set is transformed into energy.

As the fluid flows through the passage, the flow drives the first turbine blade set which starts the rotation of the second turbine blade set. As the second turbine blade set rotates it effectively pulls the fluid toward it, creating a lower pressure region between the two turbine blade sets. The same occurs when the flow of fluid is reversed, that is the fluid engages the second turbine blade set before the first turbine blade set.

The current invention is to be located in the path of a flowing fluid such that the fluid causes the turbine blade sets to rotate. In contrast to the prior art, the present invention produces energy regardless of the direction of fluid flow.

Preferably the first turbine blade set and second turbine blade set are positioned such that when fluid flows through the first blade set, the first blade set rotates, and the second blade set is induced to rotate, as the second blade set rotates the fluid is pulled through the system to be pushed out the unit, minimizing the back flow pressure and energy loss. This is also the case in the reverse flow whereby the first turbine blade set acts to pull the fluid there towards. The act of pushing the fluid out of the passage also overcomes the pressure head which exists at the exit of the passage.

Furthermore, owing to the orientation of each turbine blade sets with respect to each other, the effect of the second turbine blade set also minimises turbulence within the system, having the effect of straightening the fluid flow as it passes from the first turbine blade set..

Preferably the first turbine blade set and second turbine blade set are coaxially mounted. The first turbine blade set and second turbine blade set may be mounted on a shaft (i.e. the same shaft).

In another aspect of the invention the axis of rotation of the first turbine blade set is offset to the axis of rotation of the second turbine blade set. In this arrangement the first turbine blade set and second turbine blade set may be interconnected via a gear system.

Preferably the first turbine blade set and second turbine blade set are configured to provide maximum torque.

Preferably the turbine unit comprises a gearbox interconnected with the first turbine blade set and second turbine blade set. The gearbox may be interconnected to each turbine blade set.

Preferably the generator is secured to the housing.

Preferably the gearbox is secured with respect to the housing. The gearbox may be located in the passage.

In one aspect of the invention the generator forms part of the housing.

In another aspect of the invention the generator is located external to the housing.

The generator may be connected to a plurality of turbine units.

A plurality of generators may be connected to the turbine unit.

Preferably the gear box is connected to the shaft, which in turn is coupled to the generator such that movement of each turbine blade set is transformed by the generator into energy via the gear box.

The passage may comprise a chamber located between the first turbine blade set and second turbine blade set. The chamber may extend outwardly from the first

turbine blade set before converging as it approaches the second turbine blade set.

The passage may comprise a first nozzle located between a first end of the passage and the first turbine blade set. The passage may also comprise a second nozzle located between the second turbine blade set and a second end of the passage.

Each nozzle is configured to converge in a direction towards the chamber of the turbine unit. That is to say the larger opening of the nozzle is further away from the respective turbine blade set than the smaller opening of the nozzle.

In one flow direction the respective nozzle acts as a converging nozzle to increase the velocity of the fluid flow as the fluid moves towards the turbine blade set, whilst in the other direction the respective nozzle acts as a diverging nozzle to decrease the velocity of the fluid flow as the fluid moves away from the turbine blade set.

Preferably when the respective nozzle acts as a diverging nozzle it contributes to reducing the back pressure created by the fluid flow energy losses of the turbine blade set as the fluid moves away from the turbine blade set.

The first nozzle and the section of the chamber adjacent the first nozzle may define a first venturi. The second nozzle and the section of the chamber adjacent the second nozzle may define a second venturi.

The exterior shape of the gearbox and/or generator may be streamlined so as to have minimal impact on the fluid flow.

The exterior shape of the gearbox may be designed to reduce energy loss in the passage between the first turbine blade set and second turbine blade set. Preferably the gearbox is positioned and the chamber is configured to enhance the venturi effect through the chamber.

The exterior shape of the gearbox may have the effect of straightening the fluid flow as it passes from the first turbine blade set.

The turbine unit may comprise a first stator set for directing fluid. The first stator set may be located between the first nozzle and first turbine blade set, whereby the first stator set directs fluid onto the blades of the first turbine blade set.

The turbine unit may comprise a second stator set for directing fluid. The second stator set may be located between the second nozzle and second turbine blade set, whereby the second stator set directs fluid on to the blades of the second turbine blade set when the flow is reversed.

The turbine unit may comprise a third stator set for directing fluid. The third stator set may be located between the first turbine blade set and second turbine blade set, whereby the third stator set directs fluid on to the blades of the second turbine blade set as the flow passes from the first blade set.

The turbine unit may comprise a fourth stator set for directing fluid. The fourth stator set may be located between the first turbine blade set and second turbine blade set, whereby the fourth stator set directs fluid on to the blades of the first turbine blade set as the flow passes from the second blade set, as would be the case when the flow is reversed.

Preferably the first stator set, second stator set, third stator set and/or fourth stator set are coaxially mounted on the shaft.

Preferably the first stator set, second stator set, third stator set and/or fourth stator set are variably positioned such that the plane in which the stator set lies can be angled with respect to the shaft.

Preferably the blades of the first stator set, second stator set, third stator set and/or fourth stator set are variably adjusted so that the fluid flow can be directed towards the blades of the respective turbine blade set to maximise movement of the turbine blade set.

Each stator set may be adjusted to a position in which fluid passes therethrough without substantially moving the stator set.

The blades of each turbine blade set may be adjusted. The blades may be adjusted to a position in which fluid passes therethrough without substantially moving the turbine blade set.

The turbine unit may comprise a control system to initially start the unit so as to overcome the unit's inertia. The control system may also adjust the first stator set, second stator set, third stator set and/or fourth stator set as required.

The control system may also comprise a switching mechanism to allow the direction of the turbine blade sets to reverse direction without altering the operation of the generator. The change in direction of rotation of the blade sets will occur when the fluid flow reverses.

The turbine unit may further comprise screens at the first end and second end of the passage to prevent debris and animals entering the passage.

The present invention further provides a plurality of turbine units as herein before described wherein the units are arranged in an array. The units may be stacked one on top of the other. The units may be positioned in spaced apart relation on an ocean bed, riverbed or attached to a structure, such as an oil rig or the hull of a ship. The units may be positioned in a series. The units may be placed in an abutting arrangement such that fluid exiting a turbine unit passes immediately into another adjacent turbine unit.

The turbine unit or multiples thereof may be placed in alignment with the hydro slot of a hydroelectric dam, may be placed in a pipeline, may be located in river weir walls and/or in tidal barrages such that energy generation can be maximised from the in and outgoing tides whereby the period of tidal slack has minimal impact on energy generation. Typically when the tide changes there is a period in which the flow is reduced significantly. To negate this period of relatively little flow a tidal barrage is used to regulate flow and allow fluid to be provided at a greater flow during the period of tidal change. Other applications include dams, water supply lines, water treatment plants, in fact anywhere where there is a fluid flowing.

The invention may also be placed in a flowing gas. This includes being positioned in a plane, train or other vehicle in which the vehicle passes through the gas.

The present invention may be used to pump any fluid including air, slurries and brine.

For each unit configured to have a leading turbine blade set (first or second turbine blade set depending on the flow direction) and trailing turbine blade set (second or first turbine blade set depending on the flow direction), the energy loss created by the leading turbine blade set is compensated by the action of the trailing turbine blade set. As the system can be designed so that there is negligible net negative effect, placing a unit in a fluid flow path has negligible effects on the flow, allowing the unit to be placed in a pipeline without substantially affecting the flow through the pipeline.

The present invention provides a turbine unit adapted to be placed in a flowing fluid, the turbine unit comprises a first turbine blade set and a second turbine blade set mounted within a passage in a housing, the first turbine blade set and second turbine blade set being in opposed spaced apart relation such that fluid moving in a first direction will first move the first turbine blade set and fluid moving in a second direction will first move the second turbine blade set, wherein each blade set is connected to a generator such that movement of each blade set is transformed into electrical energy, whereby the blade set which trails the other blade set creates a relatively low pressure region within the unit, wherein the turbine unit generates power..

Preferably the first turbine blade set and second blade set are positioned in opposed direction to each other. That is to say the blades are reversed relative to each other.

Preferably the first turbine blade set and second turbine blade set are mounted on a common shaft.

The present invention provides a turbine unit adapted to be placed in a flowing fluid, the turbine unit comprises a turbine blade set mounted in a passage within a housing, a stator set for directing the fluid onto the blades of the turbine blade set, a trailing diverging nozzle incorporated in the passage and positioned such that the fluid first passes through the turbine blade set, and a leading converging nozzle incorporated in the passage positioned such that the fluid passes therethrough and onto the turbine blade set., whereby the trailing diverging nozzle creates a region in the passage of lower pressure, relative to the pressure of the fluid entering the passage, between the turbine blade set and trailing diverging

nozzle wherein the turbine unit generates power.. This minimises the energy loss created by the backflow pressure created by the turbine blade set.

The present invention provides a turbine assembly adapted to be placed in a flowing fluid, the turbine assembly comprises at least one turbine unit comprising a passage and a turbine blade set located in the passage, the passage incorporating at least one nozzle, wherein the turbine unit is connected to a generator such that movement of each blade set is transformed into electrical energy.

In one aspect, the at least one nozzle may be located such that fluid first passes through the at least nozzle after passing through the turbine blade set, the nozzle being orientated such that the fluid is decelerated as it passes therethrough as well as reducing back flow pressure created by the turbine blade set.

In another aspect the at least one nozzle may be located such that fluid first passes through the at least one nozzle before passing through the turbine blade set, the nozzle being orientated such that the fluid is accelerated as it passes therethrough.

The turbine assembly may comprise a further nozzle wherein the turbine blade set is located between the two nozzles. The nozzle upstream from the turbine blade set may accelerate fluid towards the turbine blade set whilst the nozzle downstream from the turbine blade set slows the fluid down as well as reducing back flow pressure created by the turbine blade set.

In one aspect of the invention the turbine blade assembly comprises a first turbine unit and a second turbine unit, each unit being substantially in abutment such that as fluid passes through the turbine assembly it sequentially passes through the nozzle upstream of the first turbine unit, the turbine blade set of the first turbine unit, the turbine blade set of the second turbine unit before finally passing through the nozzle downstream from the second turbine unit.

The first turbine unit and second turbine unit may be co-axially mounted.

The turbine blade assembly may comprise a third turbine unit. The third turbine unit may be in abutment with the second turbine unit such that fluid exiting the second turbine unit enters the third turbine unit. In one arrangement, fluid exiting

the second turbine unit first passes through the nozzle upstream of the third unit before passing through its turbine blade set. In another arrangement fluid exiting the second turbine unit first passes through the turbine blade set of the third unit before passing through the nozzle downstream of the second turbine blade set.

In another aspect of the invention the turbine blade assembly comprises four turbine units a first turbine unit, a second turbine unit, a third turbine unit and a fourth turbine unit, each being arranged in series such that as fluid passes through the turbine assembly it sequentially passes through the nozzle upstream of and adjacent to the first turbine unit, the turbine blade set of the first turbine unit, the turbine blade set of the second turbine unit, the nozzle downstream of and adjacent to the second turbine unit, the nozzle upstream of and adjacent to the third turbine unit, the turbine blade set of the third turbine unit, the turbine blade set of the fourth turbine unit before finally passing through the nozzle downstream of and adjacent to the fourth turbine unit to exit the turbine blade assembly.

One or more of the turbine units may comprise a stator set for directing the fluid onto the blades of the turbine blade set.

Preferably each turbine unit is arranged co-axially. Each turbine unit may be placed a distance from each other.

Each turbine unit may be mounted on an independent shaft. Two or more turbine units may be mounted on the same shaft.

The housing of two or more turbine units may be integral with adjacent units.

There may be multiple turbine units arranged substantially in series with varying orientations and configurations with respect to each other. It is to be understood that these configurations are included in the scope of this invention.

The present invention further provides a turbine assembly comprising at least two turbine units in abutment with each other such that they define a passage, each turbine unit comprises a stator which directs fluid onto a driving turbine blade set before the fluid passes to a pumping turbine blade set wherein the turbine assembly generates power..

Preferably each unit has a gearbox located between the turbine blade sets.

Preferably the section of passage between each unit is substantially straight.

Preferably the turbine assembly has a converging nozzle to accelerate fluid flow as it approaches the first unit.

Preferably the turbine assembly has a diverging nozzle to decelerate fluid flow as it exits the end unit.

The present invention further provides a turbine assembly comprising at least two turbine units in abutment with each other such that they define a passage, each turbine unit comprises a driving turbine blade set before the fluid passes to a pumping turbine blade set wherein the turbine assembly generates power..

Preferably each unit has a gearbox located between the turbine blade sets.

Preferably the section of passage between each unit is substantially straight.

Preferably the turbine assembly has a stator which directs fluid onto the driving turbine blade set fluid flow of the first unit.

Preferably the turbine assembly has a converging nozzle to accelerate fluid flow as it approaches the first unit.

Preferably the turbine assembly has a diverging nozzle to decelerate fluid flow as it exits the third unit.

It is to be understood that fluid flow into and/or out of the turbine assembly may be through multi paths and that this variation is covered by the current invention.

The present invention also provides a turbine assembly comprising:

a first venturi chamber connected to a second venturi chamber to define a passage;

a first turbine blade set positioned in or adjacent to the throat of the first venturi chamber;

a stator located between the first turbine blade set and an opening of the passage;

wherein the second venturi creates a relatively lower pressure region upstream from its throat.

Preferably a second turbine blade set is positioned in or adjacent to the throat of the second venturi chamber whereby the second turbine unit further lowers the pressure upstream therefrom.

Brief Description of the Drawings

The invention will be better understood by reference to the following description of several embodiments thereof as shown in the accompanying drawings in which:

Figure 1 provides several detailed views of a turbine assembly according to a first embodiment of the invention; figures A, B, C, and D illustrate various views of the assembly;

Figure 2 provides several detailed views of a turbine housing assembled with a generator housing according to the first embodiment of the invention, figures A, B, C, and D illustrate various views of the assembly;

Figure 3 provides several detailed views of a first turbine blade set and a second turbine blade set connected to a gear box housing according to the first embodiment of the invention, figures A, B, C, and D illustrate various views of the assembly;

Figure 4 provides several detailed views of the turbine blade set according to the first embodiment of the invention, figures A, B, and C illustrate various views of the turbine blade set;

Figure 5 provides several detailed views of a stator set according to the first embodiment of the invention, figures A, B, and C illustrate various views of the stator set;

Figure 6 provides several detailed views of the gear box housing according to the first embodiment of the invention, figures A, B, and C illustrate various views of the gear box housing;

Figure 7 is a perspective schematic view of a turbine assembly according to a second embodiment of the invention;

Figure 8 is a cross sectional schematic view of a turbine assembly according to a third embodiment of the invention;

Figure 9 is a perspective view of figure 8 without the housing.

Figure 10 is a perspective schematic view of a turbine assembly according to a fourth embodiment of the invention; and

Figure 11 is a perspective schematic view of a turbine assembly according to a fifth embodiment of the invention.

Best Mode(s) for Carrying Out the Invention

Referring to figure 1 to 6 the invention according to a first embodiment of the invention is in the form of a turbine unit 11. The turbine unit 11 is designed to be located in a fluid flow, and is configured to operate regardless of the direction of flow.

The turbine unit 11 comprises a first turbine blade set 13 and a second turbine blade set 15 coaxially mounted on a shaft 17.

The first turbine blade set 13 and second turbine blade set 15 are positioned in a passage 21 formed in a housing 19. The passage 21 channels fluid to the first turbine blade set 13 and second turbine blade set 15. Referring to figure 2, the passage 21 has a first end 23 and a second end 25. The passage 21 also incorporates a first nozzle 27 located between the first end 23 and the first turbine blade set 13, and a second nozzle 29 located between the second turbine blade set 15 and the second end 25.

The housing 19 houses a first stator set 31 and a second stator set 33. The first stator set 31 is located in close proximity to the first turbine blade set 13 between the first nozzle 27 and the first turbine blade set 13, whilst the second stator set 33 is located in close proximity to the second turbine blade set 15 between the second nozzle 29 and the second turbine blade set 15.

Each nozzle 27, 29 is configured to converge in a direction towards a chamber 41 which is incorporated in the passage21 between the first turbine blade set 13 and second turbine blade set 15. That is to say the larger opening of each nozzle 27, 29 is further away from the respective turbine blade set 13, 15 than the smaller opening of the nozzle 27, 29.

As indicated in figure 5, each stator set 31, 33 is adjustable by angle α relative to

the shaft 17.

The longitudinal axis of the shaft 17 extends along the longitudinal axis of the passage 21.

The housing 19 further houses a generator 35 connected to the shaft 17 via a gearbox 37.

The gearbox 37 is located within the chamber 41 within the passage 21 and has an external shape such that it assists in directing the flow to the second turbine blade set 15, in addition to minimising energy loose of the fluid as it passes through the chamber 41.

The turbine unit 11 also comprises a control system 39 (not shown). The control system 39 regulates the angle of each stator set 31, 33 so as to achieve the maximum movement of the turbine blade set 13, 15.

In use the fluid passes through the first end 23 of the passage 21 into the first nozzle 27. This nozzle 27 effectively increases the velocity of the fluid before it enters the first stator set 31. The first stator set 31 directs the fluid onto the first blade set 13. This turns the first turbine blade set 13, turning the shaft 17 which passes through the gearbox 37 to turn the generator 39. The generator transforms the mechanical energy into electrical energy, which can be fed directly into a grid or used for other purposes.

As the fluid leaves the first turbine blade set 13 it enters a region of low pressure created by movement of the second turbine blade set 15. The second turbine blade set 15 effectively pulls the fluid away from the first turbine blade set 13 until it passes through the second turbine blade set 15. It then pushes the fluid out the second nozzle 29.The second nozzle 29 also draws the fluid therethrough as it creates a region of relatively low pressure downstream from the second turbine blade set 15. The fluid then passes out the second end 25 of the passage 21.

Whilst the second turbine blade set 15 assists in turning the generator 35 and creating electrical energy it also draws fluid through the system mitigating the effect of backflow pressure losses created by the first turbine blade set 13. This effect also assists in reducing turbulence and increasing fluid velocity.

Obviously when the direction of fluid flow is reversed the mirror image of the

assembly dictates that the same output will be achieved by the turbine assembly.

As fluid enters the passage 21 of the turbine unit 11 it is accelerated through the first nozzle 27 towards the first turbine blade set 13. The stator 31 directs the fluid onto the first turbine blade set 13 to ensure maximum conversion of energy. As the first turbine blade set 13 rotates the second turbine blade set 15 also rotates to draw more fluid through the passage 21. This has the effect of creating a low pressure region in the chamber 41 and streamlines the fluid as it passes through the chamber 41. As the blades of the second turbine blade set 15 are reversed to those of the first blade set 13 the fluid is pulled from the first blade set 13 and pushed out of the passage 21. These factors coupled with the low pressure developed by the second nozzle add to inducing the fluid to move through and out of the passage. The velocity of the fluid increases through the system up to the point of entering the second nozzle.

The present invention has been designed to work regardless of the direction of the flow of the fluid. Hence the reverse effect happens when the fluid enters the second nozzle moving towards the second turbine blade set.

Referring to figure 7 a second embodiment of the invention is shown. In this embodiment the unit 11 comprises two generators 135 located external to the housing 19 and connected to the turbine blade sets. This application is particularly suited to the large assemblies.

Needless to say there can be multiple generators connected to the housing 19 or even multiple assemblies connected to a generator.

Referring to figures 8 and 9 a third embodiment of the invention is shown. In this embodiment two turbine units 11 as described in the first embodiment are co-axially arranged in series such that fluid exiting a first turbine unit 11a immediately enters the second turbine unit 11b. In this arrangement the second turbine unit 11b effectively draws the fluid through the first turbine unit 11a, increasing the velocity of the fluid exiting the first turbine unit 11a relative to its velocity before entering the first turbine unit 11a. In the figures numbers having an 'a' suffix indicates components of the first unit 11a, whilst those having a 'b' suffix indicate the second assembly 11b.

Referring to figure 10 a fourth embodiment of the invention is shown. This embodiment is particularly suited to those applications in which the fluid is in the form of a gas.

In this embodiment a turbine assembly 101 comprises three turbine units 111 in abutment with each other such that they define a passage 121. Each turbine unit 111 comprises a stator 131 which directs fluid onto a driving turbine blade set 113 before the fluid passes to a pumping turbine blade set 115. .

Each unit 111 has a gearbox 137 which is located between the turbine blade sets 113, 115 in a chamber 141.

The passage 131 interconnecting each turbine unit 111 is straight.

The turbine assembly 101 has a converging nozzle 127 to accelerate fluid flow as it approaches the first turbine unit 111a. The turbine assembly also has a diverging nozzle 129 to decelerate fluid flow as it exits the end turbine unit 111c.

Referring to figure 11 a fifth embodiment of the invention is shown. This embodiment is particularly suited to those applications in which the fluid is in the form of a gas.

In this embodiment a turbine assembly 101 comprises two turbine units 111 in abutment with each other such that they define a passage 121. Each turbine unit 111 comprises a driving turbine blade set 113 and a pumping turbine blade set 115 in spaced apart relation.

Each unit 111 has a gearbox 137 which is located between the turbine blade sets 113, 115 in a chamber 141.

The passage 131 interconnecting each turbine unit 111 is in the form of a straight section.

The turbine assembly 101 has a converging nozzle 127 to accelerate fluid flow as it approaches the first turbine unit 111a. The turbine assembly also has a diverging nozzle 129 to decelerate fluid flow as it exits the end turbine unit 111c.

The turbine assembly 101 also has a stator 131 located upstream from the first turbine blade set 113 of the first unit 111d to direct fluid thereon.

In the fourth and fifth embodiments gas may be feed to the passage by an air duct or a plurality of air ducts and may be located in various locations. For instance, when the turbine assembly 101 is located in a vehicle the air ducts may be in front, underneath, and/or on the side of the vehicle.

Modifications and variations such as would be apparent to the skilled addressee are considered to fall within the scope of the present invention.

Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

The Claims Defining the Invention are as Follows:

1. A turbine unit adapted to be placed in a flowing fluid, the turbine unit comprises a first turbine blade set and a second turbine blade set mounted within a passage of a housing, the first turbine blade set and second turbine blade set being in opposed relation such that in operation a region between the two turbine blade sets has a lower pressure than the fluid pressure at an opening of the passage, wherein the turbine unit is used to generate power.

2. The turbine unit according to claim 1 wherein the first turbine blade set and second blade set are in spaced apart relation.

3. The turbine unit according to claim 1 or 2 wherein the first turbine blade set and second blade set are positioned in opposed direction to each other.

4. The turbine unit according to any one of the preceding claims wherein each blade set is connected to a generator such that movement of each blade set is transformed into energy.

5. The turbine unit according to any one of the preceding claims wherein the second turbine blade set is configured to minimise turbulence within the system.

6. The turbine unit according to any one of the preceding claims wherein the first turbine blade set and second turbine blade set are coaxially mounted.

7. The turbine unit according to any one of claims 1 to 5 wherein the axis of rotation of the first turbine blade set is offset to the axis of rotation of the second turbine blade set, whereby the first turbine blade set and second turbine blade set is interconnected via a gear system.

8. The turbine unit according to any one of the preceding claims wherein the first turbine blade set and second turbine blade set are configured to provide maximum torque.

9. The turbine unit according to any one of the preceding claims wherein the turbine unit comprises a gearbox interconnected with the first turbine blade set and second turbine blade set.

10. The turbine unit according to claim 9 wherein the gearbox is interconnected with each turbine blade set.

11. The turbine unit according to claim 9 or 10 wherein the gearbox is in the passage.

12. The turbine unit according to claim 9, 10 or 11 wherein the gear box is connected to the shaft, which in turn is coupled to the generator such that movement of each turbine blade set is transformed by the generator into energy via the gear box.

13. The turbine unit according to any one of the preceding claims wherein the passage comprises a chamber located between the first turbine blade set and second turbine blade set.

14. The turbine unit according to claim 13 wherein the chamber extends outwardly from the first turbine blade set before converging as it approaches the second turbine blade set.

15. The turbine unit according to any one of the preceding claims wherein the passage comprises a first nozzle located between a first end of the passage and the first turbine blade set, the nozzle being configured to converge in a direction towards the chamber of the turbine unit.

16. The turbine unit according to any one of the preceding claims wherein the passage comprises a second nozzle located between the second turbine blade set and a second end of the passage, the nozzle being configured to converge in a direction towards the chamber of the turbine unit.

17. The turbine unit according to claims 15 or 16 wherein when the fluid flows such that the respective nozzle acts as a diverging nozzle, the nozzle contributes to reducing the back pressure created by the fluid flow energy losses of the turbine blade set as the fluid moves away from the turbine blade set.

18. The turbine unit according to claims 15, 16 or 17 wherein the first nozzle and the section of the chamber adjacent the first nozzle define a first venturi.

19. The turbine unit according to claims 16, 17 or 18 wherein the second nozzle and the section of the chamber adjacent the second nozzle define a second venturi.

20. The turbine unit according to any one of claims 9 to 19 wherein the exterior shape of the gearbox is designed to reduce energy loss in the passage between the first turbine blade set and second turbine blade set and has the effect of straightening the fluid flow as it passes from the first turbine blade set.

21. The turbine unit according to any one of claims 9 to 20 wherein the gearbox is positioned and the chamber is configured to enhance the venturi effect through the chamber.

22. The turbine unit according to any one of claims 15 to 21 wherein the turbine unit comprises a first stator set for directing fluid, the first stator set is located between the first nozzle and first turbine blade set, whereby the first stator set directs fluid onto the blades of the first turbine blade set.

23. The turbine unit according to any one of claims 16 to 22 wherein the turbine unit comprises a second stator set for directing fluid, the second stator set is located between the second nozzle and second turbine blade set, whereby the second stator set directs fluid on to the blades of the second turbine blade set when the flow is reversed.

24. The turbine unit according to any one of the preceding claims wherein the turbine unit comprises a third stator set for directing fluid, the third stator set is located between the first turbine blade set and second turbine blade set, whereby the third stator set directs fluid on to the blades of the second turbine blade set as the flow passes from the first blade set.

25. The turbine unit according to any one of the preceding claims wherein the turbine unit comprises a fourth stator set for directing fluid, the fourth stator set is located between the first turbine blade set and second turbine blade set, whereby the fourth stator set directs fluid on to the blades of the first turbine blade set as the flow passes from the second blade set, as would be the case when the flow is reversed.

26. The turbine unit according to claim 25 wherein the first stator set, second stator set, third stator set and/or fourth stator set are coaxially mounted on the shaft.

27. The turbine unit according to claim 25 or 26 wherein the first stator set, second stator set, third stator set and/or fourth stator set are variably positioned such that the plane in which the stator set lies can be angled with respect to the shaft.

28. The turbine unit according to claim 25, 26 or 27 wherein the blades of the first stator set, second stator set, third stator set and/or fourth stator set are variably adjusted so that the fluid flow can be directed towards the blades of the respective turbine blade set to maximise movement of the turbine blade set.

29. The turbine unit according to any one of the preceding claims wherein the blades of each turbine blade set are adjusted.

30. The turbine unit according to claim 25, 26, 27 or 28 wherein the turbine unit comprises a control system to initially start the unit so as to overcome the unit's inertia and to adjust the first stator set, second stator set, third stator set and/or fourth stator set as required.

31. The turbine unit according to claim 30 wherein the control system comprise a switching mechanism to allow the direction of the turbine blade sets to reverse direction without altering the operation of the generator.

32. A plurality of turbine units according to any one of the preceding claims wherein the units are arranged in an array on an ocean bed, riverbed or attached to a structure, such as an oil rig or the hull of a ship.

33. A turbine unit or multiples according to any one of the preceding claims placed in alignment with a hydro slot of a hydroelectric dam, in a pipeline, in a river weir walls, in tidal barrages, dams, water supply lines, or water treatment plants.

34. A turbine unit adapted to be placed in a flowing fluid, the turbine unit comprises a first turbine blade set and a second turbine blade set mounted within a passage in a housing, the first turbine blade set and second turbine blade set being in opposed spaced apart relation such that fluid moving in a first direction will first move the first turbine blade set and fluid moving in a second direction will first move the second turbine blade set, wherein each blade set is connected to a generator such that movement of each blade set

is transformed into electrical energy, whereby the blade set which trails the other blade set creates a relatively low pressure region within the unit, wherein the turbine unit generates power..

35. The turbine unit according to claim 34 wherein the first turbine blade set and second blade set are positioned in opposed direction to each other.

36. The turbine unit according to claim 34 or 35 wherein the first turbine blade set and second turbine blade set are mounted on a common shaft.

37. A turbine unit adapted to be placed in a flowing fluid, the turbine unit comprises a turbine blade set mounted in a passage within a housing, a stator set for directing the fluid onto the blades of the turbine blade set, a trailing diverging nozzle incorporated in the passage and positioned such that the fluid first passes through the turbine blade set, and a leading converging nozzle incorporated in the passage positioned such that the fluid passes therethrough and onto the turbine blade set., whereby the trailing diverging nozzle creates a region in the passage of lower pressure, relative to the pressure of the fluid entering the passage, between the turbine blade set and trailing diverging nozzle wherein the turbine unit generates power.

38. A turbine assembly adapted to be placed in a flowing fluid, the turbine assembly comprises at least one turbine unit comprising a passage and a turbine blade set located in the passage, the passage incorporating at least one nozzle, wherein the turbine unit is connected to a generator such that movement of each blade set is transformed into electrical energy.

39. The turbine assembly according to claim 38 wherein the at least one nozzle is located such that fluid first passes through the at least one nozzle after passing through the turbine blade set, the nozzle being orientated such that the fluid is decelerated as it passes therethrough as well as reducing back flow pressure created by the turbine blade set.

40. The turbine assembly according to claim 38 wherein the at least one nozzle is located such that fluid first passes through the at least one nozzle before passing through the turbine blade set, the nozzle being orientated such that the fluid is accelerated as it passes therethrough.

41. The turbine assembly according to claim 38, 39 or 40 wherein the assembly comprises a further nozzle wherein the turbine blade set is located between the two nozzles whereby the nozzle upstream from the turbine blade set accelerates fluid towards the turbine blade set whilst the nozzle downstream from the turbine blade set slows the fluid down as well as reducing back flow pressure created by the turbine blade set.

42. The turbine assembly according to claim 38, 39, 40 or 41 wherein the turbine blade assembly comprises a first turbine unit and a second turbine unit, each unit being substantially in abutment such that as fluid passes through the turbine assembly it sequentially passes through the nozzle upstream of the first turbine unit, the turbine blade set of the first turbine unit, the turbine blade set of the second turbine unit before finally passing through the nozzle downstream from the second turbine unit.

43. The turbine assembly according to claim 42 wherein first turbine unit and second turbine unit are co-axially mounted.

44. The turbine assembly according to any one of claims 38 to 43 wherein the turbine blade assembly comprises a third turbine unit, the third turbine unit being in abutment with the second turbine unit such that fluid exiting the second turbine unit enters the third turbine unit.

45. The turbine assembly according to claim 44 wherein the fluid exiting the second turbine unit first passes through the nozzle upstream of the third unit before passing through its turbine blade set.

46. The turbine assembly according to claim 44 wherein the fluid exiting the second turbine unit first passes through the turbine blade set of the third unit before passing through the nozzle downstream of the second turbine blade set.

47. The turbine assembly according to claim 38, 39, 40 or 41 comprising four turbine units: a first turbine unit, a second turbine unit, a third turbine unit and a fourth turbine unit, each being arranged in series such that as fluid passes through the turbine assembly it sequentially passes through the nozzle upstream of and adjacent to the first turbine unit, the turbine blade set of the first turbine unit, the turbine blade set of the second turbine unit, the nozzle

downstream of and adjacent to the second turbine unit, the nozzle upstream of and adjacent to the third turbine unit, the turbine blade set of the third turbine unit, the turbine blade set of the fourth turbine unit before finally passing through the nozzle downstream of and adjacent to the fourth turbine unit to exit the turbine blade assembly.

48. The turbine assembly according to any one of claims 38 to 47 wherein one or more of the turbine units comprise a stator set for directing the fluid onto the blades of the turbine blade set.

49. A turbine assembly comprising at least two turbine units in abutment with each other such that they define a passage, each turbine unit comprises a stator which directs fluid onto a driving turbine blade set before the fluid passes to a pumping turbine blade set, wherein the turbine assembly generates power.

50. A turbine assembly comprising at least two turbine units in abutment with each other such that they define a passage, each turbine unit comprises a driving turbine blade set before the fluid passes to a pumping turbine blade set wherein the turbine assembly generates power.

51. The turbine unit according to claim 50 wherein the turbine assembly has a stator which directs fluid onto the driving turbine blade set fluid flow of the first unit.

52. The turbine unit according to claim 49, 50 or 51 wherein each unit has a gearbox located between the turbine blade sets.

53. The turbine unit according to claim 49, 50, 51 or 52 wherein the section of passage between each unit is substantially straight.

54. The turbine unit according to any one of claims 49 to 53 wherein the turbine assembly has a converging nozzle to accelerate fluid flow as it approaches the first unit.

55. The turbine unit according to any one of claims 49 to 54 wherein the turbine assembly has a diverging nozzle to decelerate fluid flow as it exits the third unit.

56. A turbine assembly comprising:

a first venturi chamber connected to a second venturi chamber to define a passage;

a first turbine blade set positioned in or adjacent to the throat of the first venturi chamber;

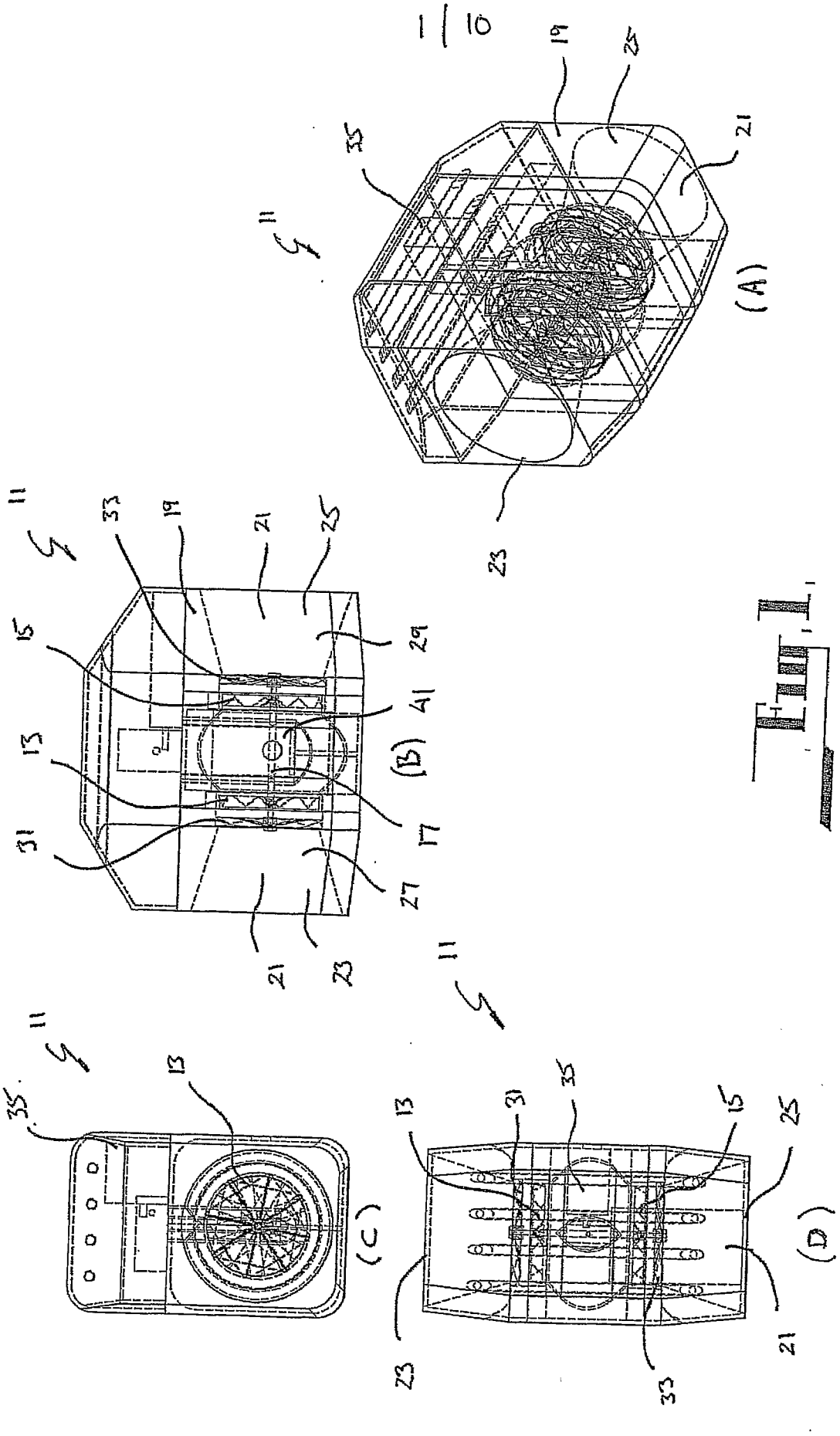
a stator located between the first turbine blade set and an opening of the passage;

wherein the second venturi creates a relatively lower pressure region upstream from its throat.

57. The turbine unit according to claim 56 wherein a second turbine blade set is positioned in or adjacent to the throat of the second venturi chamber whereby the second turbine unit further lowers the pressure upstream therefrom.

58. A turbine unit as substantially herein described with reference to the figures.

59. A turbine assembly as substantially herein described with reference to the figures.


1 / 10
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(A)
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(B)
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(C)
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(D)
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FIG. 1

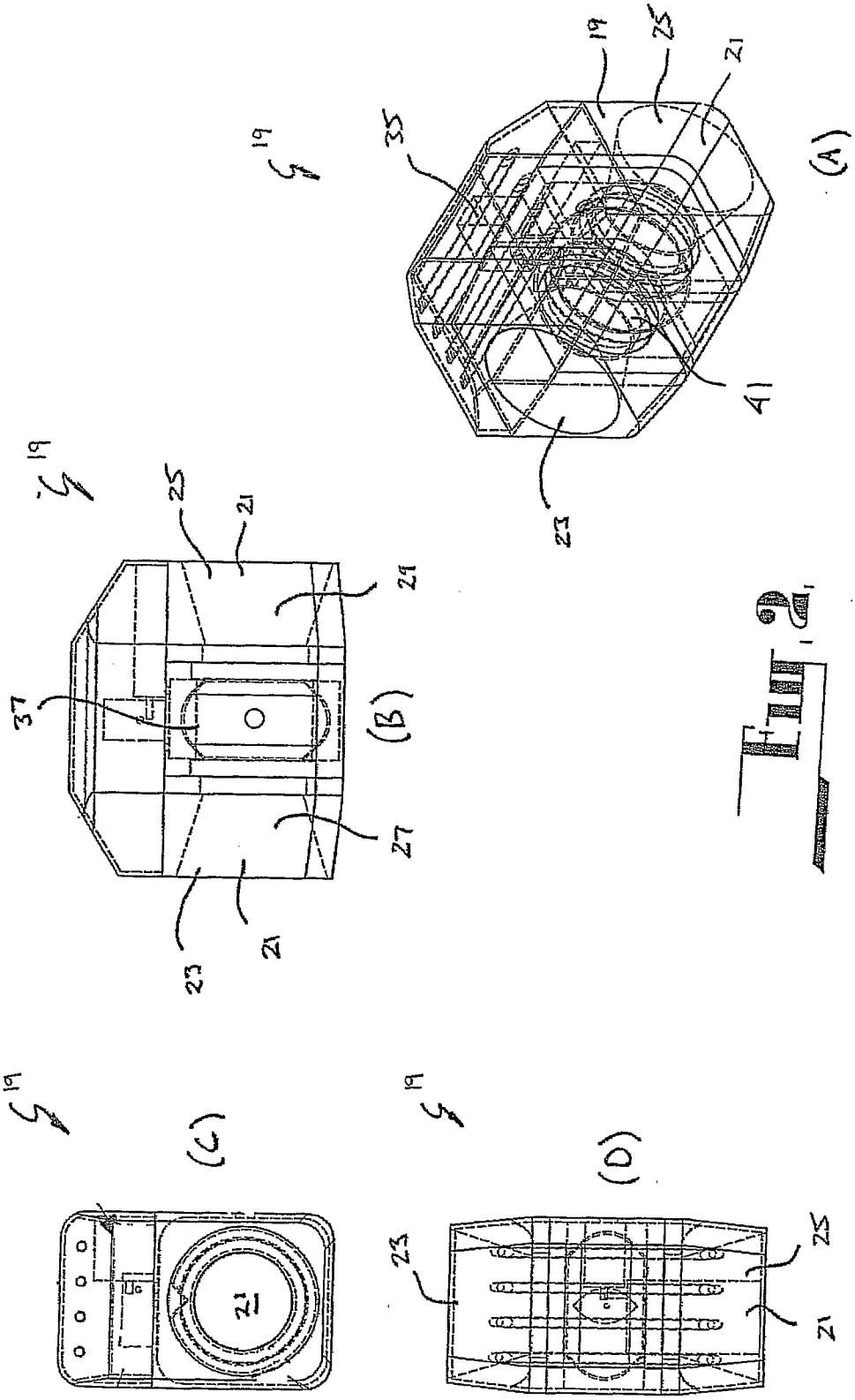


Fig 2

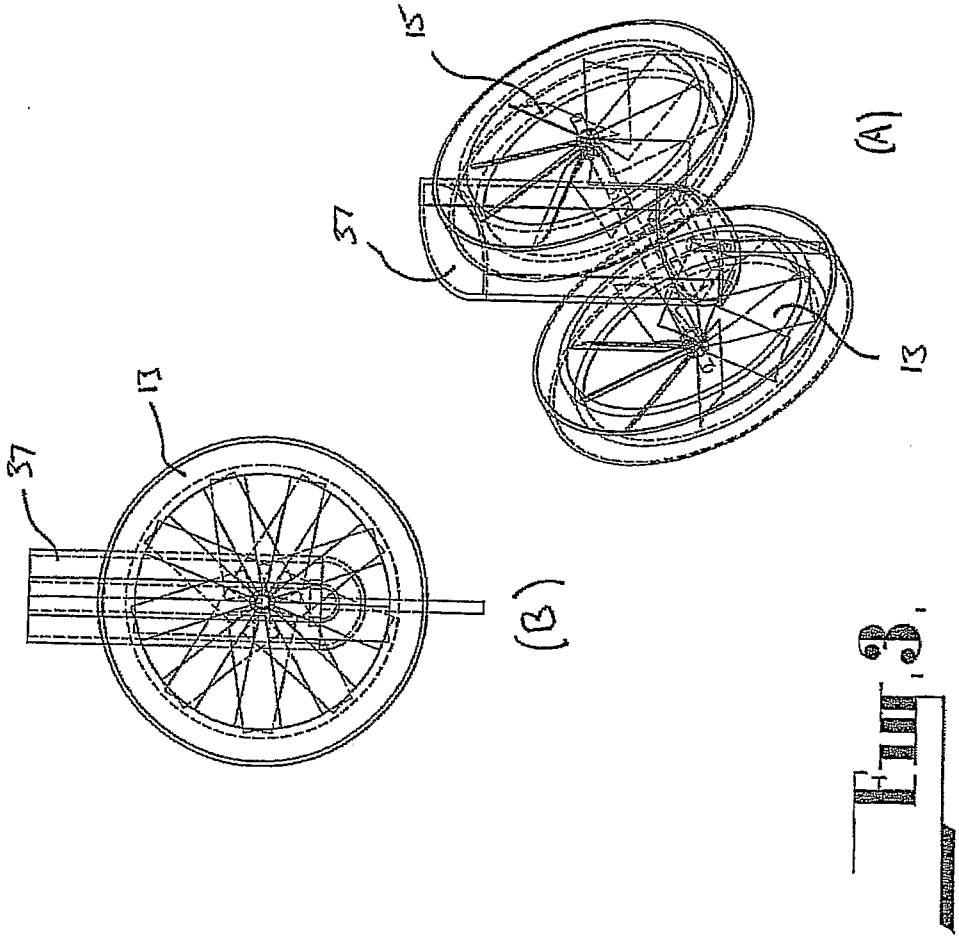
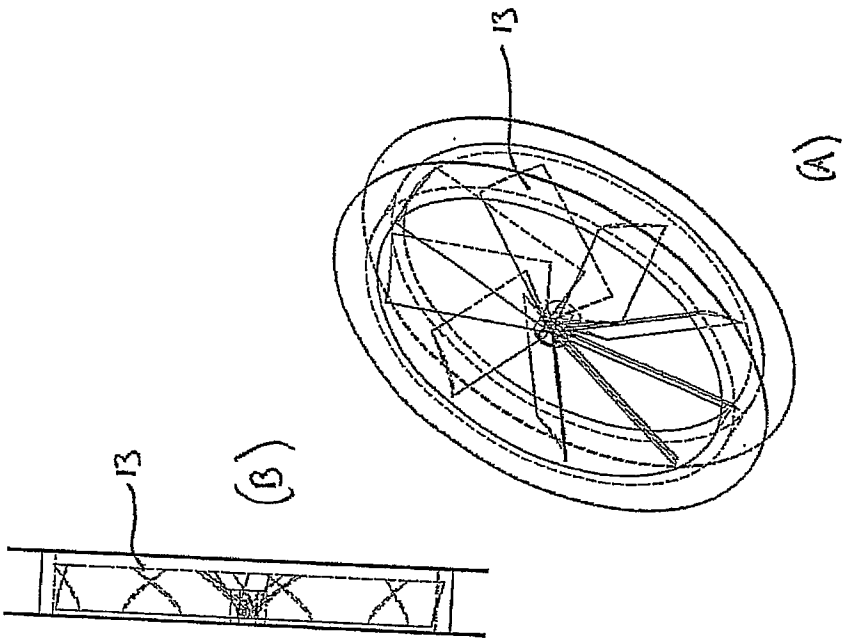


FIG. 3.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(A)
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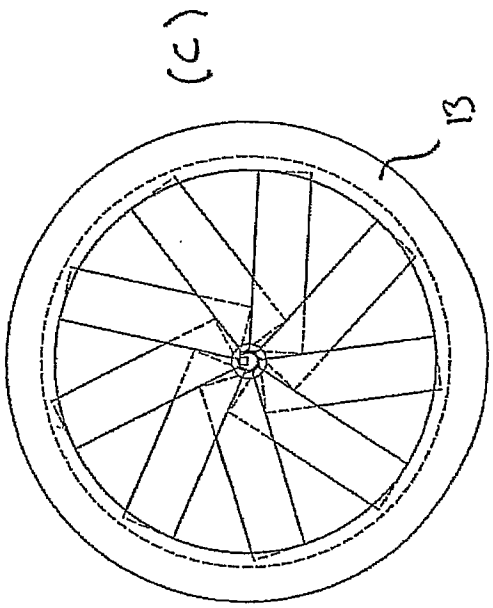
(B)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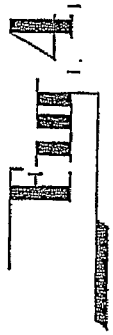


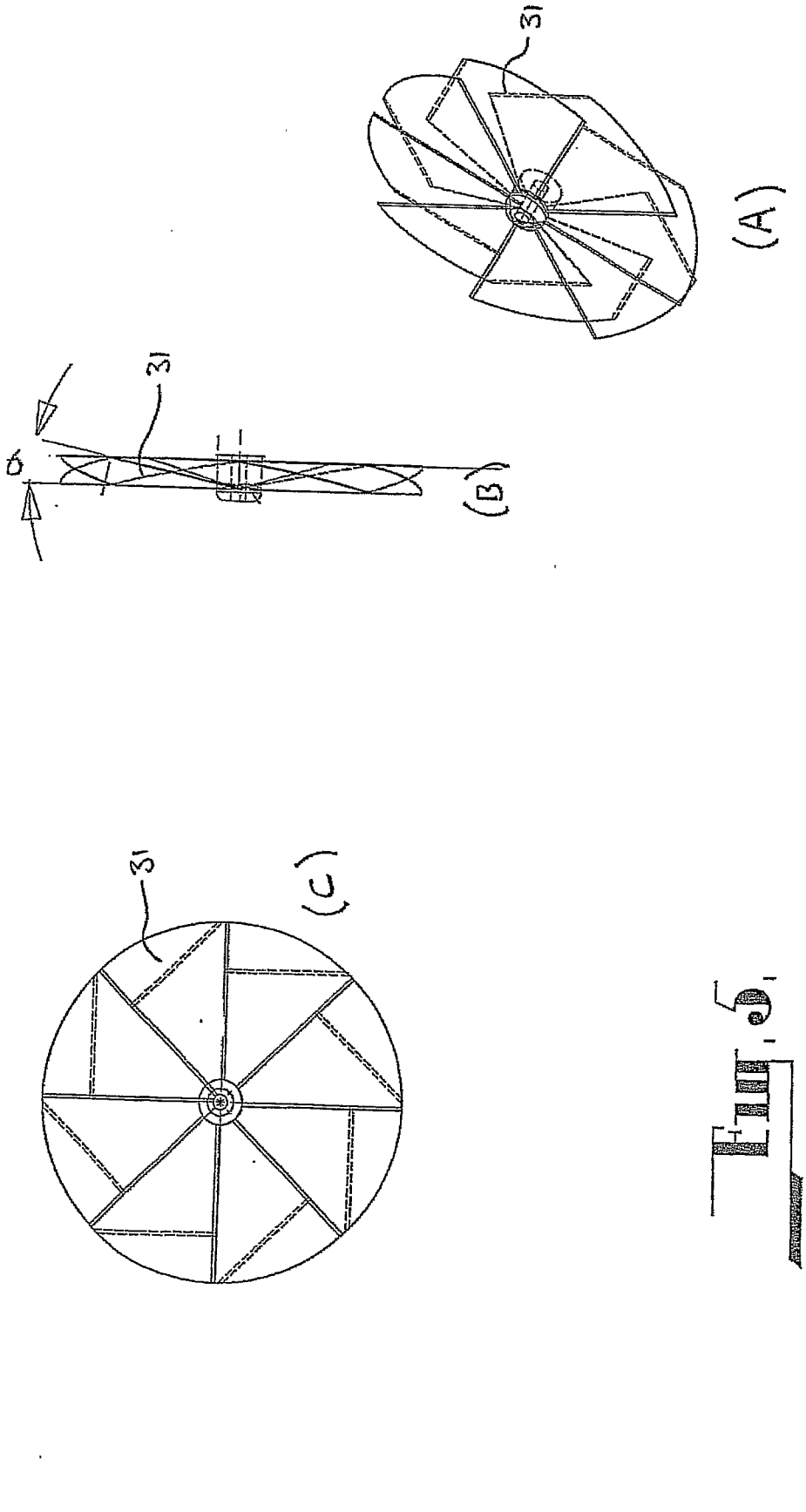
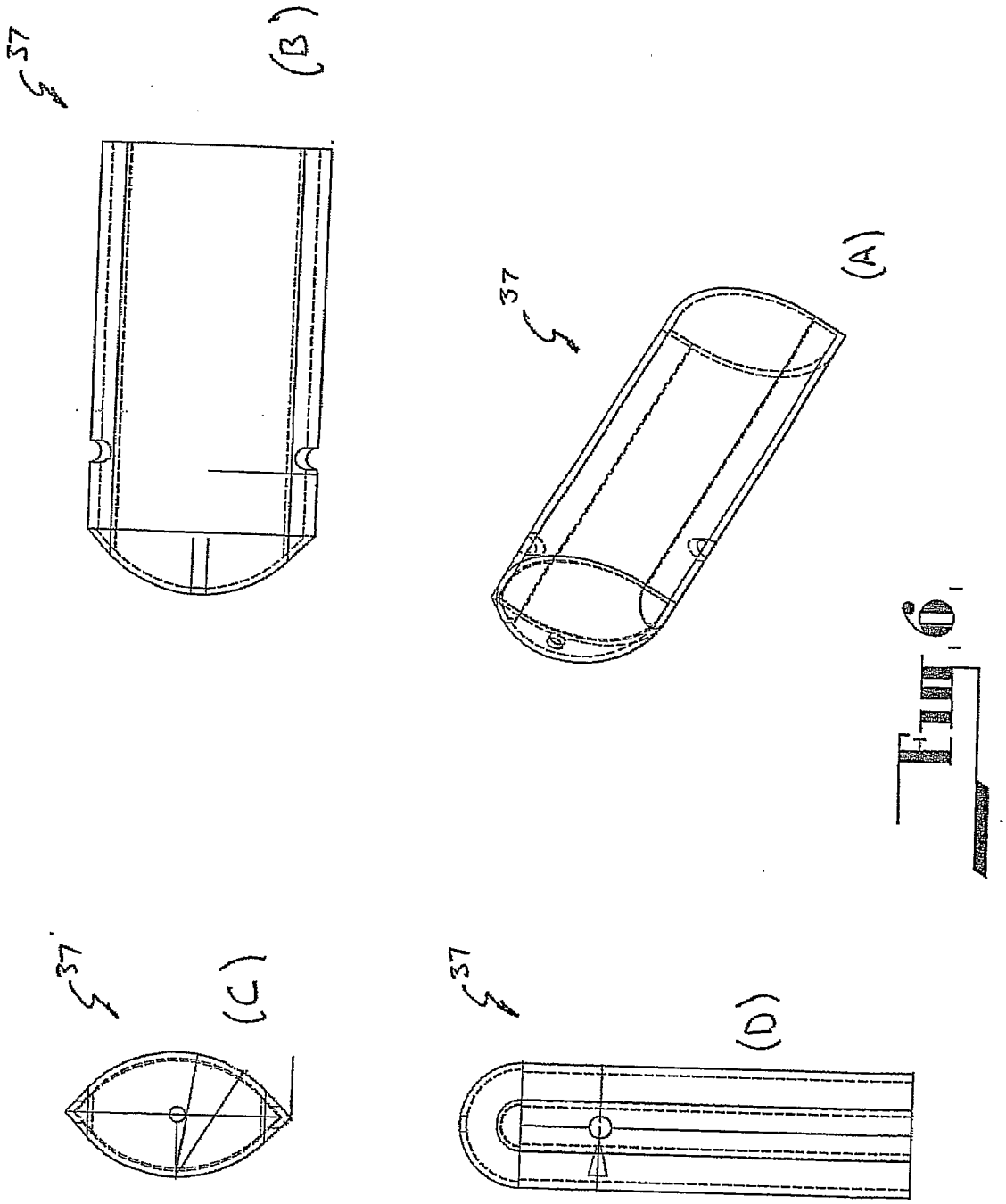


Fig. 5.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(C)
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(D)

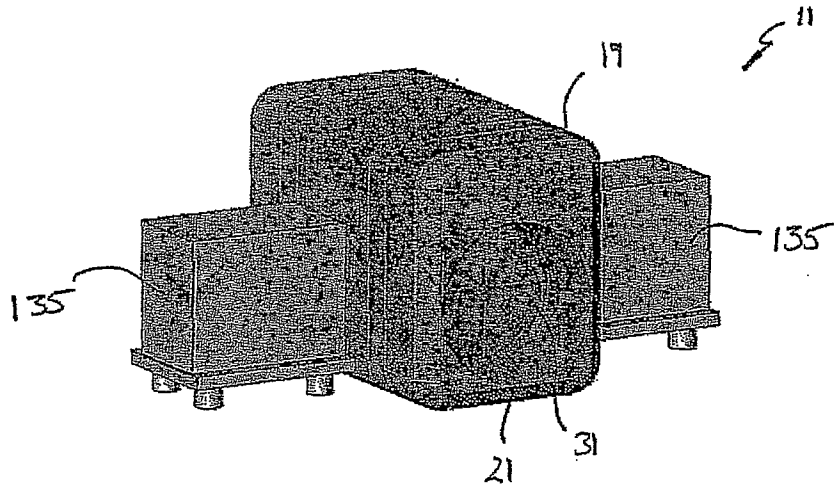
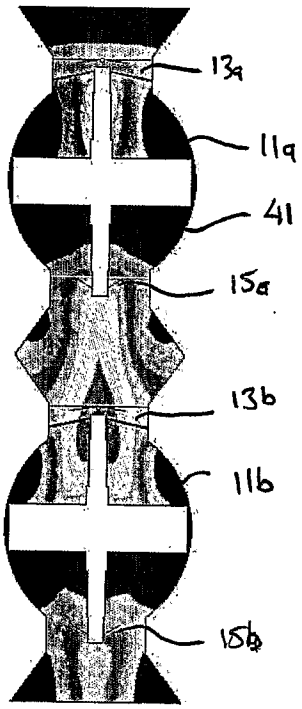


Fig. 7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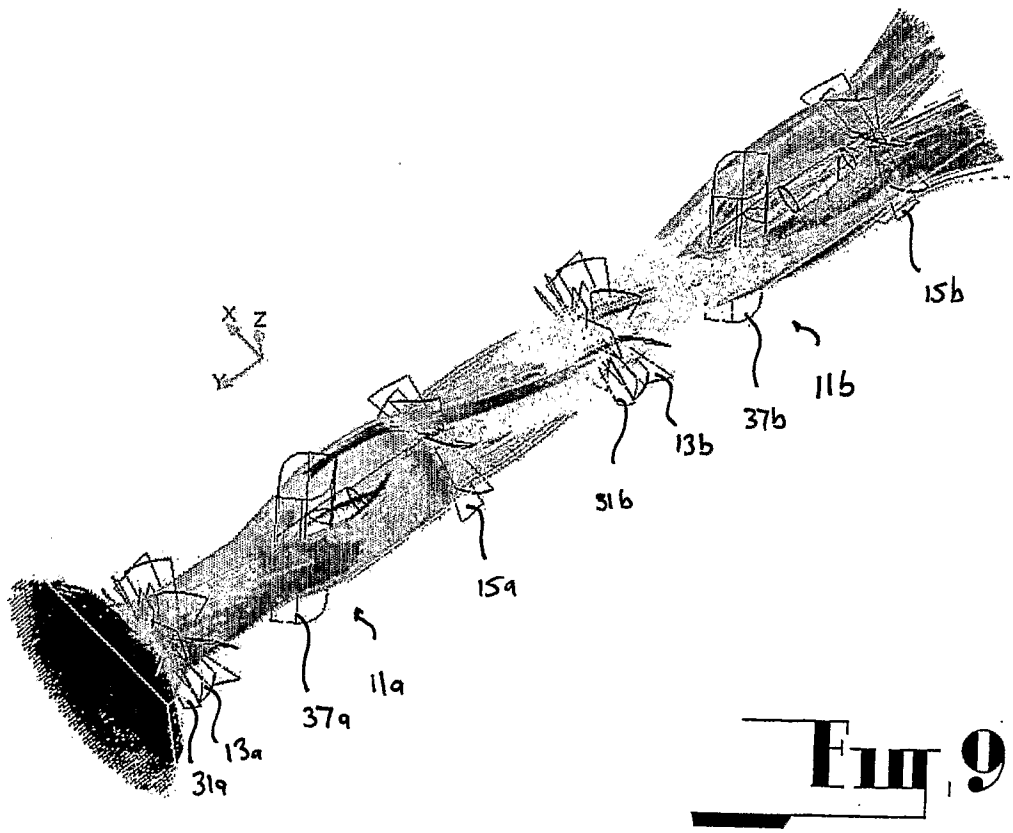
13b
11b
15b

Fig 8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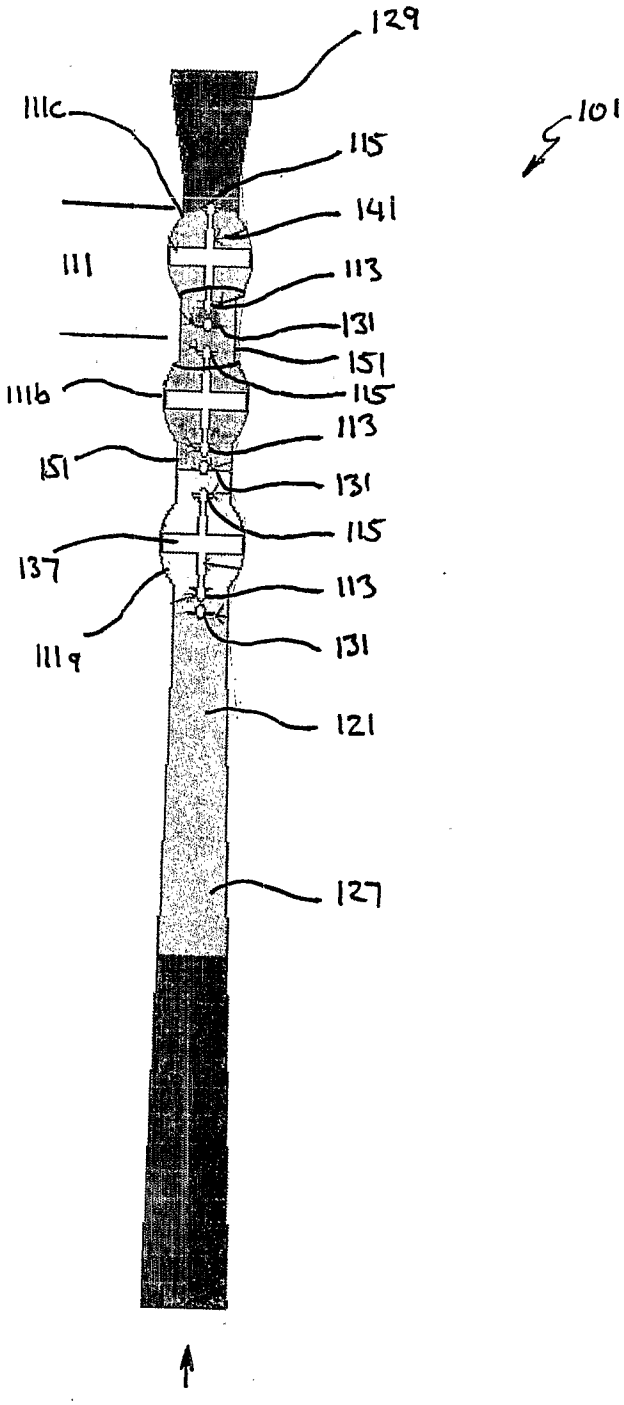
11a
37a
13a
31a

Fig 9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111a
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Fig 10

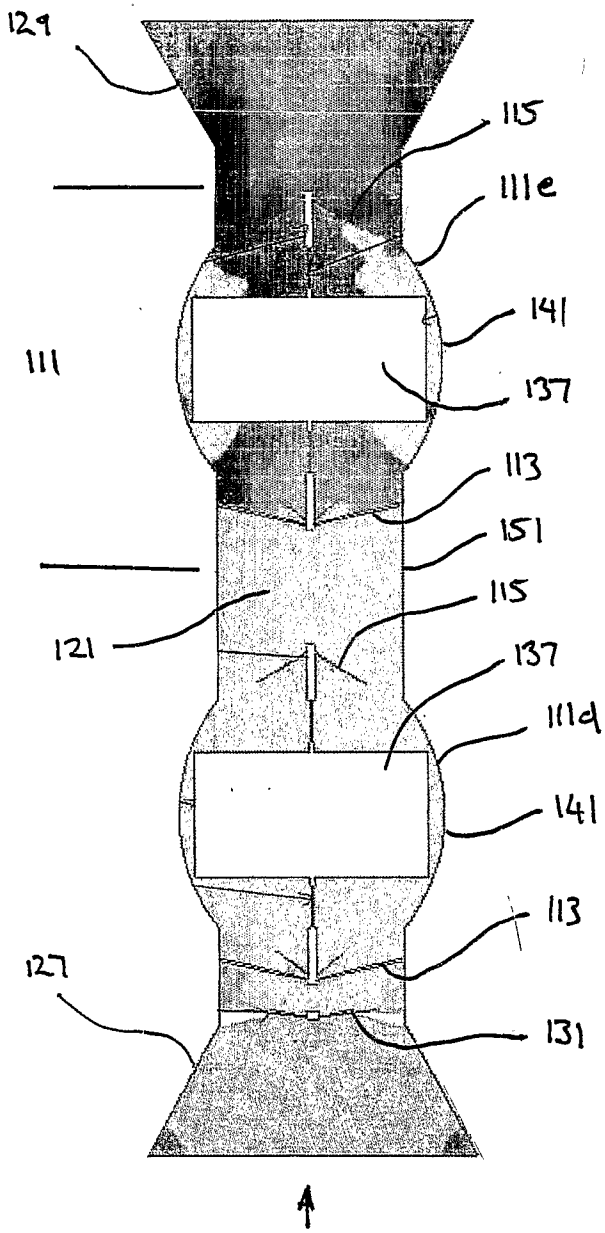
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Fig 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2007/001510

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

F03B 3/04 (2006.01) ***F03B 3/08*** (2006.01)
F03B 3/06 (2006.01) ***F03B 3/18*** (2006.01)

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)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: PAIS IPC F01D/-, F03B/-,

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

1. DWPI: IPC F01d/-, F03B/-, F03D/- and Keywords (opposed, rotation bidirectional, reverse, axial, coaxial, turbine) and related terms.
2. DWPI: IPC F01d/-, F03B/-, F03D/- and Keywords (diverge, converge venturi, nozzle, stator, trail) and like terms
3. DWPI: IPC F01D/-, F03B/-, F03D/- and Keywords (stator, pump, compress, turbine, propeller, drive, electricity) and like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	NL 7905389 A (AZZOLA) 15 January 1980 See Whole document e.g. Figures 1-3 (Also, see the whole abstract - Derwent Abstract Accession No. B2907C/06 , Class Q55)	1-13, 15-17, 20-27, 29 34-36
Y		18, 19, 28, 30-33

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"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

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 December 2007	- 7 JAN 2008
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **ADRIANO GIACOBETTI** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : (02) 6283 2579

INTERNATIONAL SEARCH REPORT	International application No. PCT/AU2007/001510

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/054290 A2 (HIRSHBERG) 26 May 2006 See whole document	37-43, 48
Y		18, 19, 30
X	FR 2445-451 A (LESTAGE) 29 August 1980 See whole document (Also, See whole abstract - Derwent Abstract Accession No. K0796 C/42, Class Q55)	38-41
X	US 6835043 B2 (MILAN et al.) 28 December 2004 See whole document	37-41
Y	US 4102599 A (ZIEGLER) 25 July 1978 Column 2, lines 2-4	28
Y	US 4120602 A (MEGNINT) 17 October 1978 Column 2, lines 5-12; Figures 1, 2	28
Y	US 7116005 B2 (CORCORAN, III) 3 October 2006 Column 1, lines 58-67	28, 31
Y	US 4468153 A (GUTIERREZ ATENCIO) 28 August 1984 Figure 9;Column 10, lines 5-10	32
Y	WO 2002/061273 A1 (WATER CROSSING ,INC) 8 August 2002 Figures 1/5, 2/5	32
Y	WO 2000/023708 A1 (KOURIS) 27 April 2000 Page 5, lines 25 - 34	33
Y	WO 20000/071890 A1 (VAUTHIER) 30 November 2000 See whole document	33
	NOTE: For Y indications, the first document, NL 7905389, can be combined with one or more of the other documents for the same claims.	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2007/001510

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please refer to the supplement sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.: **1 to 36, 37 to 48, 49 to 55 and 58, 59.**

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

Supplemental Box
(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No III: Observations where unity of invention is lacking

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

In assessing whether there is more than one invention claimed, I have given consideration to those features which can be considered to potentially distinguish the claimed combination of features from the prior art. Where different claims have different distinguishing features they define different inventions.

This International Searching Authority has found that there are different inventions as follows:

(1) Claims 1 to 36 are directed to a turbine unit comprising a first turbine blade set and second turbine blade set mounted within a passage having an opening. The first and second turbine blade sets are in opposed relation such that in operation a region between the two turbine blade sets has a lower pressure than fluid pressure at the opening of the passage. The turbine unit is used to generate power. It is considered that features of the turbine unit of independent claims 1 and 34, and in particular the first and second blade sets being in opposed relation, comprises a first distinguishing feature.

(2) Claims 37, 58 are directed to a turbine unit, and claims 38 to 48, 59 are directed to a turbine assembly comprising at least one turbine unit. The turbine unit comprises a passage and a turbine blade set located in the passage, the passage incorporating at least one nozzle (ie trailing or leading), and the turbine unit is connected to a generator such that movement of each blade set is transformed into electrical energy. It is considered that the features of the turbine assembly of claim 38 having a turbine unit having a passage with a turbine blade set and at least one nozzle comprises a second distinguishing feature.

(3) Claims 49 to 55 are directed to a turbine assembly and turbine unit. The turbine assembly comprises at least two turbine units in abutment with each other such that they define a passage and each turbine unit comprises a driving turbine blade set before fluid passes to a pumping turbine blade set and wherein the turbine assembly generates power. It is considered that the features of the turbine assembly of claim 50, and in particular the arrangement of two turbine units in abutment with each other such that they define a passage comprises a third distinguishing feature.

(4) Claims 56 and 57 are directed to a turbine assembly. The turbine assembly comprises a first venturi chamber connected to a second venturi chamber to define a passage; a first turbine blade set positioned in or adjacent to a throat of the first venturi chamber; a stator located between the first turbine blade set and an opening of the passage; wherein the second venturi creates a relatively lower pressure upstream from its throat. It is considered that the features of the turbine assembly of claim 56, and in particular the passage having first and second venturi chambers, comprises a fourth distinguishing feature.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

The only feature common to all of the claims is a turbine blade set within a passage. However this concept is known from the following prior art documents:
(a) WO 2000/023708 A1 (KOURIS) 27 April 2000
(b) GB 934364 A (SULZER FRERES SOCIETE ANONYME) 21 August 1963
(c) US 4531888 A (BUCHELT) 30 July 1985

... Continued on Supplemental Sheet

Supplemental Box
(To be used when the space in any of Boxes I to VIII is not sufficient)

... Continuation of Box No III: Observations where unity of invention is lacking

(d) DE 19636620 A1 (NETSCH) 13 March 1997
(e) CA 2301388 A1 (HYDROENERGY CORPORATION, CA) 20 September 2001
(f) CA 2527782 A1 (LAMONT) 23 November 2005

This means that the common feature can not constitute a special technical feature within the meaning of PCT Rule 13.2, second sentence, since it makes no contribution over the prior art.

Because the common feature does not satisfy the requirement for being a special technical feature it follows that it cannot provide the necessary technical relationship between the identified inventions. Therefore the claims do not satisfy the requirement of unity of invention *a posteriori*.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2007/001510

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
NL	7905389						
WO	2006/054290	AU	2005305442	EP	1841544	KR	2007009162
FR	2445451	EP	0002995	FR	2413565	FR	2497877
		GB	2043180				
US	6835043	AU	77576/01	CA	2415559	FR	2811719
		US	2003223857	WO	2002/004808		
US	4102599	AT	271276	CH	600154	DE	2706966
		FR	2348377	SE	7701779	SI	7710459
		SU	860715	YU	45977		
US	4120602	BR	7700033	CA	1073782	ES	454781
		FR	2337821	PT	66033		
US	7116005	US	2006181085				
US	4468153	NONE					
WO	2002/061273	BR	0206544	CA	2438649	CN	1496444
		EP	1360413	MX	PA03006450	NO	20033254
		RU	2003125272	SE	0100415	US	7011501
		US	2004052634	ZA	200306123		
WO	2000/023708	AU	97298/98	BR	9816058	CA	2348927
		EP	1131556	MX	PA01004002	NO	20011980
		NZ	511287				
WO	2000/071890	NONE					

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX