

Turbine Apparatus

Field of the Invention

The present invention generally relates to a turbine apparatus. In particular the invention relates to a turbine apparatus for extracting energy from a flowing fluid, wherein the fluid is contained within the apparatus or is sourced from a reservoir such as a lake, river, ocean, pond.

Background Art

The impact of carbon production and its pollution of the earth's atmosphere from current carbon based fuels is a significant consideration for industries. As the demand on earth's 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, hydro 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. These plants would not be capable of meeting base load power demand and is therefore incapable of replacing or reducing the real demand on carbon fuel based energy sources. As a result, these sources are only used to supplement energy supplied through conventional means.

The existing hydro power systems require major dam structures to be built in order to store sufficient water to create a water pressure head sufficient to drive turbines. A limitation with hydro systems is that the turbines are only capable of extracting potential energy and a minor level of kinetic energy as the water flows there through. This is as a result of the velocity of water does not exceed its terminal velocity due to gravity being the only force acting thereupon.

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Furthermore, current hydro systems are limited to rivers and those areas in which the topography enables creation of the flow and heads required. Often with hydro electric system, suitable locations are located great distances from where the power is required resulting in major transmission losses to deliver the power to
5 where it is required.

In addition, the functioning of hydro systems is dependent on the renewable inflow of water into the dams/reservoirs. If this is not sufficient then the ability for the hydro dam to produce base load power is compromised.

Another problem with renewable energy alternatives is that the plant required to
10 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
15 referred to was part of the common general knowledge as at the priority date of the application.

Disclosure of the Invention

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

The present invention provides a turbine apparatus for extracting energy from a flowing fluid, the turbine apparatus comprises at least one turbine unit through which the fluid passes, a simulation pump for delivering fluid to the at least one turbine unit, and a reservoir for storing the fluid, wherein the turbine unit is
25 configured to draw the fluid there through.

In contrast to the prior art, the present invention provides a turbine apparatus that can be located and operated in any location to generate power. The turbine apparatus may operate either as a self contained, stand alone apparatus, or as a transportable stand alone apparatus that can be setup on the side of an existing
30 dam, reservoir, river, lagoon, lake, swimming pool, tank or other body of fluid (either natural or artificial). The invention does not require a source of flowing

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water or significant infrastructure, such as dams, to create a sufficient positive head to drive the turbine units of the turbine apparatus.

The at least one turbine unit may also be configured to reduce the pressure build up at the front of the turbine unit.

5 The simulation pump may supply fluid directly to the drive turbine blade set. The simulation pump may simulate a positive head, as may be conventionally provided by a dam. Preferably the simulation pump is variably operable to vary the delivery of fluid to the at least turbine unit. Preferably the simulation pump is positioned at the front of an opening of the turbine unit.

10 The simulation pump is a fluid pump that is used to simulate the fluid and pressure heads that would normally be generated by dams or reservoirs or such like structures that could store and release a fluid at a given pressure head and flow rate to drive a turbine to generate energy.

The simulation pump requires the input of energy initially from an external source.

15 The efficiency of the simulation pump determines the minimum velocity at which a single turbine unit will produce the level of total energy that will be generated to exceed the level of potential energy required to operate the turbine unit.

The turbine unit, reservoir and simulation pump may be fluidly connected by pipes.

20 In one aspect of the invention the turbine apparatus is a substantially closed circuit. Preferably the reservoir is provided by an enlarged section of the pipe work. In operation, the reservoir may be located below the at least one turbine unit. Preferably the volume of the reservoir is equal to at least two times the volume of fluid flowing through the unit in a second time unit. That is to say, if the
25 fluid flow is 200 litres per second, the reservoir must be able to store at least 400 litres. Preferably the turbine apparatus has a void section with no fluid therein. This section may move according to the operating conditions of the turbine apparatus. The void section may be half the volume of fluid flowing through the unit in a second time unit. The void prevents the compression and stalling of the
30 apparatus.

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The turbine apparatus may comprise at least one air valve to allow equalisation of the air pressure therein with that of the atmosphere.

Due to the orientation of the turbine apparatus the void will automatically be at the top of the apparatus. It therefore follows that the at least one air valve is also
5 located at the top thereof to ensure it remains in communication with the void section.

In another aspect of the invention the reservoir is provided by an open body of fluid, wherein an inlet and an outlet of the turbine apparatus is in communication therewith.

10 Preferably, where the turbine apparatus comprises a plurality of turbine units, the velocity and mass volume remains substantially the same across the plurality of turbine units, such that the RPM of the plurality of turbine units is substantially the same.

Preferably the at least one turbine unit comprises a drive turbine blade set located
15 upstream from a pump turbine blade set mounted within a passage of a housing.

Preferably the drive turbine blade set and pump turbine blade set are mounted on a common shaft such that they are confined to rotate in the same direction and same speed.

The drive turbine blade set and pump turbine blade set may be mounted in
20 opposed relation whereby the pump turbine blade set is in reverse relation to the drive turbine blade set such that in operation the drive turbine blade set pushes the fluid towards the pump turbine blade set, and the pump turbine blade set draws the fluid away from the drive turbine blade set. The simultaneous operation
25 of the turbine blade sets may create a low pressure region in front of the drive turbine blade set and between the drive and pump turbine blade set, this pressure may be lower than the pressure of the fluid supplied to the turbine unit by the simulation pump.

With this configuration a low pressure region is created between the two turbine blade sets when compared with the fluid pressure at an opening of the passage.
30 Furthermore, as the pump turbine blade set draws the fluid through the turbine unit a region of lower pressure is also formed upstream from the drive turbine

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blade set. This is significant as it ensures there is minimal impediment to flow at the front of the turbine unit, which is typically experienced by prior art devices. As a result of the pump turbine blade set and its reversed orientation with respect to the drive turbine blade set, the mass flow through the turbine unit is significantly increased. Furthermore, the velocity of the fluid striking the drive turbine blade set is increased.

The larger pressure differential induces a larger mass flow rate as fluid travels from a high pressure region (front of the turbine unit) to a relatively lower pressure region. The higher pressure region could be caused by either natural, i.e. atmospheric pressure, or forced, i.e. pumped or pressure head. Furthermore the pumping turbine blade set evacuates the fluid and at the same time, lowers the potential of back pressure.

Preferably, where the turbine apparatus comprises a single turbine unit, the velocity of the fluid striking the driver turbine blade set is greater than the terminal velocity of the fluid. This may be influenced by the size of the pump turbine blade set.

Each turbine blade set may be in the form of a set of blades which is rotated by the force of the fluid striking the blades.

In one aspect of the invention the drive turbine blade set and pump blade set are in spaced apart relation.

In another aspect of the invention the drive turbine blade set and pump blade set overlap each other.

The turbine apparatus may be coupled to at least one generator.

The at least turbine unit may be coupled to at least one generator.

The shaft of the at least one turbine unit may be coupled to a generator.

The coupling may be via a chain drive, belt drive, direct coupling shaft to shaft, via a gear box, or other known means.

As the fluid flows through the passage, the flow drives the drive turbine blade set and simultaneously rotates the pump turbine blade set. As the pump turbine

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blade set rotates, it effectively pulls the fluid toward it, creating a lower pressure region between at least the two turbine blade sets.

As the pump blade set rotates, the fluid is pulled through the system to be pushed out the unit, minimizing the back flow pressure and energy losses associated with
5 pressure accumulation behind and in front of the drive blade set. The act of pushing the fluid out of the passage also overcomes the pressure head which may exist at the exit of the passage.

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

Where the turbine apparatus comprises a plurality of turbine units the axis of rotation of the shaft of adjacent turbine units are offset relative to each other. This enables the turbine apparatus to be more compact, whilst still allowing generators
15 to be easily connected to the shafts.

Preferably the drive turbine blade set and pump turbine blade set are configured to provide maximum torque.

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

The turbine apparatus may further comprise screens at the drive end and pump end of the passage to prevent debris and animals entering the passage.

In one aspect of the invention, the pump turbine blade set can be the same size
25 as the drive turbine blades.

In another aspect of the invention the pump turbine blade set can be of a larger diameter than that of the drive turbine blade set. Preferably the optimum ratio for the diameter of the drive turbine blade set to the pump turbine blade set is 1:1.617.

In one aspect of the invention the drive turbine blade set and pump turbine blade set can be interlocked so as to overlap each other.

In another aspect of the invention the drive turbine blade set and pump turbine blade set can be in a spaced apart relation. The drive turbine blade set and pump turbine blade may be spaced at a ratio of 3.2 times the diameter of the drive turbine blade set. The spacing to the drive turbine blade set and pump turbine blade set can be varied from this ratio.

The drive turbine blade set and pump blade can be in a spaced apart relation which allows the pump turbine blade set to be smaller, the same size or larger in diameter to the diameter of the drive turbine blade set.

The passage may comprise a chamber located between the drive turbine blade set and pump turbine blade set. The chamber may extend outwardly from the drive turbine blade set before converging as it approaches the pump turbine blade set.

The passage may comprise a converging portion located upstream from the drive turbine blade set. The passage may also comprise a diverging portion located downstream from the pump turbine blade set.

The converging portion reduces the cross sectional area through which the fluid flows, increasing the velocity and pressure of fluid passing therethrough. Whilst the diverging portion decreases the fluid velocity and pressure of fluid passing therethrough. Each portion is configured to converge in a direction towards the chamber of the turbine unit.

The converging portion assists in increasing the fluid velocity as it moves towards the drive turbine blade set. This, combined with the action of the pump turbine blade set allows the fluid velocity to exceed the terminal velocity of the fluid due to gravity (which for water is 7 metres per second). It also induces fluid velocities up to, and in excess of 35 metres per second, allowing and ensuring maximum kinetic energy may be extracted from the fluid flow.

Preferably the diverging portion 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.

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The drive turbine blade set may have a stator located upstream thereof for directing fluid onto the blades of the drive turbine blade set. Preferably the stator is coaxially mounted on the shaft.

Additional stators may also be associated with other parts of the turbine unit. A
5 stator is a set of blades which is stationery, whose main role is to deflect fluid.

In this instance, as a result of the impact of the pump turbine blade set on pressures within the turbine apparatus, the mass flow of the fluid and the associated pressure is not impeded by the stator, unlike prior art devices. Therefore the unimpeded mass flow at the higher velocity increases the force of
10 the fluid striking the drive turbine blade set, which in turn increases the available energy that can be converted to electrical energy.

The pump turbine blade set is sized to ensure minimal head losses by the fluid flowing through the passage from the simulation pump and through the converging portion and therefore ensuring minimal Impediment is incurred on the
15 mass and pressure head of the fluid flow generated by the simulation pump at the desired fluid velocity to maximise the total energy that can be generated from the available potential energy and kinetic energy.

Multiple turbine units may be positioned in series. The units may be placed in an adjacent arrangement such that fluid exiting a turbine unit passes immediately into
20 another adjacent turbine unit.

The use of multiple turbine units in series is only possible as a result of the pump turbine blade set which minimises the Impediment of fluid flow and pressure, which would otherwise exist with at the drive turbine blade set.

In one aspect of the invention, the turbine apparatus comprises a first turbine unit
25 and a second turbine unit, each turbine unit being substantially in an end to end relationship such that as fluid passes through the turbine apparatus it sequentially passes through a venturi opening upstream of the first turbine unit, the drive turbine blade set and pump turbine blade set of the first turbine unit, before passing through the drive turbine blade set and pump turbine blade set of the
30 second turbine unit and into the reservoir.

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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.

5 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.

Each turbine unit may be mounted on an independent shaft.

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

10 As the drive turbine blade set and pump blade set are positioned in reversed relation to each other, in one aspect of the invention the turbine blades of one turbine blade set are a mirror image of the turbine blades of the other turbine blade set when considered from a point between the two turbine blade sets. In another aspect the turbine blades of one turbine blade set are offset at an angle of
15 180° from the turbine blades of the other turbine blade set.

The drive turbine blade set and pump blade can be in a spaced apart relation which allows the pump turbine blade set to be smaller, the same size or larger in diameter to the diameter of the drive turbine blade set. In the alternative, the drive turbine blade set and pump turbine blade set may be interlocked or overlapped
20 whereby the two blade set slightly overlap each other.

The drive turbine blade set and pump turbine blade set are positioned in opposed relation to each other, that is to say the blades are reversed relative to each other so that as the fluid strikes the drive turbine blade set, the blades commence rotation of the shaft. As the pump turbine blade set and the drive turbine blade set
25 are connected to a common shaft, the pump turbine blade set will rotate simultaneously and at the same speed as the drive turbine blade set. As the pump turbine blade set rotates it creates a low pressure region behind the pump turbine blades, inducing a lower pressure region in front of the drive turbine blade set, as well as between the drive turbine blade set and pump turbine blade set. This
30 results in increase mass flow of the fluid across the drive turbine blade set at a

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substantially higher pressure, resulting in the fluid striking the drive turbine blade set with more force.

Brief Description of the Drawings

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

Figure 1 is a schematic plan view of a turbine apparatus according to a first embodiment of the invention;

Figure 2 is a schematic side view of the turbine apparatus in figure 1 with supporting frame work and associated generator;

10 Figure 3 is a plan view of figure 2;

Figure 4 is a cross sectional side view of a turbine unit incorporated in the turbine apparatus of the first embodiment;

Figure 5 is a schematic view of a series of turbine units incorporated in a turbine apparatus according to a second embodiment;

15 Figure 6 is a cross sectional side view of a turbine unit incorporated in the turbine apparatus of the second embodiment;

Figure 7 is an exploded cross sectional view of the turbine blade sets shown in figure 6; and

20 Figure 8 is a perspective view of a turbine apparatus according to a third embodiment of the invention.

In the drawings like structures are referred to by like numerals throughout the several views. The drawings shown are not necessarily to scale, with emphasis instead generally being placed upon illustrating the principles of the present invention.

25 Best Mode(s) for Carrying Out the Invention

Referring to figure 1 to 4 the invention according to a first embodiment of the invention is in the form of a turbine apparatus 10 for extracting energy from a

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flowing fluid. The turbine apparatus 10 comprises three turbine units 11 through which the fluid passes.

The turbine apparatus 10 also comprises a simulation pump 14 for delivering fluid to the first turbine unit 11a, and a reservoir 20 for storing the fluid.

- 5 Each of the components is in fluid communication with each other with pipes 32. As shown in figure 1 the reservoir 20 is an enlarged section of the associated pipe 32.

As shown in figure 1, 2 and 3 the turbine apparatus 10 of the first embodiment is a substantially closed system. It is appreciated, however, that from time to time the
10 turbine apparatus 10 may need to be topped up with fluid to counter any leakage. Also, the turbine apparatus 10 will have an air vent 32 to ensure the air pressure within the pipes 32 remains relatively equal with that of the atmosphere.

Referring to figures 2 and 3, the turbine apparatus 10 is shown ready for operation. In these figures the turbine apparatus 10 is supported by a frame 36
15 and orientates the turbine apparatus 10 such that the turbine units 11 remain above the reservoir 20.

Each turbine unit 11 comprises a drive turbine blade set 13 and a pump turbine blade set 15 coaxially mounted on a common shaft 17. In figure 4 the fluid flow is indicated by arrow A.

- 20 The drive turbine blade set 13 and pump turbine blade set 15 are positioned in a passage 21 formed in a housing 19. The passage 21 channels fluid to the drive turbine blade set 13 and pump turbine blade set 15.

Referring to figure 4, the passage 21 has a first end 23 and a second end 25. The passage 21 also incorporates a converging portion 27 located between the first
25 end 23 and the drive turbine blade set 13, and a diverging portion 29 located between the drive turbine blade set 13 and the pump turbine blade set 15.

As best shown in figure 3, the shaft 17 of each turbine unit 11 extends beyond the housing 19. Each shaft is coupled to a larger shaft 18 which is connected to a generator 30.

- 30 In its initial operation, the simulation pump 14 supplies fluid from the reservoir 20

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to the drive turbine blade set 13 of the first turbine unit 11a at a regulated fluid volume and pressure head. The fluid passes through the first end 23 of the passage 21 into the converging portion 27. The converging portion 27 effectively increases the velocity of the fluid before it strikes the drive turbine blade set 13.

- 5 This turns the drive turbine blade set 13, turning the shaft 17 and the pumping turbine blade set 15.

Once the pumping turbine blade set 15 is rotating a region of low pressure is created in the portion of passage 21 between the two turbine blade sets 13, 15. The pump turbine blade set 15 effectively pulls the fluid away from the drive turbine blade set 13 until it passes through the pump turbine blade set 15. It then pushes the fluid out the first turbine unit 11a to the second turbine until 11b, where the same process takes place. Similarly with the third turbine unit 11c. Upon exiting the third turbine unit 11c the fluid is discharged into the reservoir 20.

- 15 The pulling action of the pump turbine blade set 15 on the fluid mitigates the effect of backflow pressure losses created by the drive turbine blade set 13 as well as the build up of pressure which may be caused at the front of the drive turbine blade set 13, and creates a further low pressure region upstream from the drive turbine blade set 13. The pulling effect also assists in reducing turbulence and increasing fluid velocity.

- 20 As fluid enters the passage 21 of the turbine unit 11 it is accelerated through the converging portion 27 towards the drive turbine blade set 13. As the drive turbine blade set 13 rotates the pump turbine blade set 15 also rotates to draw more fluid through the passage 21. The rotation of the pump blade set 15 is induced by the rotation of the drive blade set 13 since they are mounted on the same shaft.

- 25 As the blades of the pump turbine blade set 15 are reversed to those of the drive blade set 13 the pump turbine blade set 15 pulls the fluid from the drive blade set 13 and pushes it out of the passage 21 downstream therefrom.

- A second embodiment of the invention is illustrated in figures 5, 6 and 7. For convenience features of a turbine apparatus 110 that are similar or correspond to features of the turbine apparatus 10 of the first embodiment have been referenced with the same reference numerals.
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In this embodiment the turbine apparatus 110 is more compact as a result of the configuration of each turbine unit 111. Referring to figures 6 and 7 each turbine unit 111 comprises a drive turbine blade set 13 and a pump turbine blade set 15 coaxially mounted on a common shaft 17. The drive turbine blade set 13 and pump turbine blade set 15 are positioned in a passage 121 formed in a housing 119. The passage 121 is cylindrical in shape with no converging or diverging portions.

The drive turbine blade set 13 and pump turbine blade set 15 are positioned relative to each other whereby they overlap or interlock, as best shown in figure 7. In this orientation there is no space between the two turbine blade sets 13, 15. This allows each turbine unit 111 to be significantly reduced in length, allowing the turbine apparatus 110 to be more compact.

The turbine unit 111 have a venturi bead 112 located centrally between the two turbine blade sets 13, 15 to assist with the flow of the fluid.

A third embodiment of the invention is illustrated in figure 8. For convenience features of a turbine apparatus 210 that are similar or correspond to features of the turbine apparatus 10 of the first embodiment have been referenced with the same reference numerals.

In this embodiment the turbine apparatus 210 has a reservoir 220 provided by a body of fluid 212 such as for example a dam, river, lake or swimming pool. In operation the simulation pump 14 initially supplies water from the reservoir 220 through inlet 238 to the first turbine unit 11a. Once the fluid passes through the three turbine units 11 the fluid is charged back into the reservoir 220 through outlet 240.

In each of the above embodiments the rotation of the pump turbine blade set allows for the induction of greater mass flow across the drive turbine blade set through the creation of a substantially lower pressure zone than would have been created in its absence.

For each unit configured to have a drive turbine blade set and pump turbine blade set, the energy loss created by the drive turbine blade set is compensated by the action of the pump turbine blade set since it is acting as a pump. Effectively the

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energy is transferred from the drive turbine blade set along the shaft to the pump turbine blade set. This is only possible when both blade sets are mounted on the same shaft, rotate simultaneously and are in reversed orientation such that the pump turbine blade set pulls the fluid through the turbine unit whilst the drive turbine blade set operates in a conventional manner.

The simulation pump requires the input of energy initially from an external source. The efficiency of the simulation pump determines the minimum velocity at which a single turbine apparatus will produce the level of total energy that will be generated to exceed the level of potential energy required to operate the turbine apparatus.

The total energy (T_E) is the combined potential energy (P_E) and kinetic energy (K_E) generated by the turbine apparatus, converted to mechanical energy and then to electrical energy

The electrical energy generated is then supplied back to the simulation pump to maintain its operation and supply of the fluid at the desired flow rate and pressure head.

Once the electrical energy generated exceeds the potential (electrical) energy required by the simulation pump then the turbine apparatus becomes largely a standalone unit and at that point does not require the external power source.

Assuming the fluid to be used is water, and the simulation pump has an efficiency rating of 80%, then the desired velocity of the fluid for the turbine apparatus to provide power is 16.55 metres per pump. When the simulation pump has an efficiency rating of 90% then the desired velocity of the fluid is 13.7 metres per second.

In one example, when the simulation pump is 85% efficient and the fluid velocity is 23 metres per second then the level of electrical power generated (theoretical) by the first unit in series or a single turbine apparatus is 1.41 times the electrical energy required to operate the simulation pump.

The present invention relates to a turbine apparatus whereby a simulation pump that simulates or produces the fluid flow and head that is necessary to drive a first turbine unit. Further, as result of the internal mechanical configuration of the

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turbine unit the fluid flow is not impeded and the number of turbine units can be used in series to generate power.

The drive turbine blade set comprises a set of drive blades is caused to rotate by the force of the fluid striking the blades as the fluid passes through the passage.

- 5 The pumping turbine blade set comprises a set of blades which, by their design and the resulting orientation with respect to the drive turbine blade set, draws the fluid through the passage of the housing towards the pump turbine blades before expelling the fluid away from itself. The 'draw' of the fluid through the passage is created by the pump turbine blade set which substantially lowers the pressure
10 within the passage.

- The action of the pump turbine blade set creates a high pressure differential between the front of the drive turbine blade set and the rear of the pump turbine blade set. This differential induces a larger mass flow rate as fluid travels from a region of higher pressure (in front of drive turbine blade set) to a region of lower
15 pressure (behind the pump turbine blade set). The higher pressure region could be caused by either natural (i.e. atmospheric pressure), or be forced (i.e. pumped or pressure head). The pump turbine blade set therefore induces increased mass flow and velocity of the fluid through the drive turbine blades. As a result of the action of the pump turbine blade set the velocity of the fluid passing through the
20 turbine assembly increases (for water, from 7m/sec to in excess of 35 m/sec) whereby the velocity of the fluid substantially exceeds that of its terminal velocity caused by gravity.

- In addition, the pumping turbine blade set evacuates the fluid and at the same time removes the potential of back pressure and impediment to the fluid flow that
25 would normally occur in front of the drive turbine blade set.

The diameter of the pumping turbine blade set relative to the diameter of the driving turbine blade set can be the same, smaller or larger, depending upon the required result as well as the conditions in which the turbine assembly will be used (e.g. positioned on a slope).

- 30 The common shaft extends through the housing and protrudes therefrom to allow an alternator or motor to be connected thereto in order to generate electricity.

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Both turbine blade sets may have one or more stators associated therewith. The stationery blades of the stators deflect fluid onto the blades of the turbine blade sets.

5 In some applications the housing supports a convergent venturi. The convergent venturi provides a convergence area which increases the velocity of fluid due to the conservation of mass. The conservation of mass states that as a fluid body travels through a smaller area, its velocity increases and vice versa.

10 In some applications the housing supports a divergent venturi. The divergent venturi provides a divergence area which decreases the velocity of fluid travelling there through.

The purpose of the convergent venturi immediately prior to the drive turbine blade set is to increase the velocity of the fluid to levels that exceed the terminal velocity of the fluid cause by gravity (for water this is approximately 7 m/sec). This facilitates maximum extraction of kinetic energy from the moving fluid.

15 The portion of the housing in which the pump turbine is located may also include a divergent venturi. This housing may diverge away from the drive turbine blade set to the pump turbine blade set, may be the same size between the two turbine blade sets, or may converge from the drive turbine blade set to the pump turbine blade set.

20 In order to operate, the turbine assembly is placed in fluid communication with a fluid reservoir. The fluid reservoir may take many forms, include for example any fluid body, dam, reservoir, lake, tank, enclosed conduit (pipeline or otherwise) of any size or shape that can hold fluid and which allows fluid to be constantly withdrawn by a pump or any mechanism that allows the fluid to be directed in
25 through the turbine assembly. There may be multiple turbine assemblies in series. Once the fluid passes through the turbine assembly the fluid is discharged back into the fluid reservoir.

A simulation pump is connected to the housing and is used to produce and regulate the fluid flow and head through the turbine assembly. The simulation
30 pump replaces the necessity for structures, such as dams, to house fluid to create the head and flow required to operate turbines (e.g. hydro).

The turbine apparatus can be operated with positive heads as low as 2 metres to in excess of 100 metres and fluid flow rates as low as 20 litres per pump to in excess of 100,000 litres per pump.

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

Reference to positional descriptions, such as lower and upper, are to be taken in context of the embodiments depicted in the figures, and are not to be taken as limiting the invention to the literal interpretation of the term but rather as would be understood by the skilled addressee.

- 10 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:

- 5 1. A turbine apparatus for extracting energy from a flowing fluid, the turbine apparatus comprises at least one turbine unit through which the fluid passes, a simulation pump for delivering fluid to the at least one turbine unit, and a reservoir for storing the fluid, wherein the turbine unit is configured to draw the fluid there through.
2. The turbine apparatus according to claim 1 wherein the at least one turbine unit is also configured to reduce the pressure build up at the front of the turbine unit.
- 10 3. The turbine apparatus according to claim 1 or 2 wherein the simulation pump supplies fluid directly to the drive turbine blade set.
4. The turbine apparatus according to any one of the preceding claims wherein the simulation pump is variably operable to vary the delivery of fluid to the at least turbine unit.
- 15 5. The turbine apparatus according to any one of the preceding claims wherein the simulation pump is positioned at the front of an opening of the turbine unit.
6. The turbine apparatus according to any one of the preceding claims wherein the simulation pump is a fluid pump that is used to simulate the fluid and pressure heads that would normally be generated by dams or
20 reservoirs or such like structures.
7. The turbine apparatus according to any one of the preceding claims wherein the simulation pump requires the input of energy initially from an external source.
- 25 8. The turbine apparatus according to any one of the preceding claims wherein the turbine unit, reservoir and simulation pump are fluidly connected by pipes.
9. The turbine apparatus according to any one of the preceding claims wherein the turbine apparatus is a substantially closed circuit.

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10. The turbine apparatus according to any one of the preceding claims wherein the reservoir is provided by an enlarged section of the pipe work.
11. The turbine apparatus according to claim 10 wherein the volume of the reservoir is equal to at least two times the volume of fluid flowing through the unit in a second time unit.
12. The turbine apparatus according to claims 10 or 11 wherein the turbine apparatus has a void section with no fluid therein.
13. The turbine apparatus according to claim 12 wherein the void section is half the volume of fluid flowing through the unit in a second time unit.
14. The turbine apparatus according to any one of the preceding claims further comprising at least one air valve to allow equalisation of the air pressure therein with that of the atmosphere.
15. The turbine apparatus according to any one of claims 1 to 9 wherein the reservoir is provided by an open body of fluid, wherein an inlet and an outlet of the turbine apparatus is in communication therewith.
16. The turbine apparatus according to any one of the preceding claims wherein the at least one turbine unit comprises a drive turbine blade set located upstream from a pump turbine blade set, both being mounted within a passage of a housing.
17. The turbine apparatus according to claim 16 wherein the drive turbine blade set and pump turbine blade set are mounted on a common shaft such that they are confined to rotate in the same direction and same speed.
18. The turbine apparatus according to claim 16 or 17 wherein the drive turbine blade set and pump turbine blade set are mounted in opposed relation whereby the pump turbine blade set is in reverse relation to the drive turbine blade set such that in operation the pump turbine blade set draws the fluid away from the drive turbine blade set to create a low pressure region in front of the drive turbine blade set and between the drive and pump turbine blade set, this pressure being lower than the pressure of the fluid supplied to the turbine unit.

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19. The turbine apparatus according to claim 16, 17 or 18 whereby when the turbine apparatus comprises a single turbine unit, the velocity of the fluid striking the driver turbine blade set is greater than the terminal velocity of the fluid.
- 5 20. The turbine apparatus according to any one of claims 16 to 19 wherein the drive turbine blade set and pump blade set are in spaced apart relation.
21. The turbine apparatus according to any one of claims 17, 18, 20 whereby when the turbine apparatus comprises a plurality of turbine units the axis of rotation of the shaft of adjacent turbine units are offset relative to each other.
- 10 22. The turbine apparatus according to any one of claims 16 to 21 wherein the pump turbine blade set is the same size as the drive turbine blade set.
23. The turbine apparatus according to any one of claims 16 to 21 wherein the pump turbine blade set has a larger diameter than that of the drive turbine blade set.
- 15 24. The turbine apparatus according to claim 23 wherein the optimum ratio for the diameter of the drive turbine blade set to the pump turbine blade set is 1:1.617.
25. The turbine apparatus according to any one of claims 16 to 24 wherein the drive turbine blade set and pump blade set overlap each other.
- 20 26. The turbine apparatus according to any one of claims 16 to 24 wherein the drive turbine blade set and pump turbine blade set can be in a spaced apart relation.
27. The turbine apparatus according to claim 23 wherein the drive turbine blade set and pump turbine blade is spaced at a ratio of 3.2 times the diameter of the drive turbine blade set.
- 25 28. The turbine apparatus according to any one of claims 16 to 27 wherein the passage comprises a converging portion located upstream from the drive turbine blade set.

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29. The turbine apparatus according to any one of claims 16 to 28 wherein the passage comprises a diverging portion located downstream from the pump turbine blade set.
- 5 30. The turbine apparatus according to any one of claims 16 to 29 wherein the drive turbine blade set has a stator located upstream thereof for directing fluid onto the blades of the drive turbine blade set, the stator is coaxially mounted on the shaft.
- 10 31. The turbine apparatus according to any one of the preceding claims comprising two or more turbine units, the turbine units being arranged in series with varying orientations with respect to each other.
32. The turbine apparatus according to claim 31 wherein each turbine unit has an independent shaft.