

A TURBINE DEVICE

FIELD

The present disclosure relates to a turbine device, a system for generating electrical power from a fluid flow and a method of the same.

5 BACKGROUND

With rapid urbanization and increased population, high rise apartment buildings have become the common home for many people in major cities around the world.

The provision of essential services such as power and water to apartment buildings pose significant engineering concerns as compared to the detached housing of previous years.

10 In dense urban environments, water treatment and pumping stations may be located some distance away in outlying areas. As a result, the pressure in municipal fresh water supply pipelines needs to be very high so as to ensure consistent water supply throughout the urban area. For example, Fig.1 shows a schematic diagram of a typical water distribution system 10 for an apartment building with a roof tank. In this system, fresh water from the municipal main pipe 12 is stored in a break tank 16 before being supplied to a building 11.

A pressure reducing valve 14 as shown in Fig.1 is commonly used in the system to reduce the pressure in the municipal main pipe 12, as the water pressure in municipal main pipe is typically relatively high, which may cause water leakage or damage on water pipes and appliances such as the break tank 16.

20 However, the pressure in the fresh water supply pipelines flowing from the break tank 16 may be not high enough to supply water to the users at the high levels of the high-rise apartment buildings. Therefore, water pumps in or near such high-rise apartment buildings provide water to tanks located on the roof of the high-rise buildings. In the example of Fig.1, the water is then supplied by a pump 18 to a gravity-fed water tank 15 located on the rooftop of the apartment/high-rise building 11 and finally distributed to users via distribution pipes 13.

25 As is known in the art, a pressure reducing valve typically changes the fluid flowing through the valve from a high inlet pressure to a lower outlet pressure via a change in the valve's throttling area. Unfortunately, as this kind of valve typically reduces water pressure by decreasing throttling area, the potential energy of the water pressure is wasted in the overall system.

Accordingly, there is a need to provide a turbine device which can reduce fluid pressure and use the pressure reduction in power generation and at least partially addresses the above problems. This is particularly important when the fluid is treated drinkable water supplied to domestic or commercial buildings, especially apartments.

5 SUMMARY

Features and advantages of the disclosure will be set forth in the description which follows, and in part will be obvious from the description, or can be learned by practice of the herein disclosed principles. The features and advantages of the disclosure can be realized and obtained by means of the instruments and combinations particularly pointed out in the appended claims.

10 In accordance with a first aspect of the present disclosure, there is provided a turbine device comprising: a turbine including a housing including a volute configured to direct a fluid flow path over a runner disposed therein for rotating relative to the housing a first rotatable shaft coupled thereto; and a transmission assembly engaged with the housing comprising a first rotatable member disposed therein which is magnetically coupled at one end with the first rotatable shaft
15 and coupled at the other end to a power generation system; wherein the fluid flow path in the turbine is excluded from the transmission assembly by the housing.

The transmission assembly may include a second rotatable shaft engageable at one end with the first rotatable member and at the other end with the power generating system. At least one
20 member for supporting the first and second rotatable shafts therein may be included.

Optionally, a control system including a bypass circuit, a valve, a sensor for detecting rotation of the runner, and a controller for controlling the state of the valve in response to signals received from the sensor and thereby control the fluid flow rates through the turbine device and the bypass
25 circuit. Advantageously, the bypass circuit includes a flexible tube located between two adjoining pipe sections for providing adjustable axial offset.

The material of the flexible tube may be metal or rubber.

30 The cross section of the inlet of the volute may be relatively smaller than the cross section of a main pipe of a fluid supply system for increasing the flow velocity of the fluid flowing over the runner.

The cross section of the exit of the outlet of the volute may be relatively larger than the cross section of the entrance of the outlet of the volute for decreasing the flow velocity of the fluid flowing from out of the runner.

- 5 The axis of the inlet of the volute may be aligned with the axis of the exit of the outlet of the volute.

At least one adjusting member may be installed at the upstream of the turbine device before the inlet of the volute. The adjusting member may decrease the diameter from the fluid supply pipe to the diameter of the inlet of the volute.

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At least one adjusting member may be installed at the downstream of the turbine device after the outlet of the volute. The adjusting member may increase the diameter from the outlet of the volute to the inlet diameter of the fluid supply pipe.

- 15 The first rotatable shaft may be lubricated in the housing by the fluid flowing therethrough.

In a further aspect there is provided a system for generating electrical power from a fluid flow comprising: a turbine device; and a power generating system for converting mechanical energy to electricity.

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In yet a further aspect, there is provided a method for generating electrical power from a fluid flow comprising: directing the fluid flowing through a turbine device; and connecting the turbine device to a power generating system that is operable to generate electricity.

BRIEF DESCRIPTION OF THE DRAWINGS

- 25 In order to describe the manner in which the above-recited and other advantages and features of the disclosure can be obtained, a more particular description of the principles briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only exemplary embodiments of the disclosure and are not therefore to be considered to be limiting of its scope, the principles
30 herein are described and explained with additional specificity and detail through the use of the accompanying drawings.

Preferred embodiments of the present disclosure will be explained in further detail below by way of examples and with reference to the accompanying drawings, in which:-

Figure 1 depicts a schematic diagram of a typical water distribution system with a roof tank for high-rise buildings.

Figure 2 depicts a perspective view of a system for generating electrical power from a fluid flow with a turbine device and a generator according to an embodiment of the present disclosure.

5 Figure 3 depicts a cross-sectional view of a turbine device with a generator according to an embodiment of the present disclosure.

Figure 4 depicts a cross-sectional view of a turbine according to an embodiment of the present disclosure.

10 Figure 5 depicts a pressure simulation diagram of a turbine device according to an embodiment of the present disclosure.

Figure 6 depicts a cross-sectional view of a magnetic coupling arrangement according to an embodiment of the present disclosure.

Figure 7 depicts a perspective view of a turbine device with a control system according to one embodiment of the present disclosure.

15 Figure 8 depicts a schematic flow chart of a turbine device with a control system operating according to one embodiment of the present disclosure.

Figure 9 depicts a diagram of relationship between the power output and the flow rate of a system for generating electrical power from a fluid flow with a turbine device and a generator according to an embodiment of the present disclosure.

20 Figure 10 depicts a diagram of the turbine rotation speed under the adjustment of a control system according to an embodiment of the present disclosure.

Figure 11 depicts a diagram of the output power under the adjustment of a control system according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

25 Various embodiments of the disclosure are discussed in detail below. While specific implementations are discussed, it should be understood that this is done for illustration purposes only. A person skilled in the relevant art will recognize that other components and configurations may be used without departing from the spirit and scope of the disclosure.

Figure 2 shows a perspective view of a system for generating electrical power from a fluid flow with a turbine device and a generator according to one embodiment of the present disclosure. A system 100 for generating electrical power from a fluid flow according to the present disclosure replaces the pressure reducing valve of the prior art as discussed in the background for pressure reduction in a fluid supply pipe and at least partially addresses some problems which are associated with this arrangement.

The system 100 for generating electrical power from a fluid flow comprises a turbine device 60 and a generator 80. The turbine device 60 includes a turbine 20 and a transmission assembly 40.

In this embodiment according to the present disclosure, the turbine 20 includes a housing 30. The volute of the turbine includes a volute inlet 22 and a volute outlet 26. A fluid from a supply pipe flows into the turbine 20 through the volute inlet 22, and then enters into the runner 24 through a volute flow channel 28, and finally leaves the turbine 20 through the volute outlet 26, as shown in Figure 4.

Referring now to Figure 3 there is depicted a cross-sectional view of a turbine device 60 with a generator 80 in the system 100 according to one embodiment of the present disclosure, while Figure 4 shows a cross-sectional view of a turbine according to one embodiment of the present disclosure.

Referring to Figure 3 and Figure 4, a volute, a runner 24 and a first rotatable shaft 32 are located in the housing 30 of the turbine device 60. The runner 24 includes a plurality of blades (not shown).

Advantageously, the volute inlet 22 and volute outlet 26 are configured to be aligned such that the turbine device is easier to install between the fluid supply pipes. It would be appreciated that any arrangement of the volute inlet 22 and volute outlet 26 is possible without departing from the scope of the disclosure.

In the embodiment of Figures 3 and 4, the shape of the cross section of the volute inlet 22 and volute outlet 26 is generally circular. However, it would be appreciated that other cross sectional shapes such as rectangular, hexagonal etc would also be possible for the volute inlet 22 and volute outlet 26 without departing from the scope of the disclosure.

The diameter of the cross section of the entrance 21 of the volute inlet 22 is relatively smaller than that of the fluid supply pipe so that the flow velocity of the fluid increases significantly, which enhances energy extraction of the runner. The volute outlet 26 has an entrance 23 receiving fluid from the runner 24 and an exit 25 for directing the fluid back to the downstream supply pipe. The

diameter of the cross section of the volute outlet 26 expands from the entrance 23 to the exit 25 such that the fluid velocity from the runner decreases in the volute outlet 26 and then flows into the downstream pipe.

In one preferred embodiment, the turbine device 60 is fitted into a municipal fresh water supply system to an apartment. It would be appreciated that the turbine device 60 can be applied to any fluid system, but it is particularly suited to fluid systems which have an excess pressure and which are for distributing fluid for consumption. Advantageously, in one example, the diameter of the volute inlet 22 is 25mm.

When the fresh water enters into the turbine device 60 through the volute inlet 22, the water velocity increases significantly. The diameter of the volute outlet 26 gradually increases from 50mm at the entrance 23 to 65mm at the exit 25. Thus, the velocity of the water from the runner 24 decreases and a low pressure zone occurs in the volute outlet 26, which contributes to the energy extraction from water flow.

Figure 5 shows a pressure simulation diagram of a turbine device according to one embodiment of the present disclosure. This simulation model represents the fluid shape/field flowing in the turbine. The part circled by a rectangular block indicates the fluid in the runner 24, and the remaining part indicates the fluid in the volute. It can be seen from Figure 5 that water pressure reduces gradually from the runner 24 to the volute outlet 26. A small yellow zone indicated by Point A shows a relatively high pressure of the fluid in the volute before entering into the runner and a small blue zone indicated by Point B occurs at the entrance 23 of the volute outlet 26. This small blue zone is a low pressure zone, which allows the runner to extract more energy from the water flow.

It would be appreciated that when fluid (e.g. water) flows through the turbine device 20, the runner 24 extracts energy from the fluid and transfers the energy to the generator 80 through the transmission assembly 40. The volute flow channel 28 is disposed around and proximate to the runner 24, to minimise leakage.

Figure 3 also shows an example internal structure of the system 100. In one embodiment, the turbine 20 further comprises a base plate 27 which is installed over the runner 24 via bolts. One end of the first rotatable shaft 32 is coupled to the runner 24 such that when the fluid flows over the runner 24, the runner 24 drives the first rotatable shaft 32 to rotate relative to the housing 30. A collar member 36 disposed within the housing 30 is about and engageable with the other end of the first rotatable shaft 32. The first rotatable shaft 32 passes through the base plate 27. There

are two bearings holding the first rotatable shaft 32 and a bearing holder 31 is fixed on the base plate 27 for supporting the installation of the first rotatable shaft 32 and the lubrication of the bearings. The fluid can flow in the housing 30 through the base plate 27, which lubricates the mechanical parts in the housing, including the first rotatable shaft 32. The housing 30 includes a cover member 34 for separating and sealing the fluid from the external environment, including the other components of the system.

The transmission assembly 40 is engaged with the housing 30 and comprises a first rotatable member 46, which is magnetically coupled at one end with the collar member 36 within the housing 30 and coupled at the other end to a power generation system such as a generator 80. Advantageously, the transmission assembly 40 further comprises a second rotatable shaft 42, which is engageable at one end with the first rotatable member 46 and at the other end with a power generation system such as a generator 80. A bearing holder 44 is used to fix and support the second rotatable shaft 42. Optionally, a coupling member 48 is arranged between the second rotatable shaft 42 and a power generation system such as a generator 80 for connecting the second rotatable shaft 42 and the shaft of the generator 80.

Figure 6 shows a cross-sectional view of a magnetic coupling arrangement according to one embodiment of the present disclosure. The magnetic coupling is a coupling that transfers torque from one shaft to another one by using a magnetic field rather than a physical mechanical connection.

As shown in Figure 6, the magnetic coupling arrangement comprises the cover member 34 for separating and sealing fluid within the housing 30 from an external environment, the collar member 36 within the housing 30 and the first rotatable member 46 outside the housing 30. Several magnetic poles are inserted into the collar member 36 and the first rotatable member 46, and hence the magnetic coupling arrangement can transfer torque via magnetic field. The cover member 34 separates the collar member 36 within the housing 30 and the first rotatable member 46 outside the housing 30. In this way, leakage of fluid from housing which would inevitably be associated with including a shaft with apertures thereabout would be avoided. This housing is configured to define a flow path which together with the volute separates the fluid within the housing 30 from the external environment.

As the cover member 34 and the collar member 36 directly contact the fluid, the material of the cover member 34 and the collar member 36 can be selected based on the working requirement/fluid to be transported. For example, for fresh water, the material of the cover member 34 can be 316 stainless steel and the collar member 36 should be covered by 316

stainless steel shell. Rather than using shaft seals which wear out and cause the contact surfaces to have friction when sliding against each other, the magnetic coupling arrangement of the present disclosure allows the turbine device to be more reliable and ensure water quality. Additionally, the magnetic coupling arrangement also reduces turbine's starting torque.

5 In one embodiment, the outer diameter of the cover member 34 can be 78mm and the outer diameter of the collar member 36 can be 46mm. The outer diameter of the first rotatable member 46 can be 69.5mm and the diameter of the protruding part of the first rotatable member 46 can be 35 mm. With these example dimensions, the maximum working pressure of the magnetic coupling arrangement is 2.0 MPa and in this case the magnetic coupling arrangement can
10 transmit a maximum torque 3.0 Nm.

When the fluid flows in the turbine 20 and the volute inlet 22 directs fluid to flow into the runner 24, the runner 24 extracts energy from fluid flow and drives the first rotatable shaft 32 as well as the collar member 36, which means the energy is transmitted to the collar member 36 through the bearings and the first rotatable shaft 32. With the magnetic coupling arrangement, the collar
15 member 36 transmits its rotational energy to the first rotatable member 46 by a magnetic field. Finally, the energy is transmitted to the generator 80 by the second rotatable shaft 42 and the coupling member 48 so as to generate electricity.

Figure 7 shows a perspective view of a turbine device with a control system 50 according to one embodiment of the present disclosure. The fluid from a fluid supply pipe 70 flows through the
20 turbine device 60 and rotates the runner 24. When the flow rate of fluid increases, the rotation speed of turbine and water head reduction through the turbine device 60 also increases. Therefore, at higher flow rates, the water head reduction may exceed a desired value, meaning a reduced pressure and therefore a negative influence on a normal water supply. A control system 50 is proposed to address the above problem. The main aim of the control system 50 is to avoid
25 excess water head reduction at higher flow rates by keeping turbine rotation speed in an acceptable range.

In one embodiment, the control system 50 includes a bypass circuit 52, a valve 54, a sensor for detecting rotational speed of the runner, and a controller 56 for controlling the state of the valve 54 in response to the signal received from the sensor and thereby control the fluid flow rates
30 through the turbine device 60 and the bypass circuit 52. The valve 54 can be an electromagnetic control valve. It would be appreciated that any type of valves can be possible without departing from the scope of the disclosure. Optionally, a battery 59 is provided to the controller 56.

The bypass circuit 52 is arranged parallel to the fluid supply pipe 70 and the valve 54 is controlled by the controller 56 and installed in the bypass circuit 52. A sensor is installed in the turbine device 60 to detect rotation speed and send signals to the controller 56. Once the rotation speed is too high, the controller 56 will control the valve 54 to open to some degree, so the flow rate through the turbine device 60 will be reduced and the rotation speed will decrease. A flexible tube 58 is located between two pipe sections of the bypass circuit 52 for compensating offset due to the pipe movement and resulting concentricity errors between adjoining pipe sections. The material of the flexible tube is advantageously a flexible material such as metal or rubber. To connect the fluid supply pipe 70 and the turbine device 60, at least one adjusting member is installed at the upstream of the turbine device 60 before the volute inlet and at least one adjusting member is installed at the downstream of the turbine device 60 after the volute outlet. As shown in Figure 7, an adjusting member 72 decreases the diameter from the fluid supply pipe to the diameter of the inlet of the volute and an adjusting member 74 increases the diameter from the outlet of the volute to the inlet diameter of the fluid supply pipe.

Figure 8 shows a schematic flow chart 200 of a turbine device with a control system 50 according to one embodiment of the present disclosure.

Rotation speed of the turbine relates to the flow rate, so the rotation speed was selected as the controlled parameter in the turbine control strategy.

As can be seen, the control strategy is a closed loop control.

An acceptable rotation speed range, for example 1200-1450rpm, is initially input in the controller 56 in step 202.

Next, in step 204 the real time value of the turbine rotation speed is obtained and sent to the controller 56 by the sensor.

If the rotation speed is in a correct range, as shown in step 206 the state of the valve 54 is not changed.

If the rotation speed exceeds the set range (step 208), the controller 56 will control the valve 54 in the bypass circuit 52 to open it to a larger opening degree (step 210) to permit the water to enter the bypass circuit. This means that the flow rate through the turbine device 60 is reduced and the rotation speed decreases, preferably to the required range.

Alternatively, if the rotation speed is below the required range (step 212), the controller 56 can control the state of the valve 54 to close it to a smaller opening (step 214). Once this occurs, the flow rate through the bypass circuit 52 will be reduced and the turbine rotation speed will increase.

5 By comparing the real rotation speed with the typed range every 10 seconds via the controller 56, the adjustment process can be repeated until the turbine rotation speed stabilises in a given range.

By detecting the turbine rotation speed and controlling the opening degree/state of the valve 54, the flow rates through the turbine device 60 can be controlled, and therefore the water head reduction through the turbine device 60 can also to a large extent be controlled.

10 Figure 9 shows a diagram of relationship between the power output and the flow rate of a system for generating electrical power from a fluid flow with a turbine device and a generator according to one embodiment of the present disclosure. As shown in Figure 9, the output power of the turbine increases substantially linearly with flow rate; and it can be seen that the rated output power for an exemplary turbine arrangement is 110W at 10m³/h.

15 Figure 10 shows a diagram of the turbine rotation speed under the adjustment of a control system according to one embodiment of the present disclosure. Figure 11 shows a diagram of the output power under the adjustment of a control system according to one embodiment of the present disclosure.

20 In the tests of a turbine device according to an embodiment of the disclosure, the rotating speed range is set as 1295-1350 rpm and the flow rate is increased gradually.

Referring to Figures 10 and 11, it can be seen that with the increase of flow rate, the output power and rotation speed also increase gradually. When the rotation speed is more than 1350 rpm, the valve 54 is opened.

25 At the point P, the flow rate decreases sharply, and the output power and rotation speed also decrease significantly. However, after the adjustment of the valve 54, the output power and rotation speed remain in a desired range. In this time series, the water head loss is kept below 22m water by careful selection of valve settings/flow rate.

30 It would be appreciated that the present turbine device and system provides for recovery of kinetic energy from a pressure reduction which inevitably occurs near to apartment buildings/high rise apartments. Typically the turbine device and system of the present system may be fitted inline in potable treated water supplies, as the water flow path is not contaminated by the lubrication oil

which is used for mechanical components. Advantageously, the water flow in the housing is used to provide lubrication of the rotatable shaft in the region separated from the generator.

By contrast, typical turbines used for extracting the kinetic energy from flowing fluid are used in large scale generation system. In such systems, shafts are commonly used to directly connect the turbine and generator, which may cause leakage, friction losses and mechanical abrasion, and hence decrease the overall mechanical efficiency. However, in such environments inefficiencies are not critical in view of the overall scale.

Additionally, a control circuit may be used to adjust the open or close status of wicket gates surrounding the turbine runner so as to control the fluid flowing through the runner. However, such wicket gates are typically bulky and are difficult to adjust based on the flow rate. Furthermore, these large scale systems typically are located upstream of water treatment facilities, meaning that any impurities introduced by the generation process can be addressed by subsequent treatment.

The turbine device and the system for generating electrical power according to the present disclosure has advantages of at least partially addressing the above problems of the existing systems, such as reducing mechanical losses, improving mechanical efficiency, avoiding fluid leakage, more accurate control and is particularly suitable for small scale applications, especially where installed in line just before one or more apartment buildings.

The above embodiments are described by way of example only. Many variations are possible without departing from the scope of the disclosure as defined in the appended claims.

For clarity of explanation, in some instances the present technology may be presented as including individual functional blocks including functional blocks comprising devices, device components, steps or routines in a method embodied in software, or combinations of hardware and software.

Methods according to the above-described examples can be implemented using computer-executable instructions that are stored or otherwise available from computer readable media. Such instructions can comprise, for example, instructions and data which cause or otherwise configure a general purpose computer, special purpose computer, or special purpose processing device to perform a certain function or group of functions. Portions of computer resources used can be accessible over a network. The computer executable instructions may be, for example, binaries, intermediate format instructions such as assembly language, firmware, or source code. Examples of computer-readable media that may be used to store instructions, information used,

and/or information created during methods according to described examples include magnetic or optical disks, flash memory, Universal Serial Bus (USB) devices provided with non-volatile memory, networked storage devices, and so on.

5 Devices implementing methods according to these disclosures can comprise hardware, firmware and/or software, and can take any of a variety of form factors. Functionality described herein also can be embodied in peripherals or add-in cards. Such functionality can also be implemented on a circuit board among different chips or different processes executing in a single device, by way of further example.

10 The instructions, media for conveying such instructions, computing resources for executing them, and other structures for supporting such computing resources are means for providing the functions described in this disclosure.

15 Although a variety of examples and other information was used to explain aspects within the scope of the appended claims, no limitation of the claims should be implied based on particular features or arrangements in such examples, as one of ordinary skill would be able to use these examples to derive a wide variety of implementations. Further and although some subject matter may have been described in language specific to examples of structural features and/or method steps, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to these described features or acts. For example, such functionality can be distributed differently or performed in components other than those identified herein. Rather, the
20 described features and steps are disclosed as examples of components of systems and methods within the scope of the appended claims.

CLAIMS

1. A turbine device comprising:

a turbine including

a housing including a volute configured to direct a fluid flow path over a runner disposed

therein for rotating relative to the housing a first rotatable shaft coupled thereto; and

a transmission assembly configured for engagement with the housing comprising a first rotatable member configured for disposal therein which is configured to be magnetically coupled at one end with the first rotatable shaft and coupled at the other end to a power generation system;

wherein the turbine device is configured for the fluid flow path in the turbine to be excluded from the transmission assembly by the housing.

2. The turbine device of claim 1 wherein, the transmission assembly includes a second rotatable shaft engageable at one end with the first rotatable member and at the other end with the power generating system.

3. The turbine device of claim 2 further comprising at least one member for supporting the first and second rotatable shafts therein.

4. The turbine device of claim 1 further comprising a control system including a bypass circuit, a valve, a sensor for detecting rotation of the runner, and a controller for controlling the state of the valve in response to signals received from the sensor and thereby control the fluid flow rates through the turbine device and the bypass circuit.

5. The turbine device of claim 4 wherein, the bypass circuit includes a flexible tube for location between two adjoining pipe sections for providing adjustable axial offset.

6. The turbine device of claim 5 wherein, the material of the flexible tube is metal or rubber.

7. The turbine device of claim 1 wherein, the cross section of the inlet of the volute is relatively smaller than the cross section of a main pipe of a fluid supply system for increasing the flow velocity of the fluid flowing over the runner.

8. The turbine device of claim 1 wherein, the cross section of the exit of the outlet of the volute is relatively larger than the cross section of the entrance of the outlet of the volute for decreasing the flow velocity of the fluid flowing from out of the runner.

9. The turbine of claim 1 configured for the axis of the inlet of the volute to be aligned with the axis of the exit of the outlet of the volute.

5 10. The turbine device of claim 1 further comprises at least one adjusting member configured to be installed at the upstream of the turbine device before the inlet of the volute.

11. The turbine device of claim 10 wherein the adjusting member decreases the diameter from the fluid supply pipe to the diameter of the inlet of the volute.

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12. The turbine device of any one of the preceding claims further comprising at least one adjusting member configured to be installed at the downstream of the turbine device after the outlet of the volute

15 13. The turbine device of claim 12 wherein the adjusting member increases the diameter from the outlet of the volute to the inlet diameter of the fluid supply pipe.

14. The turbine device of claim 1 configured for the first rotatable shaft to be lubricated in the housing by the fluid flowing therethrough.

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15. A system for generating electrical power from a fluid flow comprising:
a turbine device according to any of claims 1-14; and
a power generating system for converting mechanical energy to electricity.

25 16. A method for generating electrical power from a fluid flow comprising:
directing the fluid flowing through a turbine device according to any of claims 1-14; and
connecting the turbine device to a power generating system that is operable to generate electricity.

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