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Turbine flow meter, assembly, and method for measuring at least one flow characteristic

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The invention relates to an autonomous, low-power turbine flow meter. The invention also relates to an assembly of at least one flow meter according to the invention and at least one signal receiving device configured to receive signals, preferably in a wireless manner, produced and transmitted by said flow meter. The invention further relates to a method for measuring at least one flow characteristic, in particular the flow rate, of a fluid flowing through a flow meter according to the invention.

Turbine flow meter, assembly, and method for measuring at least one flow characteristic

The invention relates to an autonomous, low-power (micro)turbine flow meter. The invention also relates to an assembly of at least one flow meter according to the invention and at least one signal receiving device configured to receive signals, preferably in a wireless manner, produced and transmitted by said flow meter. The invention further relates to a method for measuring at least one flow characteristic, in particular the flow rate, of a fluid flowing through a flow meter, in particular a flow meter according to the invention.

Many different types of flow meters are used in industry and at home. Among these different types of flow meters, the turbine flow meter is one of the most commonly used. A turbine rotor, impeller or rotating member is disposed in the turbine flow meter, wherein the fluid flow, such as the flow rate, is measured by the number of revolutions per time unit of said turbine rotor or impeller. Fluid entering the turbine flow meter causes the rotor to rotate, after which the fluid exits the flow meter.

However, prior art flow meters as described above need external power sources to become operational. Moreover, the known flow meters typically make measurements of fluid flow rates inaccurate. The present invention has been made in an effort to solve at least one of the above problems.

It is an object of the present invention to provide an autonomous, low-power turbine flow meter that can measure at least one flow characteristic, in particular the flow rate, of a fluid flowing through said flow meter, in a relatively accurate manner.

It is another object of the present invention to provide an autonomous, low-power turbine flow meter that can measure at least one flow characteristic, in particular the flow rate, of a fluid flowing through said flow meter, in a reproducible manner.

To achieve at least one of the above objects, the present invention provides an autonomous, low-power (micro)turbine flow meter, comprising: a housing enclosing a single interior channel with a fluid inlet and a fluid outlet, wherein said housing is adapted to be coupled to a and/or accommodated within and/or integrated with a

conduit through which a fluid is caused to flow; at least one turbine held in place by said housing, wherein each turbine comprises: a stator connected to said housing, and an axially rotatable rotor with blades, said rotor being connected to a shaft held in place by at least one bearing element connected to said housing, wherein said

5 rotor is positioned within said single interior channel such that at least a fraction of fluid and/or sufficient fluid (to allow a (proper) flow characteristic measurement), preferably substantially all fluid, led into said single interior channel will flow through the rotor, and wherein said turbine is configured to generate electric energy from fluid flowing through said interior channel, and wherein said turbine is configured to

10 produce at least one flow characteristic related signal related to the fluid flowing through the single interior channel; and at least one electric signal processing circuit powered by said turbine, said circuit comprising at least one signal processing element, wherein at least one signal processing element is configured to process said at least one flow characteristic related signal. The flow meter

15 according to the invention has several advantages. A first advantage of the flow meter according to the invention is that a single interior channel is applied for flow-through of fluid, wherein no branched fluid conduits and/or (dedicated) bypass fluid channels (bypass conduits) are applied within the housing which could cause a fluid fraction to bypass the rotor, as a result of which all fluid fed into the flow meter

20 is led through said single channel from the inlet to the outlet, and hence as a result of which the full fluid fraction, or at least a relevant part of the fluid fraction, contributes to the measuring of at least one flow related characteristic. This leads to a relatively accurate, predictable, repeatable and reproducible measurement of the flow related characteristic of the fluid flow as such. A second advantage is that the

25 single channel in combination with the (axial) reaction turbine enables the use of the flow meter according to the invention over a wide flow range with an acceptable pressure drop, without the need for a bypass channel and/or bypass valve to reduce the pressure drop at higher flow rates. This is due to the less steep pressure drop curve of reaction turbines compared to more commonly used

30 impulse (nozzle) turbines for power generation, which are often used in combination with a bypass channel and bypass valve to reduce the pressure drop at higher flow rates. The fluid passing the bypass channel makes an accurate flow measurement more complex, or even impossible, so a separate flow sensor is used when an accurate flow measurement is needed. Therefore, using the single

35 channel, combined with an (axial) reaction turbine leads to a small, low cost and

accurate flow meter which can be used over a wide flow range without the need for a bypass and without the need for a separate flow sensor. A third advantage of the flow meter according to the invention is that the flow meter, including the housing, turbine, bearings and electronics (in particular the signal processing circuit), is designed to have the maximum efficiency of power generation and with a minimum impact on the flow measurement accuracy, repeatability and reproducibility leading to a compact, predictable, accurate and low cost flow meter which is (re)producible against reasonable cost. Another advantage of the flow meter according to the invention is that the flow meter is designed to operate in an autonomous manner.

5 This means the electrical energy required to power the circuit is generated by and originating from the turbine. Hence, no auxiliary (external) power sources, like batteries or mains power, are required to power the circuit. Batteries are environmental unfriendly and need replacement, leading to higher cost. A connection to the mains power supply requires cabling, which is not always desired and leads to higher costs of installation and sometime to unsafe situations.

10 Moreover, since the flow meter comprises all components to determine one or more fluid flow characteristics, the flow meter is a complete plug-and-play device operating in an autonomous manner. The turbine, also referred to as generator, in particular alternator, used in the flow meter according to the invention is a low-power turbine configured to generate electrical power ranging from several

20 milliWatt to typically 1 watt. The actual power generated is dependent on the number of the revolutions of the rotor (per time interval). Commonly, at least 5 to 200 milliWatt is sufficient to operate the circuit and to generate at least one flow characteristic related signal by means of at least one signal processing element.

25 The stator can for example comprise one or more coils. The rotor is preferably an axial reaction type rotor, with blades and one or more permanent magnets. The flow meter, and in particular the housing, is configured to be coupled to a (first) fluid conduit, such that fluid can flow from the flow conduit into the inlet of the single interior channel of the flow meter. Preferably, the flow meter, and in particular the housing, is configured to be coupled to a fluid conduit, such that fluid leaving the

30 interior channel via the outlet is led into a (second) fluid conduit. The first fluid conduit and the second fluid conduit may actually be formed by the same conduit which is interrupted for insertion or accommodation of the flow meter according to the invention. Coupling the flow meter, in particular the housing, to the fluid conduit

35 can be realized in various manners, for example by means of an internal and/or

external screw thread, a clamp fitting and/or a snap fitting. In the context of this patent document, the expression "fluid conduit" has to be understood broadly and includes the non-limitative examples: fluid conduit pipes, fluid conduit fittings (configured to either directly or indirectly mutually connect fluid conduit pipes), other
5 fluid conduit components, and/or complete fluid conduit applications, such as a water tap or a water shower. The fluid conduit encloses one or more fluid channels through which fluid can flow. In the context of this patent document, the expression "fluid" may relate to a liquid, such as water, and/or may relate to a gas, such as air or natural gas, and/or may relate to a mixture of liquid and gas, such e.g. steam or
10 carbonated liquid. A fluid flowing through the interior channel acts a force onto the (inclined) blades of the axial flow reaction turbine. This force causes the rotor to axially rotate, resulting in generation of alternating current (AC) electrical power by said turbine, which is at least partially used to power the signal processing circuit. An AC voltage and/or AC current is generated by the turbine, wherein the actual
15 AC waveform (sinusoidal waveform) is representative for the rotation speed (i.e. number of revolutions per time unit) of the rotor. In case the fluid flow through the flow meter e.g. becomes stronger, the rotation speed of the rotor will increase, which leads to a relatively dense (strongly fluctuating) AC waveform. Hence, the AC waveform generated by the turbine contains important information relating the
20 actual flow of the fluid, which can be used, and optionally transformed, by at least one signal processing element (also referred to as a processor) to generate at least one (other) flow characteristic related signal, commonly primarily intended for information and/or interpretation and/or control purposes. Hence, the turbine can be considered as signal producing element. Although it is not required that the signal
25 processing element modifies (transforms) the input signal, which may be an AC frequency, generated by the turbine, the signal processing element may have, for example, mere a forwarding function to forward, optionally wirelessly, the input signal unmodified (as raw data) to a signal receiver for e.g. further processing, it is well imaginable that the signal processing element transforms the input signal
30 generated by the turbine. This transformation may, for example, be based on an a simple electronic circuit converting the AC signal into another electric signal and/or a processor using a formula, algorithm and/or a database (table) containing cross-references, to determine a flow characteristic value based on rpm and co-related, possibly already transformed, AC waveform signal (voltage, frequency, etc.). In
35 case the signal processing element is configured to modify (transform) the input

signal received, the signal processing element may also be considered as signal producing element. In the following, reference is typically made to a signal producing element, since it is commonly advantageous to transform the input signal received from the turbine. However, this does not exclude that in the embodiments described below, a (passive) signal processing element (not being configured to transform the input signal received) can be used rather than an (active) signal producing element. The produced flow characteristic related signal(s) may e.g. constitute a flow volume value, a flow rate, and/or a flow direction. Apart from the fact that the AC signal generated by the turbine can be used as input signal for the signal processing element, in particular the signal producing element, other types of input signals can be used. It is, for example, thinkable that the flow meter, and in particular the turbine, is equipped with other input signal producing elements, like (electro)magnetic contacts and/or sensors configured to produce flow characteristic related input signals, such as a magnet mounted by the rotor and a hall sensor or Reed contact mounted by the housing and/or electrical circuit. These (electro)magnetic contacts and/or sensors may be considered as part of the turbine. Hence, the definition of turbine also includes components, parts, sensors, switches, magnets, signal producing elements attached to, integrated (in)to, and/or co-acting with the turbine and more particular the stator and/or the rotor. Alternatively, the flow meter can be equipped with sensors, detection elements, and/or (electro)magnetic contacts configured to generate other signals relating to (other) fluid and/or surrounding environmental characteristics, such as the temperature, humidity, fluid quality, etcetera. Hence, simultaneously (or successively) multiple input signals can be generated, at least one of which relates to the flow characteristic of the fluid and at least one other of which relates to another fluid and/or surrounding environmental characteristic. These input signals may be processed by a plurality of signal processing elements (which may be mutually connected in series and/or in parallel) of the processing circuit, either simultaneously and/or successively, although it is also well conceivable that a plurality, preferably all, input signals are processed, and optionally transformed, by one central signal processing element, in particular one central processing element. The central signal processing element is optionally configured to produce a single output signal, preferably containing a summary and/or calculation (i.e. average or total value) of the input signals, based upon said multiple input signals, enabling the flow meter to produce more complex combinations and/or calculated signals for

example related to the energy in the fluid flow calculated from the flow rate and fluid temperature. Hence, it is imaginable that a first signal producing element is configured to produce a fluid flow rate related signal, and that a second signal producing element is configured to produce a fluid flow direction related signal, and
5 that a third producing element is configured to produce a fluid flow volume related signal. The produced signal(s), i.e. the flow characteristic related signal(s) may, for example be generated and/or calculated and/or transmitted, continuously in time and/or at predefined time intervals. The signals may be used by a central processor to control other components of the circuit and/or may be directly communicated, in particular visualised, to a user of the flow meter and/or to (wirelessly) inform users
10 or other devices and/or (wirelessly) control other devices. Optionally the flow meter may comprise a plurality of the turbines, which may be positioned in line with each other and/or next to each other, as seen in longitudinal or latitudinal direction, causing fluid to flow successively or in parallel through both turbines.

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Preferably, the single interior channel is a substantially linear (straight or curved) channel. A linear channel minimizes the flow resistance for the fluid flow through said channel. Here, the inlet of the channel and the outlet of the channel is positioned in line with each other. The single interior channel and the shaft
20 connected to the rotor preferably extend in substantially the same direction. The shaft connected to the rotor is preferably positioned in the centre of the single interior channel. This configuration commonly leads to an effective axial flow reaction turbine to be used in the flow meter. Since the flow meter according to the invention will typically (also) be used to measure the water flow characteristics of
25 water flowing through a regular water conduit, preferably, the diameter of the single interior channel is smaller than or equal to 22 mm.

In a preferred embodiment, the outer diameter of the rotor substantially corresponds to the inner diameter of the single interior channel. Preferably, the
30 rotor engages an inner surface of the housing and/or wherein the distance between the rotor and an inner surface of the housing is smaller than 0.5 mm. This minimized space between outer edge(s) of the rotor and the inner surface of the housing (inner housing wall), defining the channel, minimizes (undesired) leakages of fluid in between said space. Here, it is preferred that an optional fluid bypass
35 path enclosed by the outer edge(s) of the rotor and the inner surface of the housing

is provided with one or more flow obstacles, such as walls, ridges, and/or flanges, forming a kind of labyrinth, forcing the fluid to follow a non-linear (complicated) path with a relatively high flow resistance, which will force the fluid to flow through the rotor (in between the rotor blades) rather than to bypass the rotor. This leads to a high efficiency, higher power and a stable efficiency, power and flow-rpm relation even in case of rotor position changes or rotor misalignment during production or use (or wear) of the flow meter. Preferably, a labyrinth is used that creates enough flow resistance to enable the use of a relatively big and dirt resistant channel, but with limited flow that bypasses the rotor. Also, preferably a self-regulating labyrinth is used, in which the flow that would bypass the rotor is independent or less dependent on axial or radial movement or misalignment of the rotor. For example, and with reference to figure 4, the flow through the labyrinth is independent of both axial and radial movement or misalignment of the turbine, because the total cross-section surface of the fluid bypass path, and the related fluid flow through the bypass path, will not change when the position of the rotor changes radially or axially. Finally, although it might have a negative impact on the power generated and on the efficiency, it is imaginable that for high flow rate flow meters this bypass will be deliberately used to create a small bypass to reduce the pressure drop at high flow rates.

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The rotor preferably comprises a support structure, also referred to as a rotor casing, enclosing (circumventing/surrounding) the blades of the rotor, wherein said support structure is provided with at least one (multipole) magnet, in particular an annular magnet. Here, it is often advantageous to provide the support structure with a plurality of (dipole) magnets, also known as bar magnets, arranged alternatingly, together forming an annularly shaped (multipole) magnet assembly. Other magnet based arrangements are also conceivable. The housing may comprise an annular accommodating space for accommodating an upper end of the support structure. Such an accommodating space creates a kind of labyrinth, which will increase the flow resistance for the fluid to bypass the rotor (as already addressed above), and which will force the fluid to flow through the rotor.

During rotation of the rotor, the at least one magnet of the rotor co-acts with the stator, leading to the generation of electrical energy. The stator is typically formed by at least one metal (e.g. iron or steel) ring and/or by at least one field winding, in

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particular at least one coil, which is arranged in the axial direction outside the radial projection of the rotor, and claw-pole-like magneto-conductive sheets, preferably 8, 10, 12, 14, or 16 sheets, guided axially in the radial projection of the rotor. The rotor is typically at least partially surrounded by the stator. In an alternative embodiment, during rotation of the rotor, at least one magnet of the rotor co-acts with at least one field winding, in particular at least one coil, which is arranged outside the radial projection of the rotor. Such a field winding may be considered to act as stator. In this embodiment, the field winding leads to no holding torque of the magnet in the stator, leading to a lower starting flow of the turbine and a wider measuring range.

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At least one, and preferably both, bearing elements commonly co-acts with an outer end of the shaft of the rotor. The bearing elements should be sufficiently robust to keep the rotor in place, though are preferably as lean as possible in order to minimize flow resistance for the fluid and bearing friction caused by said bearing elements.

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In order to secure that all fluid flowing through the single interior channel will contribute to the axial rotation of the rotor, it is advantageous that adjacent blades of the rotor overlap each other in longitudinal direction. The blades are preferably regularly oriented with respect to the shaft of the rotor. Typically each rotor comprises 3, 4, 6, 8, or more than 8 blades, although alternative embodiments are also conceivable. Each blade of the rotor preferably has a curved geometry providing each blade a three dimensional design. Preferably, the angle enclosed by an inner portion of each blade and the shaft of the rotor is smaller than the angle enclosed by an outer portion of each blade and the shaft. For the purpose of measuring flow characteristics, this kind of blade design commonly leads to the most accurate flow measuring results. Preferably, the angle enclosed by an inner portion of each blade and the shaft of the rotor is between 0 and 60 degrees, preferably between 30 and 55 degrees. Preferably, the angle enclosed by an outer portion of each blade and the shaft is between 40 and 90 degrees.

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In a preferred embodiment, the flow meter comprises a controllable valve for at least partially closing the single interior channel. By controlling the valve, the interior channel can be fully opened (allowing flow-through of fluid), partially closed or substantially fully closed (preventing fluid to flow-through the flow meter). The

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controllable valve is commonly electronically connected to a central processor of the signal processing circuit. The central processor may control the valve to close the channel, for example in case a flow exceeds a predefined maximum flow. Hence, the central processor may be formed by a signal processing element and/or
5 may be connected, directly or indirectly, to at least one (other) signal processing element, in particular at least one other signal producing element (if applied), configured to control the valve based upon the flow and/or surrounding environment related signal(s), produced by at least one signal processing and/or signal producing element. Also, it is possible that the signal processing circuit,
10 (wirelessly) receives signals from an external device or user, possibly based on its own flow- and/or surrounding environmental related signals, to control the valve. i.e. the flow meter transmits signals relating to the flow of the fluid to a receiver and when a predefined set value is achieved the receiver transmits the command to (partially) close the valve.

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The signal processing element is preferably configured to transform at least one flow related signal into at least one other signal, preferably representative for the flow of the fluid through the single interior channel. The signal processing element may be part of, or may be formed by, aforementioned central processor.

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In a preferred embodiment, the circuit comprises at least one temperature sensor, configured as signal producing element to produce a signal representative for the temperature of the fluid flowing through the single interior channel. By using a temperature sensor, the temperature of the fluid may also be measured and
25 communicated to a user. The same applies in case other types of sensors would be applied in the flow meter, configured to measure other fluid characteristics, like the humidity, quality, pressure, viscosity, translucency of the fluid or other surrounding characteristics.

30 The circuit may comprise at least one signal processor (which may be the same processor as referred to above) and at least one indicator light, wherein the signal processor is configured to control the indicator light, based upon the signal received from at least one signal processing and/or signal producing element and/or to control the light based on externally received signals. Optionally, the light colour
35 generated by the indicator light is controlled by the signal processor, wherein, for

example, green light can be generated during normal operation and red light can be generated in case an abnormal situation is detected (e.g. malfunctioning of the turbine, excessive flow rates, etc.), which allows a user to quickly monitor the actual state and operation of the flow meter.

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The circuit preferably comprises at least one storage for storing electrical energy, in particular a capacitor or a rechargeable battery. This (temporarily) stored energy can be used at moments in time, wherein the turbine does not produce (sufficient) power to power the circuit due to situation wherein no or less fluid flows through the channel and/or when the turbine is shut down to perform a no-load or limited load flow characteristic measurement.

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Preferably, the circuit comprises at least one electronic transmitter configured to transmit at least one signal to an external receiver, wherein the transmitter is preferably configured for wireless communication. The flow meter may (also) comprise at least one electronic receiver configured to receive signals from an external transmitter, preferably via wireless communication. This receiver may be integrated with the signal processor. The received signals may be used or transformed by the signal processor e.g. into an output signal which can be observed by a person. Examples of such output signals are visual signals and/or audio signals. To this end, the unit preferably comprises at least one light generating source and/or at least one sound generation source. Also, the received signals may be used to control the flow meter or parts of the flow meter, for example to control an integrated valve.

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Preferably, the signal processing circuit is configured to regulate, predict and/or measure the electric load of the circuit. The signal processing circuit preferably regulates and/or uses the (actual) electrical load to determine at least one flow characteristic of the fluid. The actual flow characteristic related parameter, such as the rpm which is related to the flow rate, is dependent on the actual load of the electric circuit. A higher electrical load will namely impede rotation of the rotor, while a reduced electrical load (or even no load) allows the rotor to axially rotate in a relatively unhindered manner. By using (e.g. by predefining and/or by regulating and/or by predicting and/or by measuring) the electric load, a flow value, such as the flow rate, can be determined in a relatively simple, accurate, repeatable and

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reproducible manner. Here, the actually measured flow characteristic will typically be determined and/or corrected based upon the influenced and/or actual (predicted) load of the circuit, i.e. by using a correction factor, a (load related) flow-rpm table and/or a (load related) formula or algorithm, which preferably are stored in the memory of the processor. To this end, during measurement of the flow characteristic(s) the load may be reduced to zero, though may also be regulated to a predefined constant or predictable value. It is advantageous in case the electronic circuit comprises an electrical load regulating circuit, which may for example be configured – commonly by using a processor – to (partly) disconnect the load and/or to apply a constant and/or predefined and/or minimum and/or maximum load related parameter value of at least one parameter chosen from the group consisting of: power, voltage, current, load, and impedance. The regulation is commonly an electronic regulation. Since the determination of the desired flow characteristics is commonly dependent on the electrical load of the circuit, regulating said load will commonly improve the simplicity, repeatability, reproducibility and accuracy of the flow characteristic measurement. Consequently, this may also reduce the need for individual calibration of each product, enabling a more simple, reproducible and less costly production process. Especially the no-load or reduced load measurement has the advantage that it, besides eliminating or reducing the influence of the load, it also eliminates or reduces the influence of the variation in generator performance on the flow measurement. In case a continuous (repeating) no load measurement and/or a regulated load measurement are undesirable, these measurement methods can be used periodically to self-calibrate the flow meter and to correct the flow characteristic(s) measurement for load variations and/or generator performance variations, by creating, updating or correcting the formula, algorithm, correction factor and/or cross-reference table, which may be (pre)stored in a memory of the electronic circuit and/or the processor, hence making (individual) measurement and pre-programming of the flow-rpm-load relation and/or (individual) calibration unnecessary, leading to a simpler, less costly, reproducible flow meter.

Preferably, the circuit comprises at least one electrical switch connected to and controllable by at least one signal processor of the circuit. The signal processor may be the same signal processor as referred to above. The application of one or more electrical switches makes it possible to disconnect at least a part of the

electric circuit from the turbine, and preferably also of the signal producing element, which reduces the electrical load of the circuit impeding rotation of the rotor.

Preferably the load is reduced to zero, or at least to a predefined (known) reduced load. This temporary disconnection allows the rotor to rotate more freely (more
5 unhindered) during the period of measuring one or more flow characteristics, which is commonly in favour of the accuracy of the measurement results. Preferably, the electrical load is reduced and/or influenced for a certain period before the actual flow characteristic measurement is done. The duration of this period can be related
10 to the time needed to increase and/or stabilize the speed of the rotor, which can be defined by a fixed period of time in seconds (e.g. 3, 5, or 10 seconds) and/or by monitoring and/or calculating and/or predicting the increase and/or stabilization of the speed of the rotor.

It is also conceivable to measure and/or calculate and/or predict the load during the
15 measurement of the fluid flow, in order to subsequently calculate, determine, and/or correct the measured flow characteristic value(s) based upon the measured and/or calculated and/or predicted load. Commonly, there will be a known relation between load and flow characteristics, which relation may be stored, for example as a formula, algorithm or a cross-reference table, which may be (pre)stored in a
20 memory of the electronic circuit and/or the memory of the processor. Commonly, there will be a known relation between load, rpm and flow characteristics, which relation may be defined in a formula (algorithm) and/or which may be stored, for example as cross-reference table, in a database (e.g. a flow-rpm-load database), which database may be (pre)stored in a memory of the electronic circuit and/or the
25 memory of the processor.

The invention also relates to an assembly of at least one flow meter according to the invention and at least one signal receiving device configured to receive signals produced and transmitted by said flow meter. Preferably, the flow meter and at
30 least one signal receiving device are configured to communicate wirelessly.

The invention further relates to a method for measuring at least one flow characteristic, in particular the flow rate, of a fluid flowing through a flow meter according to the invention, comprising the steps of: A) allowing a fluid to flow
35 through the single interior channel causing the fluid to act a force onto the blades of

the rotor resulting in axial rotation of the rotor and the generation of alternating current (AC) electrical energy, wherein the alternative current and/or the alternating voltage (AC voltage) is representative for the number of revolutions (rpm) of the rotor, and wherein substantially all fluid, or at least sufficient fluid (e.g. >90% of the total fluid flowing through led into the interior channel), flows through the rotor, B) powering at least one electric signal processing circuit by said electrical energy, C) detecting the number of revolutions (rpm) of the rotor by means of said circuit, and D) producing at least one flow characteristic, in particular flow rate, related signal related to the fluid flowing through the single interior channel, based upon the detected number of revolutions (rpm) of the rotor, and based upon a predefined relation between the number of revolutions (rpm) of the rotor and said flow characteristic, in particular the flow rate. Steps A) and B) and C), and optionally D), may overlap in time. Preferably, during step C) the turbine operates either substantially without electric load of the circuit or with a, preferably regulated, predefined (constant) electric load of the circuit. Preferably, during step C) the electrical load of the circuit is measured and/or predicted and/or calculated, and wherein during step D) at least one flow characteristic, in particular flow rate, related signal related to the fluid flowing through the single interior channel is produced, which is based upon the detected number of revolutions per time unit (typically per minute) (rpm) of the rotor, and which is based upon a predefined relation between the (rpm) of the rotor and said flow characteristic, in particular the flow rate, and which is based upon the electrical load measured and/or predicted and/or calculated during step C). During step D) an electrical load dependent flow characteristic correction factor is preferably retrieved from a prestored cross-reference database (e.g. a flow-rpm database or a flow-rpm-load database) to correct the measured flow characteristic based upon the load detected during step C). Alternatively, during step D) an electrical load dependent flow characteristic correction factor may be calculated by using one or more algorithms (formulas). Disconnecting and/or regulating and/or predicting and/or measuring of the electrical load of the circuit allows the flow-meter to be subjected to a self-calibration based upon the electrical load measured, predicted and/or predefined (preset) during step C). The load regulations described above typically can have the advantage, that they can be used to limit the generated energy and to not generate more energy than strictly is needed for the flow meter functions, which prevents the electric circuit to heat up which is positive for the life time and impact on the optional

temperature measurement, also not generating more energy than needed increases the life time of hydraulic mechanical components like bearings and rotor blades because the forces and stresses are minimized.

- 5 The invention will be elucidated on the basis of non-limitative exemplary embodiments shown in the following figures. Herein shows:
- figure 1 a schematic representation of a turbine flow meter according to the invention;
- figure 2a a side view of a second embodiment of a turbine flow meter according to
10 the invention;
- figure 2b a cross section of the turbine flow meter shown in figure 2a;
- figure 3a a cross section of a first possible embodiment of a turbine according to the invention;
- figure 3b a cross section of a second possible embodiment of a turbine according
15 to the invention;
- figure 3c a cross section of a third possible embodiment of a turbine according to the invention;
- figure 3d a cross section of a fourth possible embodiment of a turbine according to the invention;
- 20 figure 4 a cross section of a fifth possible embodiment of a turbine according to the invention;
- figure 5 a scheme of the electrical circuitry powered by a turbine according to the invention;
- figure 6 is related to figure 5 and shows a flow chart for low flow conditions; and
25 figure 7 is related to figure 5 and shows a flow chart for high flow conditions;

Figure 1 shows an autonomous, low-power turbine flow meter (100) according to the invention, comprising a housing (101) enclosing a single interior channel (102) with a fluid inlet (103) and a fluid outlet (104), wherein said housing (101) is
30 adapted to be coupled to a conduit (not shown) through which a fluid is caused to flow. The turbine flow meter (100) further comprises a turbine (105) held in place by said housing (101), wherein the turbine (105) comprises a stator (106) connected to said housing (101) and a rotor (107) with blades (108a, 108b). The rotor (107) is connected to an axially rotatable shaft (109) held in place by bearing elements
35 (110a, 110b) connected to the housing (101). In the shown embodiments the upper

bearing (110a) is an integral part of the housing (101b), whereas the lower bearing (110b) is a separate element which is connected to the housing (101). The rotor (107) is positioned within the single interior channel (102) such that substantially all fluid led into said single interior channel (102) will flow through the rotor (107). The turbine (107) is configured to generate electric energy from fluid flowing through said interior channel (102). The flow meter (100) comprises an electric signal processing circuit (111) powered by said turbine (107), said circuit (111) comprising at least one signal processing element, more particular at least one signal producing element (116), which is configured to process at least one flow characteristic related signal related to the fluid flowing through the single interior channel (102). At least one flow characteristic related signal is produced by the turbine itself during flow of fluid through the single interior channel (102) causing the rotor (107) to axially rotate. The single interior channel (102) is a substantially linear channel and is tapered towards the rotor (107). In the shown embodiment, the housing (101) consists of two separate housing parts (101a, 101b) which are watertight connected to each other via a sealing ring (112). The upper part of the housing (101a) and the lower part of the housing (101b) can also be an integral part of a housing (101) made of one piece. The rotor (107) comprises a support structure (113) which encloses the blades (108a, 108b) of the rotor (107). The support structure (113) is provided with a multipole magnet (114) or a plurality of bi-pole magnets (114). In the shown configuration the plurality of magnets (114) forms an annular magnet assembly (114). The stator (106) has an annular configuration and substantially circumvents the rotor (107). The stator (106) comprises a second support structure (118).

The electrical signal processing circuit (111) of the flow meter (100) is connected to the stator (106), for example with a coil inside the stator (106). A LED indicator light (117) is connected to and regulated by the electrical signal processing circuit (111). The LED indicator light (117) can for example have lighting colours and/or light intensity dependent on energy consumption, flow rate, temperature and/or water consumption. Furthermore, a temperature sensor (122), which may also be formed by another type of sensor, is connected to the electrical processing circuit (111). Both end parts of the housing (101) are provided with coupling means (115a, 115b) for coupling for example a conduit (not shown). In the shown embodiment, the upper part of the housing (101a) comprises coupling means (115a) in the form of screw thread (115a) which is provided inside the upper part of the housing (101a).

The lower part of the housing (101b) comprises coupling means (115b) in the form of screw thread (115b) which is provided on the outer diameter of the end part of the lower housing part (101b). The coupling means (115a, 115b) are arranged for coupling complementary coupling means (115a, 115b). The coupling means can be
5 any type of suitable coupling means for conduits and the like, but can also be part of a complete fluid conduit application like for example a faucet or shower. The housing comprises an annular accommodating space (120) for accommodating an upper end of the support structure (113) of the rotor (107). In the shown embodiment this accommodating space (120) is located in the lower part of the
10 housing (101b). The upper part of the housing (101a) comprises a third annular accommodating space (119) for accommodating at least part of the electrical signal processing circuit (111) and/or for example a battery (not shown) to be charged by the turbine. The lower part of the housing (101b) comprises a second annular accommodating space (121) for accommodating the stator (106). The third annular
15 accommodating space (119) is located between the wall of the single interior channel (102) and the outer wall of the housing (101).

Figures 2a and 2b show a schematic representation of a second embodiment of a turbine flow meter (200) according to the invention. Figure 2a shows a side view of
20 the turbine flow meter (200). Figure 2b shows a cross section of the turbine flow meter (200) shown in Figure 2a. The turbine flow meter (200) comprises a housing (201) consisting of an upper housing part (201a) and a lower housing part (201b). Both housing parts (201a, 201b) are mutually coupled. A watertight coupling between the upper housing part (201a) and the lower housing part (201b) is
25 obtained by the use of a sealing ring (212). The autonomous, low-power flow turbine (200) comprises a turbine (205). The turbine (205) comprises a stator (206) and a rotor (207). The rotor (207) comprises a plurality of blades (208). The blades (208) are preferably curved blades, as this leads to a good power output and a high efficiency. Furthermore, the curved blade rotor has a stable and predictable flow
30 rate versus speed relation. The housing (201) encloses a single interior channel (202) with a fluid inlet (203) and a fluid outlet (204), wherein said housing (201) is adapted to be coupled to a conduit (not shown) through which a fluid is caused to flow. The inner diameter of the single interior channel (202) substantially corresponds to the outer diameter of the rotor (207). In the shown embodiment, a
35 plurality of dipole magnets (214) forms an annular magnet assembly (214) at the

rotor (207). However, the annular magnet assembly (214) can possibly also be formed by a multipole magnet. The rotatable shaft (209) which is connected to the rotor (207) extends in substantially the same direction as the single interior channel (202). The shaft (209) is positioned in the centre of the single interior channel (202).

5 The shaft (209) is held in place by bearing element (210a, 210b) connected to the housing (201). In the shown embodiment the combination of the bearing elements (210a, 210b) and the rotatable shaft (209) have a substantially symmetric configuration. The housing (201) comprises two contact holes (221a, 221b) which are provided in the lower part of the housing (201b). The contact holes (221a,
10 221b) are arranged for enabling an electrical connection. In the shown embodiment, the housing (201) comprises an outer flange (222). In particular, both the upper housing part (201a) and the lower housing part (201b) comprise an outer flange (222a, 222b) at an outer end of the housing part (201a, 201b). However, it is also possible that the housing (201) of the flow meter (200) has a diameter
15 substantially equal to the diameter of the connected conduit parts (not shown) as to be substantially fully integrated in the conduit. Both end parts of the housing (201) are provided with coupling means (215a, 215b) for coupling for example a conduit (not shown).

The flow meter (200) further comprises an electric signal producing circuit
20 according to the invention (not shown) which is powered by the turbine (205).

Figures 3a-d show cross sections of possible embodiments of a turbine (305a-d) according to the invention applicable in a flow meter according to the invention. In specific, the turbines (305a-d) are axial flow reaction turbines (305a-d). The
25 turbines (305a-d) are held in place by a housing (301a-d). The rotor (307a-d) of each turbines (305a-d) is provided with 3 or 4 blades (308a-j), a number of which are shown in the figures. Adjacent blades of the rotor configurations of figures 3a and 3d overlap each other in longitudinal direction. The blades (308a-j) have a curved geometry. The angle enclosed by an inner portion of each blade (308a-j)
30 and the shaft (309a-d) of the rotor (307a-d) is smaller than the angle enclosed by an outer portion of each blade (308a-j) and the shaft (309a-d). An important aspect of the turbines (305b-d) is that they are designed to prevent internal leakage, e.g. fluid flowing in and through an undesired fluid path. Internal leakage is disadvantageous for the efficiency and accuracy of the flow meter. The arrows
35 (323) indicate the direction of the incoming fluid. This is the desired direction of the

fluid flow. The arrows (324) show the fluid following an undesired fluid path causing an undesired leakage. The most straightforward positioning of the rotor (305a) in the housing (301a) is shown in figure 3a. As can be seen is internal leakage relatively easy to occur as the fluid flow (323) can relatively easy follow the

5 undesired fluid path. Figures 3b-3d show that the turbines (305b-d) comprise a labyrinth configuration. This labyrinth construction ensures minimal leakage by introducing a number of obstructions (325a-d) into the undesired fluid path. The obstructions (325a-d) cause a minimization of the internal leakage and a

10 minimization of the internal leakage variation, caused by axial or radial position changes and/or misalignment of the rotor caused during design (tolerance build up), production (variation) or use (bearing wear). The obstructions (325a-d) prevent that internal leakage which occurs due to design, production and use as described above. The labyrinth construction can be fully integrated in a support structure (313a-d) of the rotor (307a-d). Although, it is preferred that part of the labyrinth

15 construction is integrally part of the housing (301a-d). The labyrinth construction is configured to change the direction of the leakage fluid and/or to obstruct the pathway of the leakage fluid. The labyrinth construction is preferably designed such that reducing the size of the channel is not necessary, as a significant reduction of the size of the channel would negatively impact the dirt resistance of the turbine.

20

Figure 4 shows a cross section of a fifth possible embodiment of a turbine (405) according to the invention, which is applicable in a flow meter according to the invention. The turbine (405) comprises a housing (401) which can be accommodated in a conduit (not shown). The turbine (405) comprises an axially

25 rotatable rotor (407) which is provided with multiple blades (408a, 408b). The rotor (407) is (slightly) displaceable in axial and radial direction within said housing (401). Hence, some play is present between the rotor (407) and the housing (401). Also the rotor (407) position (orientation) and alignment can vary in axial and radial direction due to variances in the production and assembly process and due to wear

30 (e.g. of the bearings). The turbine (405) is provided with a labyrinth construction comprising two labyrinth components bilaterally engaging the rotor (407). Due to the presence of the play between the rotor (407) and the housing (401), leading to (slight) displaceability of the rotor (407) within the housing (401), the labyrinth construction applied functions as a self-regulated labyrinth, in which the fluid flow,

35 and the fluid flow resistance, through said labyrinth is substantially independent of

the position (orientation) of the rotor. The flow through the labyrinth is independent of both axial and radial movement or misalignment of the turbine (405), because the total cross-section surface of the fluid bypass path (424), and the related fluid flow through the bypass path, will not change when the position of the rotor (407) changes radially or axially. The arrows (423a) indicate the direction of fluid flowing into the turbine (405). Arrows (423b) indicate the direction of fluid leaving the turbine (405).

Figure 5 shows a scheme of the electrical circuit powered by a turbine according to the invention. The generator GEN1 producing an alternating current AC is coupled to a bridge rectifier B1. The resulting rectified voltage is applied via switch S1 to a storage capacitor C1 and energy consuming load Rload. Rload is preferably formed by at least one (central) processor P and/or a transmitter T and/or receiver R. The (central) processor P uses the signal of voltage monitor means M1 (voltage meter) to set switch S1 and S2 and uses the signal of Amplifier A1 for measuring a flow characteristic. Voltage meter M1 is monitoring the voltage on the storage capacitor. It is conceivable that the processor P is configured to measure voltage (and therefore may act as voltage meter) and/or is configured to act as amplifier. The storage capacitor is chosen large enough to be able to store sufficient energy for short amounts of time, for example to turn on a radio transceiver to transmit a short message with sensor data. Switch S2 can be closed when not enough voltage is present due to for example a low fluid flow. Then the rectifier B1 acts as a voltage doubler. The value of the capacitor C2 can be chosen such that the inductance of the generator GEN1 is resonating at the frequency or rpm where the highest efficiency is needed; the effect of capacitor C2 is to improve the power factor of the generator, while in voltage doubling mode. The switch S1 is also used to protect the load and capacitor against excessive voltages caused by very high flowrates. When a too high voltage is detected on C1 by voltage meter M1, the switch is opened and the system and load is supplied from the energy in the storage capacitor C1, until the voltage on C1 needs to be replenished by the generator. The voltage meter M1 is initiating the closure of the switch as well. A means of measuring the speed in rpm of the generator is provided by amplifier A1 (acting as signal processing element) converting the generator signal to a square wave signal that can be processed by the subsequent processor (also acting as signal processing element). In case a no-load or reduced load flow measurement is

desired, switch S1 can also be used to disconnect or reduce the load by the processor for a period needed to perform a measurement and/or based on for example voltage meter M1 and/or amplifier A1 related information. For other load using measurements, as described earlier, not described here, additional
5 electronics are needed to regulate, predict and measure the load. The processor is also used to perform the fluid flow characteristic(s) measurement(s) based on a predefined and/or stored relation between the rpm related signals, for example the signal A1 or other sensor signals and/or the (actual) load and/or prediction or
10 calculation of the load, and the fluid flowrate through the flow meter, as described in more detail earlier. Optionally, one or more sensors (S) (of which only a single sensor is shown) may be incorporated in the electrical circuit to detect other parameters, like for example environmental parameters (temperature, humidity, etcetera).

15 Figure 6 is related to figure 5 and shows a possible flow chart for low flow conditions. The flow chart shows that the voltage doubler switch S2 is closed when a too low voltage is detected. Switch S2 is opened when a higher voltage is detected and then the diode bridge (bridge rectifier B1) is used to rectify the voltage. The predetermined values of the minimum and maximum allowable
20 voltage can depend on specific conditions.

Figure 7 is related to figure 5 and shows a flow chart for high flow conditions. The flow chart shows that the switch S1 is closed when a too high voltage is detected. The voltage monitor M1 is arranged to protect the electronic circuitry in case of
25 excessive flow conditions. The predetermined values of the maximum allowable voltage can depend on specific conditions.

It will be apparent that the invention is not limited to the working examples shown and described herein, but that numerous variants are possible within the scope of
30 the attached claims that will be obvious to a person skilled in the art.

The above-described inventive concepts are illustrated by several illustrative embodiments. It is conceivable that individual inventive concepts may be applied without, in so doing, also applying other details of the described example. It is not
35 necessary to elaborate on examples of all conceivable combinations of the above-

described inventive concepts, as a person skilled in the art will understand numerous inventive concepts can be (re)combined in order to arrive at a specific application.

- 5 The verb "comprise" and conjugations thereof used in this patent publication are understood to mean not only "comprise", but are also understood to mean the phrases "contain", "substantially consist of", "formed by" and conjugations thereof.

Conclusies

1. Autonome, laag vermogen turbinedebietmeter, omvattende:
 - een behuizing die een enkel intern kanaal met een fluïduminlaat en een fluïdumuitlaat omsluit, waarbij voornoemde behuizing is ingericht om gekoppeld te worden met en/of opgenomen te worden in een leiding waarin een fluïdumstroom tot stand is gebracht;
 - ten minste één turbine die op haar plaats wordt gehouden door voornoemde behuizing, elke turbine omvattende:
 - o een stator verbonden met voornoemde behuizing, en
 - o een axiaal roteerbare rotor met bladen, waarbij voornoemde rotor verbonden is met een as die op zijn plaats wordt gehouden door ten minste één met voornoemde behuizing verbonden lagerelement, waarbij voornoemde rotor zodanig in voornoemd enkele interne kanaal is gepositioneerd dat ten minste een fluïdumfractie, bij voorkeur in hoofdzaak alle fluïdum, dat naar voornoemd enkel intern kanaal geleid wordt, door de rotor zal stromen, en waarbij voornoemde turbine is ingericht om elektrische energie te genereren uit door voornoemd enkele interne kanaal stromend fluïdum, en waarbij voornoemde turbine is ingericht om ten minste één stromingskarakteristiek gerelateerd signaal voort te brengen dat gerelateerd is aan het fluïdum dat door het enkele interne kanaal stroomt, en
 - ten minste één elektrisch signaalverwerkend circuit aangedreven door voornoemde turbine, waarbij voornoemde circuit ten minste één signaalverwerkend element omvat, waarbij ten minste één signaalverwerkend element is ingericht om voornoemd ten minste ene stromingskarakteristiek gerelateerde signaal te verwerken.

2. Debietmeter volgens conclusie 1, waarbij het enkele interne kanaal een in hoofdzaak lineair kanaal is.

3. Debietmeter volgens conclusie 1 of 2, waarbij het enkele interne kanaal en de met de rotor verbonden as zich in hoofdzaak in dezelfde richting uitstrekken.

4. Debietmeter volgens een van de voorgaande conclusies, waarbij de met de rotor verbonden as in het midden van het enkele interne kanaal is gepositioneerd.
5. Debietmeter volgens een van de voorgaande conclusies, waarbij de
5 buitendiameter van de rotor in hoofdzaak overeenkomt met de binnendiameter van het enkele interne kanaal.
6. Debietmeter volgens een van de voorgaande conclusies, waarbij de rotor
aangrijpt op een inwendig oppervlak van de behuizing en/of waarbij de afstand
10 tussen de rotor en een inwendig oppervlak van de behuizing kleiner is dan 0,1 mm.
7. Debietmeter volgens een van de voorgaande conclusies, waarbij de rotor
een draagstructuur omvat die de bladen van de rotor omsluit, waarbij voornoemde
draagstructuur is voorzien van ten minste één magneet, in het bijzonder een
15 ringvormige magneet.
8. Debietmeter volgens conclusie 7, waarbij voornoemde draagstructuur is
voorzien van een magneet met meerdere polen en/of een meervoud aan
magneten, in het bijzonder dipoolmagneten, die samen een ringvormige
20 magneetsamenstelling vormen.
9. Debietmeter volgens conclusie 7 of 8, waarbij de behuizing een ringvormige
opneemruimte omvat voor het opnemen van een bovenste einde van de
draagstructuur.
25
10. Debietmeter volgens een van de conclusies 7-9, waarbij de ten minste ene
magneet van de rotor, ten minste tijdens rotatie van de rotor, samenwerkt met de
stator.
- 30 11. Debietmeter volgens een van de voorgaande conclusies, waarbij de stator is
ingericht om ten minste een deel van de rotor te omringen.
12. Debietmeter volgens een van de voorgaande conclusies, waarbij ten minste
één lagerelement samenwerkt met een buitenste einde van de as van de rotor.

13. Debietmeter volgens een van de voorgaande conclusies, waarbij aangrenzende bladen van de rotor elkaar in lengterichting overlappen.
14. Debietmeter volgens een van de voorgaande conclusies, waarbij de bladen
5 van de rotor regelmatig georiënteerd zijn ten opzichte van de as van de rotor.
15. Debietmeter volgens een van de voorgaande conclusies, waarbij de bladen van de rotor een gekromde geometrie hebben.
- 10 16. Debietmeter volgens een van de voorgaande conclusies, waarbij de hoek die ingesloten wordt door een binnenste deel van elk blad en de as van de rotor kleiner is dan de hoek die ingesloten wordt door een buitenste deel van elk blad en de as.
- 15 17. Debietmeter volgens een van de voorgaande conclusies, waarbij aangrenzende bladen van de rotor elkaar in lengterichting overlappen.
18. Debietmeter volgens een van de voorgaande conclusies, waarbij elke rotor is voorzien van 3, 4, 6 of 8 bladen.
20
19. Debietmeter volgens een van de voorgaande conclusies, waarbij de debietmeter in hoofdzaak vrij is van iedere bypass-leiding verbonden met voornoemd enkele interne kanaal.
- 25 20. Debietmeter volgens een van de voorgaande conclusies, waarbij door ten minste één buitenste rand van de rotor en een binnenoppervlak van de behuizing een niet-lineair fluïdumbypasspad wordt omsloten.
21. Debietmeter volgens een van de voorgaande conclusies, waarbij de
30 diameter van het enkele interne kanaal kleiner is dan of gelijk is aan 22 mm.
22. Debietmeter volgens een van de voorgaande conclusies, waarbij de debietmeter een regelbare klep omvat voor het ten minste gedeeltelijk afsluiten van het enkele inwendig kanaal.

23. Debietmeter volgens een van de voorgaande conclusies, waarbij ten minste één van voornoemd signaalverwerkend element is ingericht voor het voortbrengen van ten minste één stromingssnelheidkarakteristiek gerelateerd signaal dat gerelateerd is aan de stromingssnelheid van het fluïdum dat door het enkele interne kanaal stroomt.
5
24. Debietmeter volgens een van de voorgaande conclusies, waarbij ten minste één van voornoemd signaalverwerkend element is ingericht voor het voortbrengen van ten minste een stromingsrichtingkarakteristiek gerelateerd signaal dat gerelateerd is aan de stromingsrichting van het fluïdum dat door het enkele interne kanaal stroomt.
10
25. Debietmeter volgens een van de voorgaande conclusies, waarbij het signaalverwerkend element is ingericht voor het omzetten van ten minste één stroming gerelateerd signaal in ten minste één ander signaal, dat bij voorkeur representatief is voor de stroming van het fluïdum door het enkele interne kanaal.
15
26. Debietmeter volgens conclusie 22 en conclusie 25, waarbij ten minste één van voornoemde signaalverwerkende elementen is ingericht voor het regelen van de klep op basis van het stroming gerelateerde signaal dat is voortgebracht door ten minste één signaalverwerkend element.
20
27. Debietmeter volgens een van de voorgaande conclusies, waarbij het circuit ten minste één sensor omvat, die ingericht is als signaalverwerkend element voor het produceren van een signaal dat representatief is voor ten minste één fluïdumkarakteristiek, anders dan een stromingskarakteristiek, van het fluïdum dat door het enkele interne kanaal stroomt.
25
28. Debietmeter volgens een van de voorgaande conclusies, waarbij het circuit ten minste één indicatorlicht omvat, waarbij ten minste één signaalverwerkend element is ingericht voor het regelen van het indicatorlicht, op basis van het signaal dat is ontvangen van voornoemd ten minste ene signaalverwerkend element.
30
29. Debietmeter volgens een van de voorgaande conclusies, waarbij de turbine is ingericht voor het genereren van ten minste één sinusvormige golfvorm, waarbij
35

voornoemde golfvorm elektrische energie vormt die door voornoemde turbine is gegeneerd, en waarbij voornoemde golfvorm fungeert als stromingskarakteristiek gerelateerd signaal dat gerelateerd is aan het fluïdum dat door het enkele interne kanaal stroomt.

5

30. Debietmeter volgens een van de voorgaande conclusies, waarbij het circuit ten minste één opslag voor het opslaan van elektrische energie omvat, in het bijzonder een condensator of een batterij.

10

31. Debietmeter volgens een van de voorgaande conclusies, waarbij het circuit ten minste één schakelaar voor het loskoppelen van elektrische belasting en/of ten minste één schakelaar voor het reduceren van elektrische belasting omvat, verbonden met en regelbaar door ten minste één signaalverwerkend element, en/of waarbij het circuit ten minste één constante belasting omvat.

15

32. Debietmeter volgens een van de voorgaande conclusies, waarbij het signaalverwerkend circuit een elektrische belasting regelend circuit omvat.

20

33. Debietmeter volgens een van de voorgaande conclusies, waarbij het signaalverwerkend circuit is ingericht voor het reguleren en/of het gebruiken van de werkelijke elektrische belasting, bij voorkeur voor het bepalen van ten minste één stromingskarakteristiek van het fluïdum.

25

34. Debietmeter volgens een van de voorgaande conclusies, waarbij het signaalverwerkend circuit een elektrisch belasting regelend circuit en/of een belasting voorspellend en/of belasting metend circuit omvat, bij voorkeur voor het bepalen van ten minste één stromingskarakteristiek van het fluïdum.

30

35. Debietmeter volgens een van de voorgaande conclusies, waarbij het signaalverwerkend circuit is ingericht voor het reguleren, voorspellen en/of meten van de elektrische belasting van het circuit, bij voorkeur voor het bepalen van ten minste één stromingskarakteristiek van het fluïdum.

35

36. Debietmeter volgens een van de voorgaande conclusies, waarbij het signaalverwerkend circuit een elektrische belasting regulerend circuit en/of

belasting voorspellend en/of belasting metend circuit omvat, bij voorkeur voor het bepalen van ten minste één stromingskarakteristiek van het fluïdum.

5 37. Debietmeter volgens een van de voorgaande conclusies, waarbij het circuit ten minste één elektronische zender omvat die ingericht is voor het uitzenden van ten minste één signaal naar een externe ontvanger, waarbij de zender bij voorkeur is ingericht voor draadloze communicatie.

10 38. Debietmeter volgens een van de voorgaande conclusies, waarbij het circuit ten minste één elektronische ontvanger omvat die ingericht is voor het ontvangen van signalen van een externe zender, bij voorkeur via draadloze communicatie.

15 39. Debietmeter volgens een van de voorgaande conclusies, waarbij de turbine een axiale reactieturbine is.

40. Samenstel van ten minste één debietmeter volgens een van de voorgaande conclusies en ten minste één signaalontvangende inrichting ingericht voor het ontvangen van signalen die zijn voorgebracht en verzonden door voornoemde debietmeter.

20 41. Samenstel volgens conclusie 40, waarbij de debietmeter en ten minste één signaalontvangende inrichting zijn ingericht om draadloos te communiceren.

25 42. Werkwijze voor het meten van ten minste één stromingskarakteristiek, in het bijzonder de stromingssnelheid, van een fluïdum dat door een debietmeter volgens een van de conclusies 1-39 stroomt, omvattende de stappen:

30 A) het toestaan dat een fluïdum door het enkele interne kanaal stroomt, waardoor het fluïdum een kracht uitoefent op de bladen van de rotor resulterende in een axiale rotatie van de rotor en de opwekking van een wisselstroom (AC) en/of een wisselspanning (AC spanning) elektrische energie, waarbij de wisselstroom en/of wisselspanning representatief is voor het aantal omwentelingen per tijdseenheid, in het bijzonder het aantal omwentelingen per minuut (rpm), van de rotor, en waarbij in hoofdzaak alle fluïdum, of ten minste voldoende fluïdum, door de rotor stroomt,

- B) het aandrijven van ten minste één elektrisch signaal verwerkend circuit met voornoemde elektrische energie,
- C) het detecteren van het aantal omwentelingen (rpm) van de rotor door middel van voornoemd circuit, en
- 5 D) het voortbrengen van ten minste één stromingskarakteristiek gerelateerd, in het bijzonder stromingssnelheid gerelateerd, signaal dat gerelateerd is aan het fluïdum dat door het enkele interne kanaal stroomt, op basis van het gedetecteerde aantal omwentelingen (rpm) van de rotor, en op basis van een vooraf bepaalde verhouding tussen het aantal omwentelingen (rpm) van
- 10 de rotor en voornoemde stromingskarakteristiek, in het bijzonder de stromingssnelheid.

43. Werkwijze volgens conclusie 42, waarbij stappen A) en B) en B), en eventueel D), in de tijd overlappen.

15

44. Werkwijze volgens conclusie 42 of 43, waarbij tijdens stap C) de turbine ofwel in hoofdzaak zonder elektrische belasting van het circuit, of met een, bij voorkeur gereguleerde, vooraf gedefinieerde belasting, in het bijzonder een constante belasting, van het circuit functioneert.

20

45. Werkwijze volgens een van de conclusies 42-44, waarbij tijdens stap D) ten minste één stromingskarakteristiek gerelateerd, in het bijzonder stromingssnelheid gerelateerd, signaal dat gerelateerd is aan het fluïdum dat door het enkele interne kanaal stroomt wordt voortgebracht, op basis van het gedetecteerde aantal

25 omwentelingen per tijdseenheid (rpm) van de rotor, en op basis van een vooraf bepaalde verhouding tussen het aantal omwentelingen per tijdseenheid (rpm) van de rotor en voornoemde stromingskarakteristiek, in het bijzonder de stromingssnelheid, en op basis van de tijdens stap C) toegepaste elektrische belasting.

30

46. Werkwijze volgens een van de conclusies 42-45, waarbij tijdens stap C) de elektrische belasting van het circuit wordt gemeten, en waarbij tijdens stap D) ten minste één stromingskarakteristiek gerelateerd, in het bijzonder stromingssnelheid gerelateerd, signaal dat gerelateerd is aan het fluïdum dat door het enkele interne

35 kanaal stroomt wordt voortgebracht, op basis van het gedetecteerde aantal

omwentelingen per tijdseenheid (rpm) van de rotor, en op basis van een vooraf bepaalde verhouding tussen het aantal omwentelingen per tijdseenheid (rpm) van de rotor en voornoemde stromingskarakteristiek, in het bijzonder de stromingssnelheid, en op basis van de tijdens stap C) gemeten elektrische
5 belasting.

47. Werkwijze volgens conclusie 46, waarbij de debietmeter wordt onderworpen aan een zelfkalibratie op basis van de tijdens stap C) gemeten elektrische belasting, bij voorkeur ofwel op basis van een belastingvrije meting en/of op basis
10 van een gereguleerde belastingmeting, in het bijzonder door het schakelen tussen (i) een ongereguleerde belastingmeting en (ii) een belastingvrije meting en/of een gereguleerde belastingmeting.

48. Werkwijze volgens een van de voorgaande conclusies 45-47, waarbij
15 tijdens stap D) een elektrische belasting afhankelijke stromingskarakteristiek correctiefactor wordt verkregen van een vooraf opgeslagen kruisverwijzingsstroming-rpm-database, bij voorkeur een kruisverwijzingsbelasting-stroming-rpm-database, voor het corrigeren van de gemeten stromingskarakteristiek op basis van de tijdens stap C) toegepaste belasting.

20

49. Werkwijze volgens een van de conclusies 45-48, waarbij tijdens stap D) een elektrische belasting afhankelijke stromingskarakteristiek correctiefactor wordt berekend, door ten minste één vooraf opgeslagen algoritme te gebruiken, voor het corrigeren van de gemeten stromingskarakteristiek op basis van de tijdens stap C)
25 toegepaste belasting.

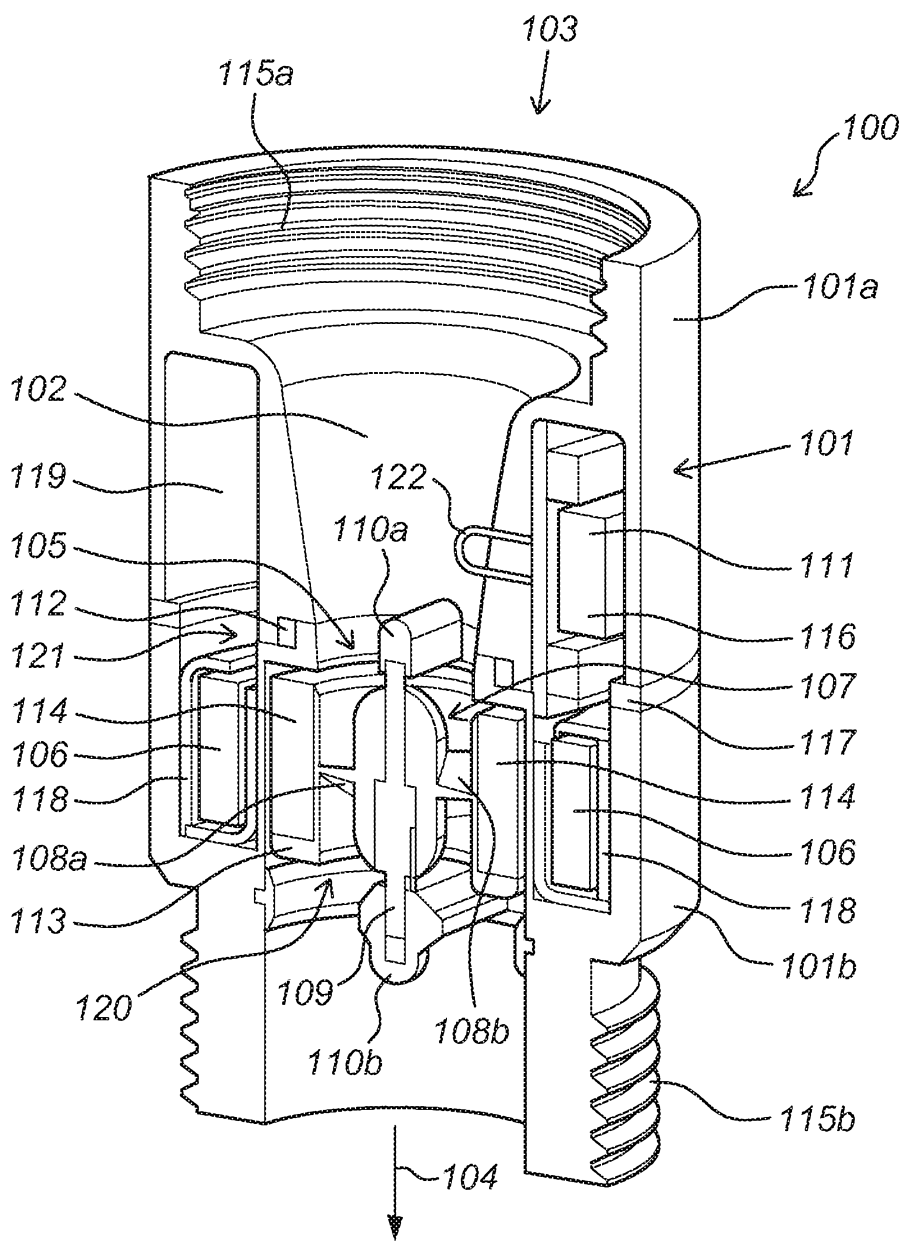


Fig. 1

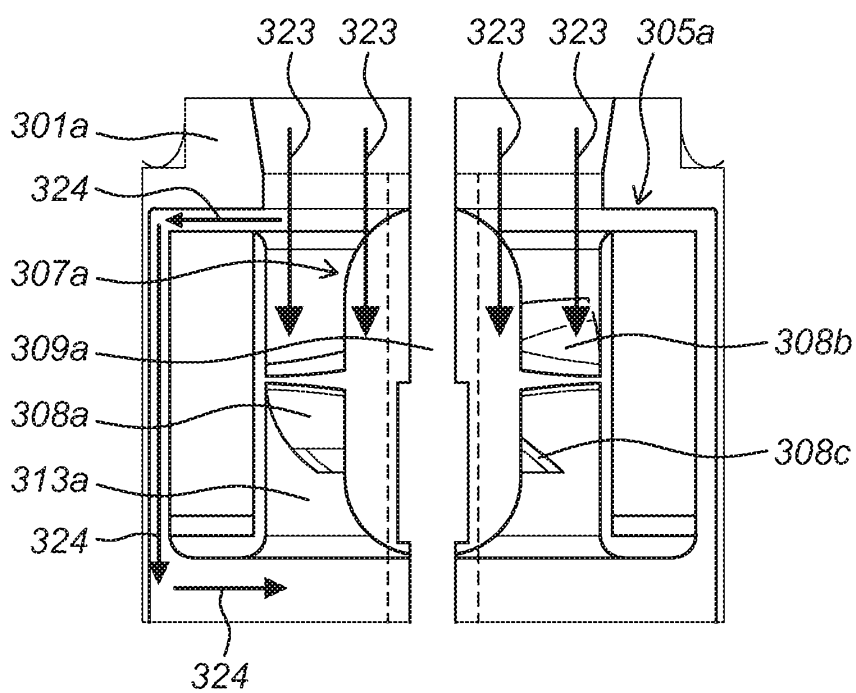


Fig. 3a

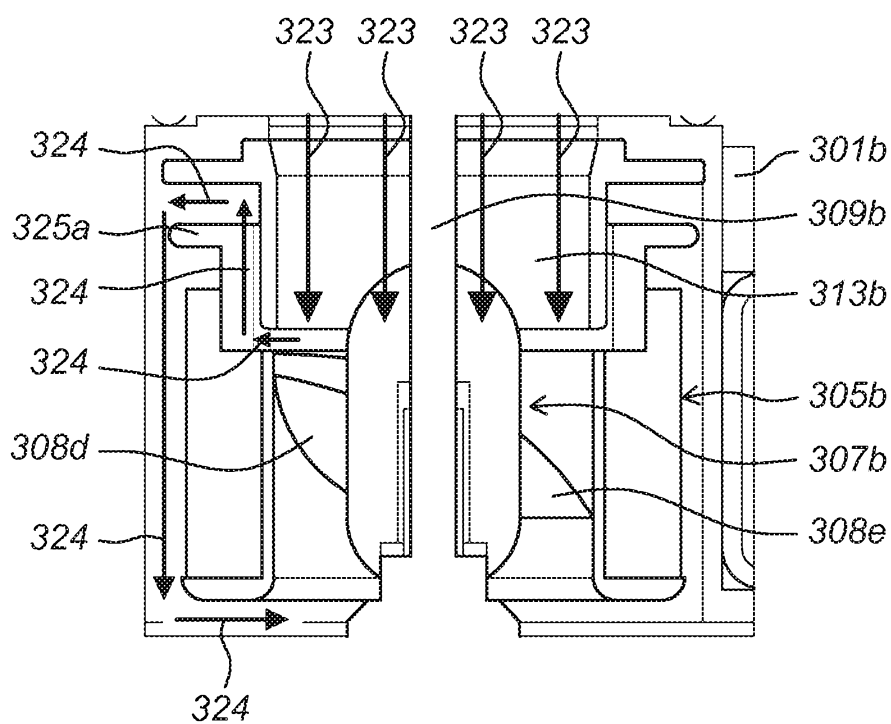


Fig. 3b

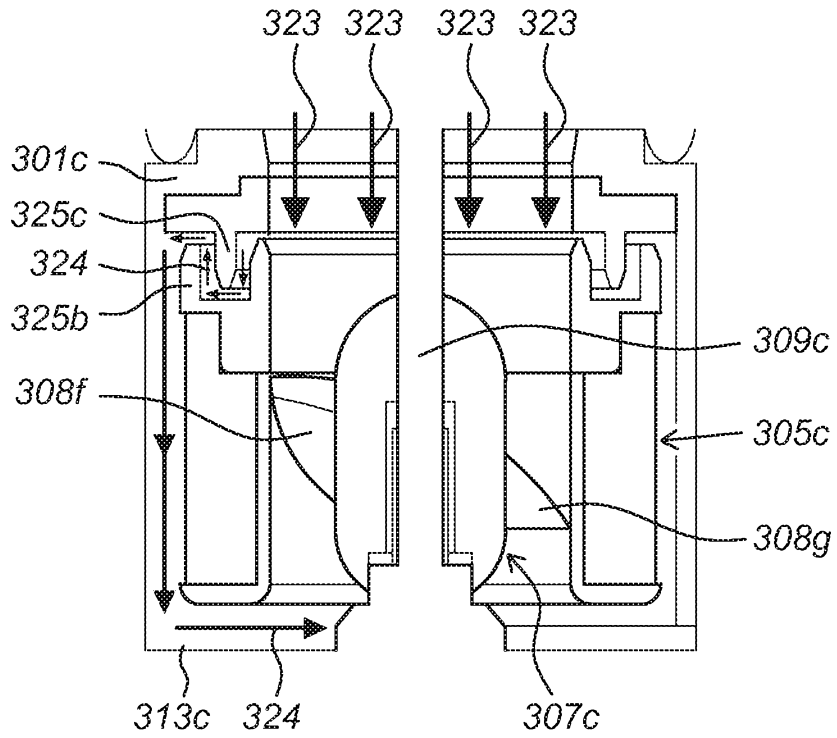


Fig. 3c

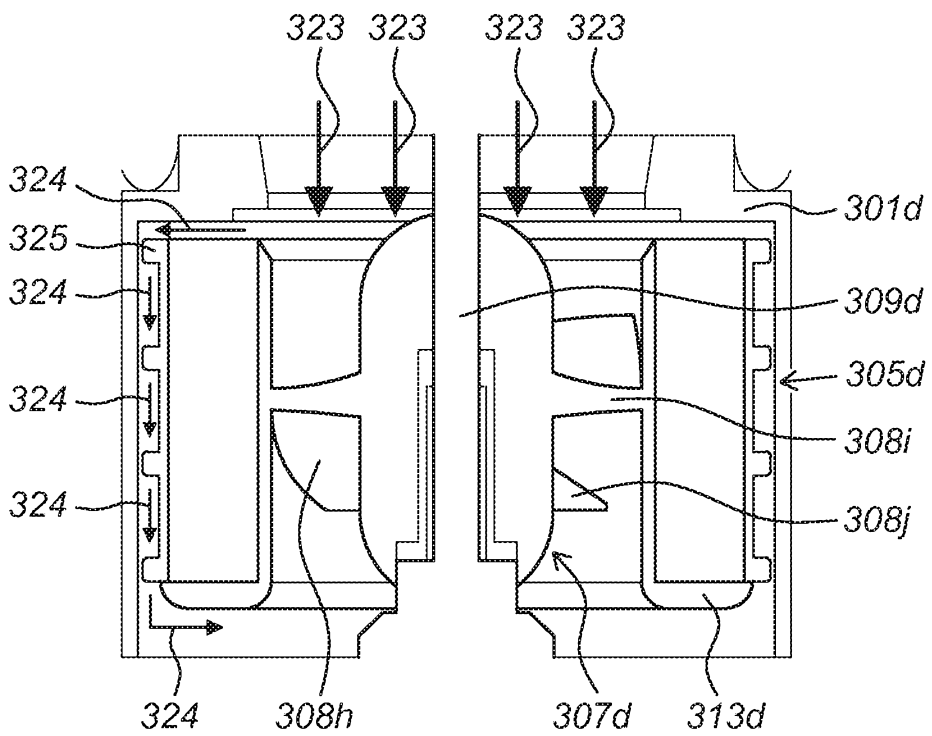


Fig. 3d

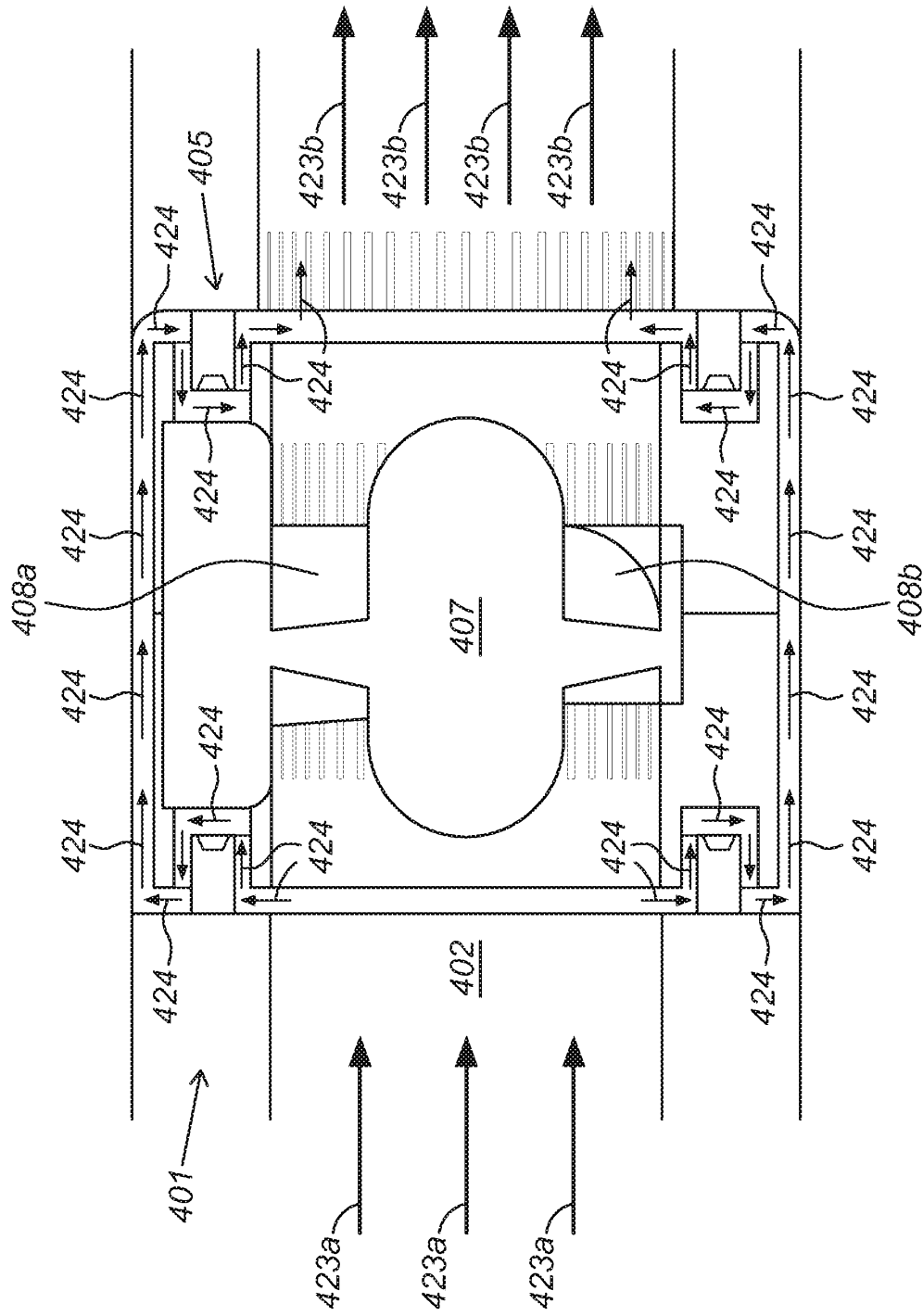


Fig. 4

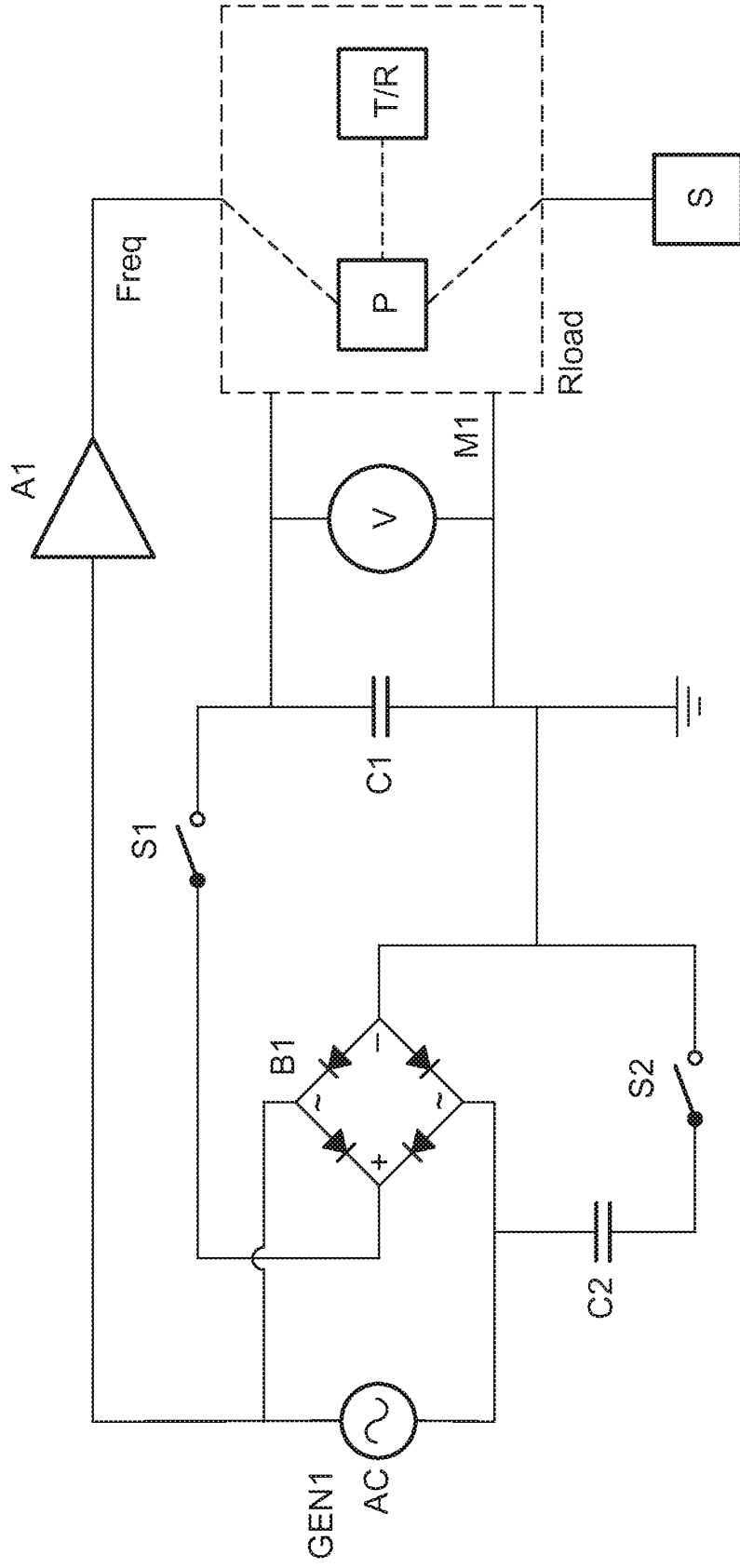


Fig. 5

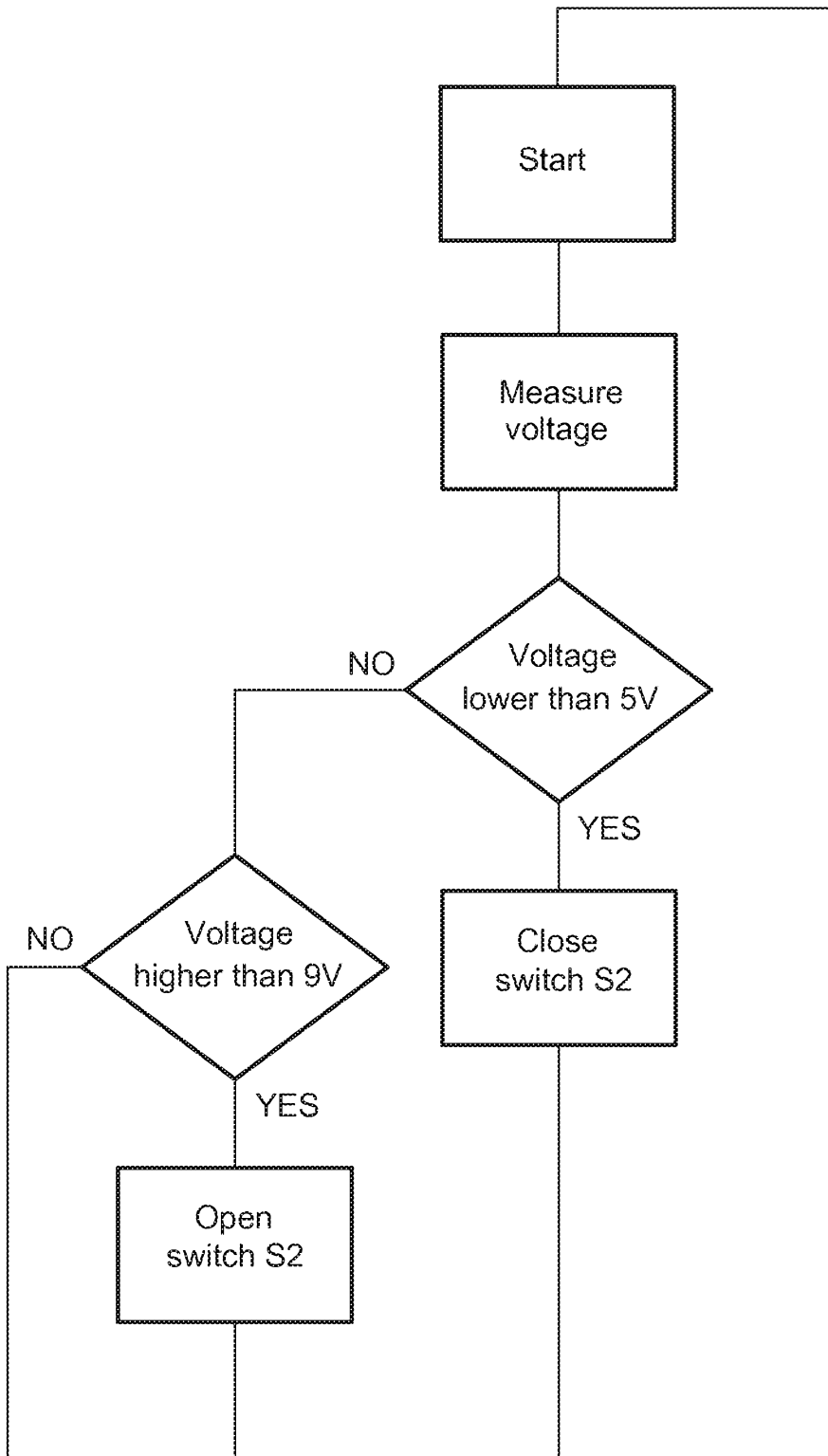


Fig. 6

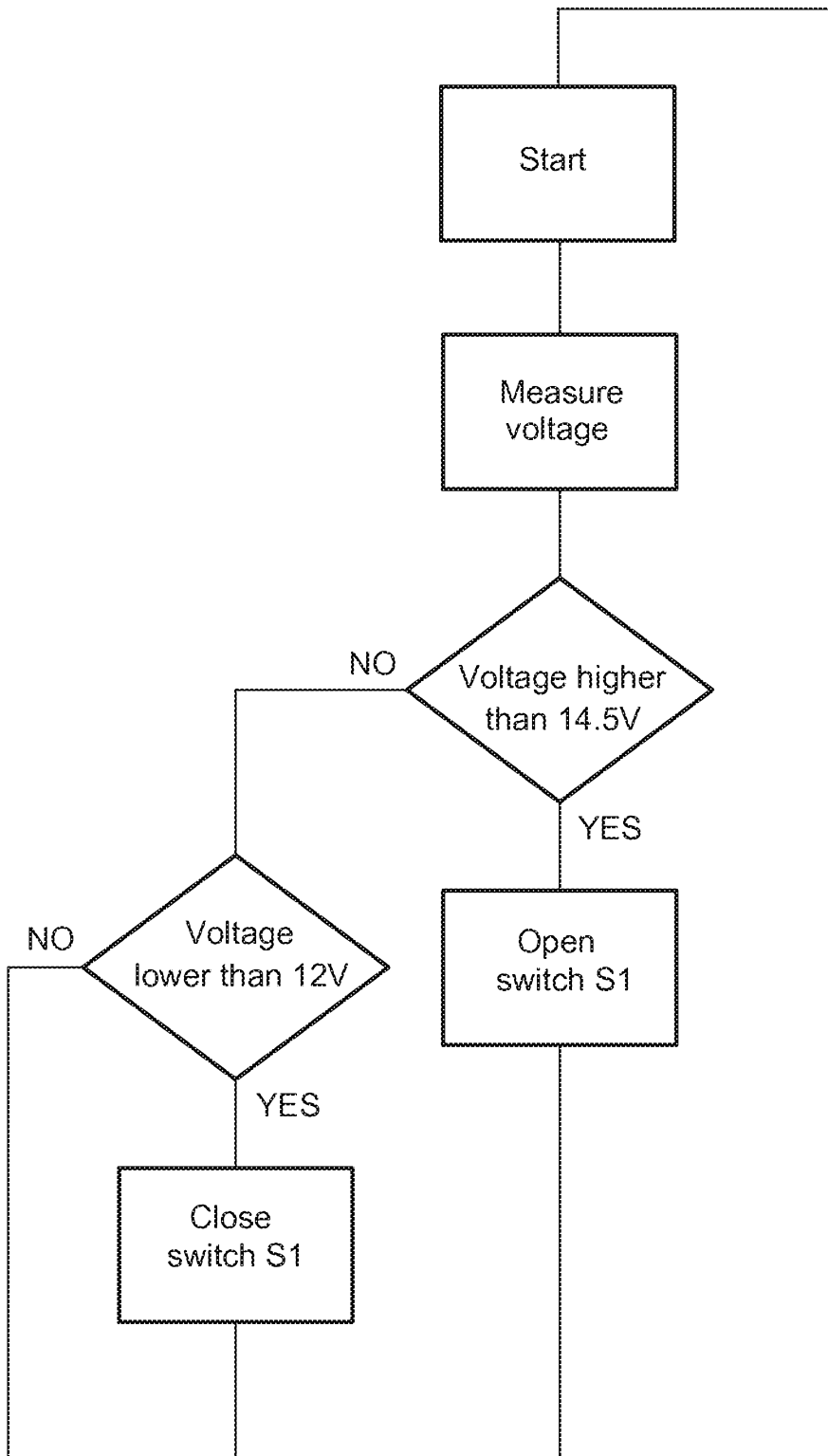


Fig. 7

Abstract

The invention relates to an autonomous, low-power turbine flow meter. The invention also relates to an assembly of at least one flow meter according to the invention and at least one signal receiving device configured to receive signals, preferably in a wireless manner, produced and transmitted by said flow meter. The invention further relates to a method for measuring at least one flow characteristic, in particular the flow rate, of a fluid flowing through a flow meter according to the invention.

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	1.1181.004 NL-V
Nederlands aanvraag nr.	Indieningsdatum
2019028	07-06-2017
	Ingeroepen voorrangsdatum
Aanvrager (Naam)	
KINETRON B.V.	
Datum van het verzoek voor een onderzoek van internationaal type	Door de instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr.
26-08-2017	SN69543
I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)	
Volgens de internationale classificatie (IPC)	
G01F1/075;G01F25/00;G01F15/00	
II. ONDERZOCHE GEBIEDEN VAN DE TECHNIEK	
Onderzochte minimumdocumentatie	
Classificatiesysteem	Classificatiesymbolen
IPC	G01F
Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen	
III.	GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES (opmerkingen op aanvullingsblad)
IV.	GEBREK AAN EENHEID VAN UITVINDING (opmerkingen op aanvullingsblad)

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar
de stand van de techniek

NL 2019028

A. CLASSIFICATIE VAN HET ONDERWERP
INV. G01F1/075 G01F25/00 G01F15/00
ADD.

Volgens de internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHETE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)

G01F

Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)

EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geopteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	WO 2012/131677 A2 (HYDROSPIN MONITORING SOLUTIONS LTD [IL]; PELEG DANI [IL]) 4 oktober 2012 (2012-10-04)	1-12, 14-16, 18-26, 29,30, 37-45
Y	* bladzijde 2, laatste alinea - bladzijde 3, alinea 1 * * bladzijde 3, alinea 4 - alinea 8 * * bladzijde 4, alinea 3 * * bladzijde 10, alinea 2 - bladzijde 11, alinea 3 * * bladzijde 11, laatste alinea - bladzijde 12, alinea 1 * * bladzijde 13, laatste alinea - bladzijde 14, alinea 2 * * bladzijde 17, alinea 4; figuren 1,3,4,7,8 * * figuren 1,3,4,6,7,8,9a,10b * ----- -/--	31-36, 46-49

Verdere documenten worden vermeld in het vervolg van vak C.

Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

* Speciale categorieën van aangehaalde documenten

A niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

D in de octrooiaanvraag vermeld

E eerdere octrooi(aanvraag), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

L om andere redenen vermelde literatuur

O niet-schriftelijke stand van de techniek

P tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

T na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvraag, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

X de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

Y de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geopteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

Z lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid

6 maart 2018

Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type

Naam en adres van de instantie

European Patent Office, P.B. 5818 Patentlaan 2
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Fax: (+31-70) 340-3016

De bevoegde ambtenaar

Verdoodt, Erik

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar
de stand van de techniek
NL 2019028

C. (Vervolg). VAN BELANG GEACHTE DOCUMENTEN		
Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
Y	US 2014/286802 A1 (SINGH BRIJ N [US]) 25 september 2014 (2014-09-25) * alinea [0026] - alinea [0030] * * figuur 2 *	31-36, 46-49
X	----- US 2 299 406 A (POTTER DAVID M) 20 oktober 1942 (1942-10-20) * bladzijde 1, linker kolom, regel 26 - regel 35 * * bladzijde 2, linker kolom, regel 3 - regel 26 * * bladzijde 2, linker kolom, regel 47 - regel 60 * * bladzijde 3, rechter kolom, regel 33 - regel 67 * * bladzijde 3, rechter kolom, regel 73 - bladzijde 4, linker kolom, regel 1 *	1-6, 11-15, 17,19, 21,23, 24,39, 42-45,49
X	----- US 2008/022920 A1 (CUSTODIS UDO [HK]) 31 januari 2008 (2008-01-31) * figuren 1,2,5,7 * * alinea's [0016], [0020] * * alinea [0034] - alinea [0038] * * alinea [0040] *	1-4,14, 15,19, 21,23, 25,27, 28,39
A	----- FR 2 960 638 A1 (AFRIAT ANAT [FR]; MIZRAHI SIGAL [IL]) 2 december 2011 (2011-12-02) * bladzijde 1, regel 18 - laatste regel * * bladzijde 2, regel 1 - regel 17 * * bladzijde 4, regel 15 - laatste regel * * bladzijde 5, regel 8 - regel 12 * * bladzijde 5, regel 18 - bladzijde 6, regel 4 * * bladzijde 5, regel 13 - regel 23 * * figuren 2,3 *	1,2,4, 11,12, 14,18, 19, 21-26, 29,30, 37,38, 40-43, 45,46,49

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar
de stand van de techniek

NL 2019028

In het rapport genoemd octrooigecchrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 2012131677	A2	04-10-2012	AU 2012235633 A1 10-10-2013
			BR 112013024202 A2 13-12-2016
			CA 2831005 A1 04-10-2012
			CN 103547793 A 29-01-2014
			EP 2691643 A2 05-02-2014
			EP 3181894 A2 21-06-2017
			KR 20140048871 A 24-04-2014
			RU 2013148548 A 10-05-2015
			US 2011221197 A1 15-09-2011
			WO 2012131677 A2 04-10-2012
US 2014286802	A1	25-09-2014	EP 2784917 A2 01-10-2014
			US 2014286802 A1 25-09-2014
US 2299406	A	20-10-1942	GEEN
US 2008022920	A1	31-01-2008	DE 102006032007 A1 24-01-2008
			US 2008022920 A1 31-01-2008
FR 2960638	A1	02-12-2011	GEEN

WRITTEN OPINION

File No. SN69543	Filing date (day/month/year) 07.06.2017	Priority date (day/month/year)	Application No. NL2019028
International Patent Classification (IPC) INV. G01F1/075 G01F25/00 G01F15/00			
Applicant KINETRON B.V.			

This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the application
- Box No. VIII Certain observations on the application

	Examiner Verdoodt, Erik
--	----------------------------

WRITTEN OPINION

Application number
NL2019028

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - a sequence listing
 - table(s) related to the sequence listing
 - b. format of material:
 - on paper
 - in electronic form
 - c. time of filing/furnishing:
 - contained in the application as filed.
 - filed together with the application in electronic form.
 - furnished subsequently for the purposes of search.
3. In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes: Claims	31-36, 46-48
	No: Claims	1-30, 37-45, 49
Inventive step	Yes: Claims	
	No: Claims	1-49
Industrial applicability	Yes: Claims	1-49
	No: Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION

Application number
NL2019028

Box No. VIII Certain observations on the application

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

- D1 WO 2012/131677 A2 (HYDROSPIN MONITORING SOLUTIONS LTD [IL]; PELEG DANI [IL]) 4 oktober 2012 (2012-10-04)
- D2 US 2014/286802 A1 (SINGH BRIJ N [US]) 25 september 2014 (2014-09-25)
- D3 US 2 299 406 A (POTTER DAVID M) 20 oktober 1942 (1942-10-20)
- D4 US 2008/022920 A1 (CUSTODIS UDO [HK]) 31 januari 2008 (2008-01-31)

1 Claim 1: Lack of clarity; Lack of novelty

- 1.1 The relative term "low power (laag vermogen)" used in claim 1 has no well-recognized meaning and leaves the reader in doubt as to the meaning of the technical features to which it refers, thereby rendering the definition of the subject-matter of said claims unclear.
- 1.2 Furthermore, the above-mentioned lack of clarity notwithstanding, the subject-matter of claim 1 is not new, and the criteria of patentability are therefore not met.
- 1.3 D1 discloses (zie bladzijde 2, laatste alinea - bladzijde 3, alinea 1; bladzijde 3, alinea 4 - alinea 8; bladzijde 4, alinea 3; bladzijde 11, laatste alinea - bladzijde 12, alinea 1; bladzijde 13, laatste alinea - bladzijde 14, alinea 2; bladzijde 17, alinea 4; figuren 1,3,4,7,8): "Autonome (p. 10, last line - p. 11, first line: "This power storage means 22 e.g., chargeable battery or capacitor, is charged by the power that is created by the apparatus itself."; p. 2, last paragraph: "The apparatus can further be configured for measuring the amount of liquid passing through the current generator, and further comprise: a controller for receiving the electrical signals for processing and producing output signals indicative of the amount of liquid, and wherein the power storage means includes a power storage and supply unit configured to charge the apparatus and to supply power to the controller required for its operation. For example, the power storage and supply unit can be rechargeable and/or the power storage means can be configured to provide power to the apparatus during cessation or low flow of liquid. "), laag vermogen turbinedebietmeter (zie fig.

1), omvattende:

- een behuizing (11) die een enkel intern kanaal met een fluïduminlaat en een fluïdumuitlaat omsluit, waarbij voornoemde behuizing is ingericht om gekoppeld te worden met en/of opgenomen te worden in een leiding ("pipeline") waarin een fluïdumstroom tot stand is gebracht (p. 10, l. 6-10);
- ten minste één turbine (p 10, l. 10-12) die op haar plaats wordt gehouden door voornoemde behuizing, elke turbine omvattende:
 - o een stator (13) verbonden met voornoemde behuizing, en
 - o een axiaal roteerbare rotor (1"rotor" met bladen (14), waarbij voornoemde rotor verbonden is met een as (15) die op zijn plaats wordt gehouden door ten minste één met voornoemde behuizing verbonden lagerelement (*implicitly disclosed*), waarbij voornoemde rotor zodanig in voornoemd enkele interne kanaal is gepositioneerd dat ten minste een fluïdumfractie, bij voorkeur in hoofdzaak alle fluïdum, dat naar voornoemd enkel intern kanaal geleid wordt, door de rotor zal stromen, en waarbij voornoemde turbine is ingericht om elektrische energie te genereren uit door voornoemd enkele interne kanaal stromend fluïdum (p. 10, fifth paragraph: "*Through the housing 11 a liquid 12 is passing and spins the turbine, which is comprised of the rotor having the rotor vanes 14 and magnets 16 that are installed on the edges of each vane and rotatable on the shaft 15 . The stator 13 is built on the housing 11 having coils 17 where the electrical power is created according to the spin of the vanes 14 with the magnets 16, i.e., rotor.*"), en waarbij voornoemde turbine is ingericht om ten minste één stromingskarakteristiek gerelateerd signaal voort te brengen dat gerelateerd is aan het fluïdum dat door het enkele interne kanaal stroomt, en
- ten minste één elektrisch signaalverwerkend circuit aangedreven door voornoemde turbine, waarbij voornoemde circuit ten minste één signaalverwerkend element ("*controller 18*") omvat, waarbij ten minste één signaalverwerkend element is ingericht om voornoemd ten minste ene stromingskarakteristiek gerelateerde signaal te verwerken. (p. 10, last paragraph: "*Some of the electrical power can be transferred to a controller 18, wherein any parameter of the created electrical power, i.e., voltage, current or frequency, can be used to calculate the liquid quantity that passes during a time sequence. Controller 18 includes an integrator 19 to calculate the passed liquid, a control unit 20 capable to store information and use it for controlling valves or controlling other systems via a communication channel 21.*"

- 1.4 Also D3 (*bladzijde 1, linker kolom, regel 26 - regel 35; bladzijde 2, linker kolom, regel 3 - regel 26; bladzijde 2, linker kolom, regel 47 - regel 60; bladzijde 3, rechter kolom, regel 33 - regel 67; bladzijde 3, rechter kolom, regel 73 - bladzijde 4, linker kolom, regel 1*) and D4 (*figuren 1,2,5,7; alinea [0016], [0020]; alinea [0034] - alinea [0038]; alinea [0040]*) disclose the subject-matter of claim 1.

2 Claim 42

- 2.1 The present application does not meet the criteria of patentability, because the subject-matter of claim 42 is not new.
- 2.2 D1 discloses: "Werkwijze voor het meten van ten minste één stromingskarakteristiek, in het bijzonder de stromingssnelheid, van een fluïdum dat door een debietmeter volgens een van de conclusies 1-39 stroomt, omvattende de stappen:
A) het toestaan dat een fluïdum door het enkele interne kanaal stroomt, waardoor het fluïdum een kracht uitoefent op de bladen van de rotor resulterende in een axiale rotatie van de rotor en de opwekking van een wisselstroom (AC) en/of een wisselspanning (AC spanning) elektrische energie (impliciet), waarbij de wisselstroom en/of wisselspanning representatief is voor het aantal omwentelingen per tijdseenheid (p. 10, paragraph 4-last paragraph), in het bijzonder het aantal omwentelingen per minuut (rpm), van de rotor (p. 4, last paragraph: "frequency"), en waarbij in hoofdzaak alle fluïdum, of ten minste voldoende fluïdum, door de rotor stroomt (see fig. 1),
B) het aandrijven van ten minste één elektrisch signaal verwerkend circuit met voornoemde elektrische energie (p. 10, last paragraph: "The controller is operated by the power storage means."),
C) het detecteren van het aantal omwentelingen (rpm) van de rotor (p. 4, last paragraph: "frequency") door middel van voornoemd circuit, en
D) het voortbrengen van ten minste één stromingskarakteristiek gerelateerd, in het bijzonder stromingssnelheid gerelateerd, signaal dat gerelateerd is aan het fluïdum dat door het enkele interne kanaal stroomt, op basis van het gedetecteerde aantal omwentelingen (rpm) van de rotor (p. 10, last paragraph: "used to calculate the liquid quantity that passes during a time sequence"), en op basis van een vooraf bepaalde verhouding tussen het aantal omwentelingen (rpm) van de rotor en voornoemde stromingskarakteristiek, in het bijzonder de stromingssnelheid. (p. 10, last paragraph: "Controller 18 includes an integrator 19 to calculate the passed liquid")."

- 3 Dependent claims 2-41, 43-49**
- 3.1 Dependent claims 2-19, 21-49 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step.
- 3.2 Claims 2-4: see D1 (fig. 1).
- 3.3 Claim 5: see D1 (fig. 1), with the rotor blades (14) holding the magnets (16) in close proximity to the housing wall (11).
- 3.4 Claims 7-10: see D1 (see fig. 1 and fig. 4; p. 11, last paragraph: "The rotor 104 has a shaft 108, a plurality of vanes 110 and a ring or several magnetic elements 112 affixed to the periphery of the rotor 104.").
- 3.5 Claim 11: see D1 (fig. 1; p. 11, last paragraph: "The stator 106 includes a body 114 supporting windings of a coil 116, a shield 118 housing the coil 116, an upstream housing part in the form of a strainer 120.").
- 3.6 Claim 12: see D1 (fig. 6).
- 3.7 Claim 13 (and 17, see also below section VIII, § 4.1): see D3 (fig.1-2), in which the two vanes are overlapping along a lengthwise direction.
- 3.8 Claims 14-16, 18: see D1 (fig. 10b).
- 3.9 Claim 19: see D1 (fig. 1).
- 3.10 Claim 20: reference is made to section VIII below, § 5.1.
- 3.11 Claim 21: the channel diameter is a design parameter, which can not be regarded to comprise an inventive step.
- 3.12 Claim 22: see D1 (fig. 3; p. 11, paragraph 3: valve 26).
- 3.13 Claim 23: see D1 (p. 10, last paragraph: "To calculate the liquid quantity that passes during a time sequence. Controller 18 includes an integrator 19 to calculate the passed liquid.").
- 3.14 Claim 24: it would be obvious to determine the flow direction from the electrical signal produced with the turbine disclosed in D1.
- 3.15 Claims 25, 26: see D1 (p. 11, l. 16: " In case of reducing flow the command 28 will close the valve 26. ").
- 3.16 Claim 27: D4 discloses the use of an additional temperature sensor (see § 21-24) in a flow meter with turbine to produce electrical energy.
- 3.17 Claim 28: D4 discloses the use of an indicator light (§ 40, 41).

- 3.18 Claim 29: see D1 (p. 10, last paragraph): as parameter, the frequency of the electrical signal can be used to calculate the liquid quantity. As the rotator has a circular motion, the signal will exhibit a sinusoidal shape.
- 3.19 Claim 30: see D1 (p 10, last line).
- 3.20 Claims 31-36: D2 discloses a machine for measuring a rate of flow of material through a chute. The material is no fluid, but agricultural material. As the material flows, electrical energy is produced by the rotating impeller in association with stator windings. A power manager is used to switch the electrical load of the circuit as required (§ 28). When a battery is connected to the circuit, it can be charged (§ 29). When this optional load 59 is released from the circuit, the outputted direct current signal is indicative of the rate of flow of material (§ 30). The skilled person thus finds in D2 the technique of changing the electrical load by switching components into or out of the circuit. As a result, the features of claims 31-36 are not comprising an inventive step, when the knowledge of D2 is combined with D1.
- 3.21 Claims 37, 38, 40, 41: D1 also discloses wireless communication means for the flow meter and a remote receiving system (see p. 14, l. 5-10).
- 3.22 Claims 39: see D1 (fig. 1).
- 3.23 Claim 43: the method steps disclosed in D1 are also overlapping each other in time (see p. 10, last paragraph).
- 3.24 Claims 44, 45: as the electrical load of the circuit disclosed in D1 is not being changed, it is operating at a fixed, predefined constant load as well.
- 3.25 Claims 46-49: reference is made to section VIII below, § 6.2.

Re Item VIII

Certain observations on the application

- 4 **Claims 13, 17: Lack of conciseness**
- 4.1 The content of claim 17 is identical to the content of claim 13.
- 4.2 As a result, claim 17 is not concise.

5 Claim 20: Lack of clarity

- 5.1 The term "niet-lineair fluidumbypasspad (non-linear fluid by-pass path)" used in claim 20 is vague and unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers, thereby rendering the definition of the subject-matter of said claim unclear.

6 Claims 45-48: Lack of clarity

- 6.1 Claims 45-48 refer to the "tijdens stap C) toegepaste elektrische belasting".
- 6.2 However, the "toegepaste elektrische belasting" is only defined for the first time in claim 44. As a result, claims 45 and 46 should depend of claim 44 or claims 44 and 45 respectively only, and not of claims 42 or 43.

7 Claim 43: obvious typing error

- 7.1 In claim 43, "step B)" is referred to twice.