

DESCRIPTION

TITLE OF THE INVENTION: AXIAL FLOW POSITIVE DISPLACEMENT FLOWMETER

TECHNICAL FIELD

[0001]

The present invention relates to an axial flow positive displacement flowmeter and more particularly to an axial flow positive displacement flowmeter equipped with a pair of spiral gears having different torsional directions in a casing.

BACKGROUND ART

[0002]

Conventionally, axial flow positive displacement flowmeters are classified into two types depending on the presence of a pilot gear and, if a pilot gear is included, it is not necessary to give consideration to friction resistance of a tooth surface while cost of manufacturing is increased in terms of the number of parts and the difficulty of assembling work. Therefore, preferably, a pilot gear is not added to construct an inexpensive flowmeter. However, if no pilot gear is included, it is difficult to inexpensively construct an accurate flowmeter with a conventional technology since friction resistance of a rotor tooth surface has a considerable effect on accuracy.

[0003]

For example, Patent Document 1 describes a typical existing axial flow positive displacement flowmeters. Although a pair of rotors having different tooth profiles is

used as depicted in Figs. 19(A) and 19(B), if rotor tooth profiles are different, it is problematic that a lot of effort is required for the manufacturing such as fabricating tools corresponding to their respective tooth profiles and it is difficult to keep balance, resulting in a disadvantage, i.e., unsuitability for usage at high speed. An instrumental error characteristically moves to the negative direction in an instrumental error curve as a flow rate increases.

[0004]

Therefore, it is important to suppress leakage of measured liquid from a constant volume portion formed between a rotor and a casing or between both rotors to realize highly accurate measurement. Since this leakage depends on a size and width of a gap between a rotor and a casing and a differential pressure between before and after measurement (pressure drop of a flowmeter), a method for realizing higher accuracy is conceivable such as reducing a gap between a rotor and a casing or a gap between rotors and reducing the pressure drop, but the reduction of the former gap is limited because the parts mutually move, and it is believed that the practical limit level has already been reached.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0005]

Patent Document 1: German Patent Application Laid-Open
Publication No. DE19513781A1

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006]

Although various structures are under study such as eliminating the presence of a curved portion to reduce the pressure drop in a conventional axial flow positive displacement flowmeter, in the case of the conventional axial flow positive displacement flowmeter described in Patent Document 1, since a pair of rotors is configured as two-blade and three-blade rotors and have different sizes, the rotors are difficult to be balanced with each other and used at high speed and it is problematic that a lot of efforts are required for the manufacturing.

[0007]

The present invention was conceived in view of the situations and it is therefore the object of the present invention to provide an inexpensive highly-accurate axial flow positive displacement flowmeter capable of reducing a pressure drop.

MEANS FOR SOLVING THE PROBLEM

[0008]

To solve the problem, a first technical means comprises a pair of spiral gears of the same shape and the same size having different torsional directions; a casing that houses the pair of the spiral gears the axes of which is disposed along a flow direction of measured fluid; an inflow side lid that seals an inflow end of the casing; an inflow port formed in a pipe connecting portion of the inflow side lid; an outflow side lid that seals an outflow end of the casing; an outflow port formed in a pipe connecting portion of the outflow side lid; a magnet disk attached to the back end of any one of the pair of the spiral

gears; and a detecting portion that detects rotation of the magnet disk, wherein bearing portions that rotatably support the pair of the spiral gears are arranged on the same plane and partially opening lid portions are provided on the inflow end and the outflow end of the casing to form spaces capable of ensuring flow channels between both axial ends of the pair of the spiral gears and the respective lid portions, and the inflow port and the outflow port are arranged on a straight line along the flow direction of the measured fluid.

[0009]

A second technical means is the first technical means, wherein the magnet disk has a plurality of air vent holes formed in a disk and around its attachment portion.

[0010]

A third technical means is the first or second technical means, wherein a counter weight having the same inertia moment as the magnet disk is attached to the back end of the other spiral gear without the magnetic disk attached.

[0011]

A fourth technical means is any one of the first to third technical means, wherein the detecting portion is made up of an amorphous sensor and is disposed in the circumferential direction of the magnetic disk near an outflow side of the lid portion formed at the outflow end of the casing.

[0012]

A fifth technical means is any one of the first to fourth technical means, wherein the lid portion has an opening area that is equal to or greater than an inflow area of a measuring chamber formed by the spiral gears and the casing.

[0013]

[0014]

[0015]

[0016]

[0017]

EFFECTS OF THE INVENTION

[0018]

According to the present invention, since a pair of spiral gears of the same shape having different torsional directions is equipped in a casing and an inflow port and an outflow port are arranged on a straight line in the same direction as a flow direction of measured fluid to eliminate the presence of a curved portion, it is possible to realize higher accuracy inexpensively and reduce a pressure drop at the same time.

BRIEF DESCRIPTION OF DRAWINGS

[0019]

[Fig. 1] Fig. 1 is a diagram of an exemplary configuration of an axial flow positive displacement flowmeter according to a first embodiment of the present invention.

[Fig. 2] Fig. 2 shows cross-sectional views taken along lines X-X and Y-Y of the axial flow positive displacement flowmeter depicted in Fig. 1.

[Fig. 3] Fig. 3 is a diagram of a side view of the axial flow positive displacement flowmeter depicted in Fig. 1 when it is turned by 90 degrees.

[Fig. 4] Fig. 4 shows the axial flow positive displacement flowmeter depicted in Fig. 3 when it is viewed from the inflow side lid and from the outflow side lid.

[Fig. 5]

[Fig. 6]

[Fig. 7] Fig. 7 is a diagram of an exemplary configuration of a bearing portion equipped in the axial flow positive displacement flowmeter of the present invention.

[Fig. 8] Fig. 8 is a diagram of an exemplary configuration of an axial flow positive displacement flowmeter according to a second embodiment of the present invention.

[Fig. 9]

[Fig. 10] Fig. 10 is a diagram of a side view of the axial flow positive displacement flowmeter depicted in Fig. 8 when it is turned by 90 degrees.

[Fig. 11] Fig. 11 shows the axial flow positive displacement flowmeter depicted in Fig. 10 when it is viewed from the inflow side lid and from the outflow side lid.

[Fig. 12] Fig. 12 is a diagram of an exemplary configuration of a pickup disk.

[Fig. 13]

[Fig. 14]

[Fig. 15]

[Fig. 16]

[Fig. 17]

[Fig. 18]

[Fig. 19] Fig. 19 is a diagram of a configuration of a conventional axial flow positive displacement flowmeter.

PREFERRED EMBODIMENTS OF THE INVENTION

[0020]

Preferred embodiments of an axial flow positive displacement flowmeter of the present invention will now be

described with reference to the accompanying drawings.

[0021]

(First Embodiment)

Fig. 1 is a diagram of an exemplary configuration of an axial flow positive displacement flowmeter according to a first embodiment of the present invention. Fig. 2(A) depicts a cross-sectional view taken along line X-X of the axial flow positive displacement flowmeter and Fig. 2(B) depicts a cross-sectional view taken along line Y-Y of the axial flow positive displacement flowmeter.

Fig. 3 is a diagram of a side view of the axial flow positive displacement flowmeter depicted in Fig. 1 when it is turned by 90 degrees. Fig. 4(A) depicts the axial flow positive displacement flowmeter depicted in Fig. 3 when it is viewed from the inflow side lid and Fig. 4(B) depicts the axial flow positive displacement flowmeter depicted in Fig. 3 when it is viewed from the outflow side lid. In Figs. 1 to 4, 1 denotes an axial flow positive displacement flowmeter and the axial flow positive displacement flowmeter 1 includes an inflow side lid 2, an outflow side lid 3, a casing 4, bearing fixing portions 5, 6, bearing portions 7, 8, and spiral gears (hereinafter, rotors) 10.

[0022]

In Figs. 1 to 4, the casing 4 houses the rotors 10 and rotatably supports rotor shafts of the rotors 10 with the bearing portions 7, 8 provided on both ends. A pair of the rotors 10 is configured with the same shape and the same size, has different torsional directions, and rotates in a mutually engaging manner. The casing 4 is provided with a measuring chamber M which communicates with an outflow port 31 and an

inflow port 21 and the inflow side lid 2 and the outflow side lid 3 are attached to seal the both opening ends of the measuring chamber M. The inflow side lid 2 is provided with the inflow port 21 allowing inflow of measured fluid and a flange 22 for connecting with external pipe arrangement (not shown). The outflow side lid 3 is provided with the outflow port 31 allowing outflow of the measured fluid and a flange 32 for connecting with the external pipe arrangement. The flanges 22, 32 correspond to pipe connecting portions and form the inflow port 21 and the outflow port 31, respectively, and the axial flow positive displacement flowmeter 1 is connected to the external pipe arrangement through the flanges 22, 32. The measured fluid flows in a direction of an arrow of Fig. 1.

[0023]

A magnet disk provided with transmitting magnets (not shown) is integrally attached to the rotor shaft of the rotor 10 and this magnet disk rotates in accordance with the rotation of the rotor shaft. A magnet sensor (not shown) is disposed in close vicinity to this magnet disk. The magnet sensors may be, for example, those that utilize Barkhausen jump employing a hall element, a magnetoresistance element, or an amorphous metal fiber. This magnetic sensor detects the rotation of the magnetic disk, i.e., the rotation of the rotor 10, to measure a flow rate of the measured fluid. A configuration of the magnetic disk will be described later in detail with reference to Figs. 8, 10 to 12.

[0024]

The axial flow positive displacement flowmeter 1 of this embodiment is configured with the inflow port 21 and the outflow port 31 that are arranged on a straight line along the flow

direction of the measured fluid to eliminate the presence of a curved portion from the inflow port 21 to the outflow port 31. This reduces the pressure drop due to a curved portion. A pair of the rotors 10 is configured with the same shape and size and therefore inexpensively produced by constraining the cost of manufacturing as compared to rotors having different shapes.

[0025]

The bearing portions 7, 8 rotatably support the rotor shafts of the rotors 10. The bearing portions 7, 8 are made up of radial ball bearings (described later in Fig. 7), etc., on the inflow side (the bearing portion 7) and the outflow side (the bearing portion 8) and, if a thrust load is heavy, the bearing portion 8 on the outflow side is preferably made up of an angular ball bearing which has excellent load resistance characteristics in radial ball bearings. The bearing portion 7 on the inflow side is generally subjected to a lighter thrust load. This is because when the measured fluid flows in the flowmeter, the rotors 10 are pressed against the outflow side due to a pressure difference and the thrust load is increased on the outflow side and reduced on the inflow side. Therefore, the bearing portion 7 on the inflow side may not necessarily be an angular ball bearing.

[0026]

Partially opening lid portions are formed at the inflow end and the output end of the casing 4. The lid portions correspond to the bearing fixing portions 5, 6 (hereinafter, often, lid portions 5, 6) and an opening area of the lid portion 5, i.e., an area of through-holes 51 formed in the lid portion 5 depicted in Fig. 2(A), is set equal to or greater than the

inflow area of the rotors 10. This inflow area corresponds to an area of white portions S depicted in Fig. 2(B), i.e., an inflow area of the measuring chamber M formed by the rotors 10 and the casing 4. This makes it possible to eliminate a pressure difference in the measuring chamber M and reduce the pressure drop. Through-holes are assumed to be formed in the lid portion 6 on the outflow side in the same manner as in the lid portion 5.

[0027]

In Fig. 1, the casing 4 is provided with a space g between the axial inflow end of the rotor 10 and the lid portion 5 and between the axial outflow end of the rotor 10 and the lid portion 6. This makes it possible to further reduce the pressure drop. The lid portions 5, 6 are provided with through-holes to allow passage of the measured fluid. If no space exists between the lid portions 5 and 6 in a flow channel for inflow and outflow between the lid portions 5, 6 and the measuring chamber of the rotors 10, it is thought that the pressure drop increases because the flow channel is narrowed down. Providing the space g as above enables further reduction of the pressure drop. Although the space g is provided at both ends in the direction of axial of the rotor 10 in the example of Fig. 1, the space g may be provided at only one end in the direction of axial of the rotor 10.

[0028]

[0029]

[0030]

[0031]

[0032]

[0033]

Fig. 7 is a diagram of an exemplary configuration of a bearing portion equipped in the axial flow positive displacement flowmeter of the present invention. Fig. 7(A) depicts a configuration of the bearing portion 7 on the inflow side; in Fig. 7, 71 denotes an outer ring; 72 denotes an inner ring; 73 denotes a cage; and 74 denotes a ball. Fig. 7(B) depicts a configuration of the bearing portion 8 on the outflow side; 81 denotes an outer ring; 82 denotes an inner ring; 83 denotes a cage; and 84 denotes a ball.

[0034]

In the case of this example, the bearing portion 7 depicted in Fig. 7(A) is made up of a deep groove ball bearing and the bearing portion 8 depicted in Fig. 7(B) is made up of an angular ball bearing. The former deep groove ball bearing is a most typical rolling bearing and has a wide range of application and a groove of a raceway track provided on the inner ring 72/the outer ring 71 are able to be subjected to the radial load of a cross-section of a circular arc of a radius slightly greater than the radius of the rolling ball 74, and in addition the thrust load (also called axial load) is applicable in both directions. This bearing has low friction torque and is suitable for portions rotating at high speed or applications requiring low noise and low vibration.

On the other hand, the latter angular ball bearing is able to be subjected to the radial load and the thrust load in one direction. For example, the ball 84 and the inner ring 82/the outer ring 81 have a contact angle of 15, 25, 30, or 40 degrees and the larger contact angle is, the bigger load resistance to the thrust load becomes and the smaller contact angle is, the more advantageous to high-speed rotation becomes.

Two bearings are normally faced to each other and used by adjusting an internal gap.

[0035]

(Second Embodiment)

Fig. 8 is a diagram of an exemplary configuration of an axial flow positive displacement flowmeter according to a second embodiment of the present invention.

Fig. 10 is a diagram of a side view of the axial flow positive displacement flowmeter depicted in Fig. 8 when it is turned by 90 degrees. Fig. 11(A) depicts the axial flow positive displacement flowmeter depicted in Fig. 10 when it is viewed from the inflow side lid and Fig. 11(B) depicts the axial flow positive displacement flowmeter depicted in Fig. 10 when it is viewed from the outflow side lid. The axial flow positive displacement flowmeter 1 includes the inflow side lid 2, the outflow side lid 3, the casing 4, the bearing fixing portions 5, 6, the bearing portions 7, 8, and the rotors 10 as is the case with the first embodiment. The flowmeter of this embodiment has the same constituent elements as those of the flowmeter of the first embodiment except the different shape of the rotors 10.

[0036]

In Figs. 8, 10 to 11, the casing 4 houses the rotors 10 and rotatably supports the rotor shafts of the rotors 10 with the bearing portions 7, 8 provided on both ends. A pair of the rotors 10 is configured with the same shape and the same size, has different torsional directions, and rotates in a mutually engaging manner. The casing 4 is provided with the measuring chamber M which communicates with the outflow port 31 and the inflow port 21 and the inflow side lid 2 and the outflow side

lid 3 are attached to seal the both opening ends of the measuring chamber M. The inflow side lid 2 is provided with the inflow port 21 allowing inflow of measured fluid and the flange 22 for connecting with the external pipe arrangement. The outflow side lid 3 is provided with the outflow port 31 allowing outflow of the measured fluid and the flange 32 for connection with the external pipe arrangement.

[0037]

In Fig. 8, the flowmeter is equipped with a magnet disk (hereinafter, a pickup disk) 9a attached to the back end of one of a pair of the rotors 10 and an amorphous sensor 9b corresponding to a detecting portion that detects the rotation of the pickup disk 9a. The amorphous sensor 9b is provided in the vicinity of the outflow side surface of the lid portion 6 formed at the outflow end of the casing 4. The pickup disk 9a is sized such that the flow of the measured fluid flowing out from the lid portion 6 is not prevented and is desirably made of a lightweight material so as not to add a rotational load to the rotor 10. The amorphous sensor 9b is provided on the back side of a rib of the lid portion 6 so as not to prevent the flow of the measured fluid flowing out from the lid portion 6.

[0038]

A counter weight 9c having the same inertia moment as that of the pickup disk 9a is attached to the back end of the other rotor 10 to which the pickup disk 9a is not attached. This keeps the rotational balance of the rotors 10 well.

[0039]

Fig. 12 is a diagram of an exemplary configuration of the pickup disk 9a. Fig. 12(A) is a side view of the pickup

disk 9a; Fig. 12(B) is a front view of the pickup disk 9a; and Fig. 12(C) is an enlarged view of an X portion of the pickup disk 9a. Transmitting magnets are arranged along an outer circumference portion of the pickup disk 9a. The letter, N, denotes a north pole of the transmitting magnets and S denotes a south pole of the transmitting magnets. A plurality of air vent holes h1 to h10 are formed in the pickup disk 9a and around an attachment portion thereof (i.e., around a portion projecting to the right in Fig. 12(A)). When the attachment portion of the pickup disk 9a is attached to the back end of the rotor 10, the vent holes h1 to h10 facilitate ventilation.

[0040]

The pickup disk 9a, the amorphous sensor 9b, and the counter weight 9c are assumed to be arranged in the axial flow positive displacement flowmeter depicted in Fig. 1 in the same way as described above.

[0041]

According to this embodiment, as described in the first embodiment, since a pair of spiral gears of the same shape having different torsional directions is equipped in a casing and an inflow port and an outflow port are arranged on a straight line in the same direction as a flow direction of measured fluid and no curved portion exists, it is possible to realize the higher accuracy inexpensively and reduce the pressure drop at the same time.

[0042]

[0043]

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EXPLANATIONS OF REFERENCE NUMERALS

[0067]

1...axial flow positive displacement flowmeter;
2...inflow side lid; 3...outflow side lid; 4...casing; 5, 6...bearing
fixing portion (lid portion); 7, 8...bearing portion; 9a...pickup
disk; 9b...amorphous sensor; 9c...counter weight; 10...spiral gear
(rotor); 14...rotation center; 21...inflow port; 22, 23...flange;
and 31...outflow port.

CLAIMS

1. (Amended) An axial flow positive displacement flowmeter comprising: a pair of spiral gears of the same shape and the same size having different torsional directions; a casing that houses the pair of the spiral gears the axes of which is disposed along a flow direction of measured fluid; an inflow side lid that seals an inflow end of the casing; an inflow port formed in a pipe connecting portion of the inflow side lid; an outflow side lid that seals an outflow end of the casing; an outflow port formed in a pipe connecting portion of the outflow side lid; a magnet disk attached to the back end of any one of the pair of the spiral gears; and a detecting portion that detects rotation of the magnet disk, wherein

bearing portions that rotatably support the pair of the spiral gears are arranged on the same plane and partially opening lid portions are provided on the inflow end and the outflow end of the casing to form spaces capable of ensuring flow channels between both axial ends of the pair of the spiral gears and the respective lid portions, and

the inflow port and the outflow port are arranged on a straight line along the flow direction of the measured fluid.

2. (Amended) The axial flow positive displacement flowmeter of claim 1, wherein the magnet disk has a plurality of air vent holes formed in a disk and around its attachment portion.

3. (Amended) The axial flow positive displacement flowmeter of claim 1 or 2, wherein a counter weight having the

same inertia moment as the magnet disk is attached to the back end of the other spiral gear without the magnetic disk attached.

4. (Amended) The axial flow positive displacement flowmeter of any one of claims 1 to 3, wherein the detecting portion is made up of an amorphous sensor and is disposed in the circumferential direction of the magnetic disk near an outflow side of the lid portion formed at the outflow end of the casing.

5. (Amended) The axial flow positive displacement flowmeter of any one of claims 1 to 4, wherein the lid portion has an opening area that is equal to or greater than an inflow area of a measuring chamber formed by the spiral gears and the casing.

6. (cancelled)

7. (cancelled)

8. (cancelled)

9. (cancelled)

10. (cancelled)