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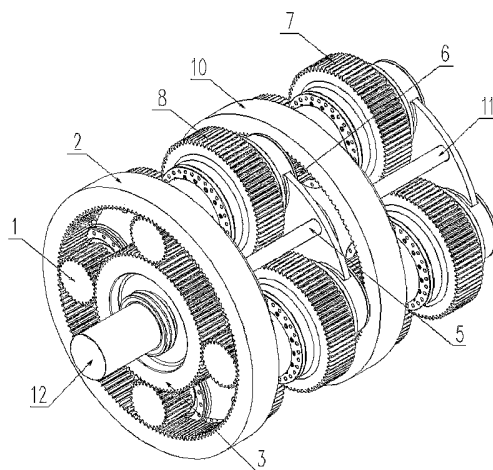
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(54) **Title:** ENERGY CONVERSION/INVERSION SYSTEM



(57) **Abstract:** A new mechanical model for converting and inverting mechanical pendular movement caused by wave-induced motion in order to transform it into unidirectional rotary movement, which can be used in wave energy recovery systems. The system consists of a set of gears containing anti-reverse bearings, grouped together in such a way as to convert and invert the mechanical pendular movement existing on a central shaft attached to a structure subject to irregular change in wave motion into unidirectional rotary movement on the output shaft. This model will make it possible to resolve one of the biggest problems in the development of technology for using wave energy, i.e. the problem of mechanical inversion with high efficiency. As well as making the movement unidirectional and rotary, this system makes an initial multiplication of the input movement, making it possible to fit a multiplication box onto the output shaft.

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ENERGY CONVERSION/INVERSION SYSTEM

DESCRIPTION**ENERGY CONVERSION/INVERSION SYSTEM**

5

Field of the invention

The present invention relates to a mechanical
10 model for converting and inverting mechanical pendular
movement caused by wave-induced motion in order to
transform it into unidirectional rotary movement, which can
be used in wave energy recovery systems.

15 **Background to the invention**

Fossil fuels are currently the most widely used
source of energy in the world. Since they are an
exhaustible source of energy, it is essential to find other
20 sources. The way forward will be renewable sources of
energy. One of the renewable forms of energy on Earth is
wave energy.

The use of wave energy has been studied for a
25 long time. Various ideas have been proposed and assessed,
some of which have given rise to pilot systems. The two
systems that have already been tested in real situations
are the *Pelamis* and the *Archimedes Wave Swing*.

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The first system consists of various cylinders linked by joints in which the flexing motion between the sections is used to generate energy.

5 The second system consists of a submerged apparatus which uses variations in pressure to generate movement and energy (based on the *Point Absorber Theory*).

Of the various currently existing ideas, the following should be mentioned:

- *Waverider* of the company SeaVolt, which consists of a buoy connected to a generator on the seabed;
 - A HydroVenturi apparatus based on the Bernoulli effect;
 - *Waveboy*, a device developed by Wavebob which floats well
- 15 below the sea surface.

One of the biggest problems facing this type of renewable energy is the conversion system and its efficiency and viability, and the objective of this

20 innovative invention is to resolve some of these difficulties, in particular those concerning the problem of inverting movement caused by sea and/or ocean wave-induced motion in an effective and economically viable way, with application in wave energy recovery systems such as

25 *shoreline, onshore, nearshore* and *offshore* systems. The system presented provides a different and innovative way of converting the movement caused by wave-induced motion into electric energy.

Brief description of the figures

The following description is based on the attached drawings in which:

5 Figure 1 represents a perspective view of the system of the invention;

Figure 2 represents a schematic view of the input toothed wheel with external teeth;

10 Figure 3 represents a schematic view of the planetary gears and the fixed toothed wheel with internal teeth;

Figure 4 represents a schematic view of the planetary gears with a moveable toothed wheel having external teeth;

15 Figure 5 represents a schematic view of the transmission between the moveable toothed wheel with external teeth and the driven sprocket;

Figure 6 represents a schematic view of the transmission of figure 5, but with the input shaft (12) rotating in the opposite direction;

20 Figure 7 represents a schematic view of the moveable toothed wheel with external teeth;

Figure 8 represents a schematic view of the planetary gears and the moveable toothed wheel with external teeth;

Figure 9 represents a schematic view of the output gear;

25 Figure 10 represents a schematic view of the transmission between the gear and the output shaft (13);

Figure 11 represents a schematic view of the transmission between the moveable toothed wheel with

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external teeth and the driven sprocket of a second output unit.

Figure 12 represents a longitudinal section of the system of the invention.

5

Detailed description of the invention

The system of the invention, as illustrated in figure 1, consists of a box with a mechanical system for the transmission of potential energy which converts a two-way periodic pendular-type input movement into a one-way (unidirectional) periodic oscillating-type output movement, as well as increasing the output speed in relation to the input speed.

15

The system comprises an input toothed wheel with external teeth (3) having pendular movement, labelled primary command unit, a fixed toothed wheel with internal teeth (2) for reacting the forces of input movement, labelled fixed input unit, a group of movement transmission planetary gears (1) with anti-reverse bearings and gears (8), labelled movement transmission planetary gear with a moveable toothed wheel having internal teeth (10) (see figure 4), a group of movement transmission planetary gears (6) with anti-reverse bearings and gears (7), labelled fixed movement transmission planetary gear (see figure 9), and a set of output gears (4) and (9) labelled one-way periodic oscillating movement output unit or potential energy inlet, as shown in figure 9.

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Figure 2 represents the input toothed wheel with external teeth (3), labelled primary command unit, which is the gear that transmits the potential energy to the unit in the form of two-way periodic pendular movement. The fixed toothed wheel with internal teeth (2), labelled fixed input unit, is the gear that reacts the forces of input movement in order to create pendular movement of the cage of the transmission planetary gear with a moveable toothed wheel having internal teeth (10). The planetary gears (1), due to their typology and the way in which they are connected, engage with the input toothed wheel with external teeth (3) and with the fixed toothed wheel with internal teeth (2). The movement transmitted by the input toothed wheel with external teeth (3) causes an identical movement of planetary gears (1) and, in turn, an angular shift of its cage around the fixed toothed wheel with internal teeth (2), as can be seen in figure 3.

20

In view of the fact that the fixed toothed wheel with internal teeth (2) is a unit attached to the outside body of the box and has no movement, it forces planetary gears (1) to move on their axis in the opposite direction to that of the input toothed wheel with external teeth (3), causing a shift of the cage which secures them in place in the same direction as the movement of the input toothed wheel with external teeth (3), labelled shift of the moveable cage (5) of planetary gears (1), which contain

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anti-reverse bearings attached to planetary gears (1), forming a unit with gears (8) whenever the planetary gears move in the direction schematized in figure 4, the said planetary gears transmitting power to gears (8), otherwise
5 these gears (8) will rotate in the opposite direction to planetary gears (1) and will not receive useful potential energy but rather absorption (consumed potential) energy. In figure 4 it can be seen that gears (8) engage into the driven sprocket (4) belonging to the movement output unit
10 or potential energy inlet (see figure 4) and whenever the movement of gears (8) is in the direction of the blocked anti-reverse bearings, as shown in figure 5, potential energy is transmitted through the driven sprocket (4) to the movement output unit or potential energy inlet,
15 otherwise, when the movement of gears (8) is in the opposite direction to that of the blocked anti-reverse bearings, as shown in figure 6 and labelled unblocked anti-reverse bearings, no potential energy is transmitted through the driven sprocket (4) to the movement output unit
20 or potential energy inlet, owing to the fact that gears (8) are freewheeling in relation to their planetary gears (1) due to the application of the anti-reverse bearings, as shown in figure 6. In this case, gears (8) continue to rotate in the same direction as the movement shown in
25 figure 5, which is considered, as mentioned above, as freewheel mode, resulting from the movement represented in figure 6, labelled movement output unit or potential energy inlet, through the driven sprocket (4) which is attached to output gear (9) within the same unit, as shown in figure 9.

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The potential energy transmitted by planetary gears (1) in this part of the pendular cycle of the input toothed wheel with external teeth (3) is absorbed by the cage which secures them in place. However, this cage, as well as securing planetary gears (1), also attaches the moveable movement transmission toothed wheel with internal teeth (10), represented in figure 4, to the group of movement transmission planetary gears (6) with anti-reverse bearings and gears (7) labelled fixed movement transmission planetary gear, as shown in figure 7.

The moveable toothed wheel with internal teeth (10), when it receives potential energy from the pendular movement resulting from the shift of the cage which secures planetary gears (1), whenever these gears move on their axis in a direct or backward direction, creates an identical potential energy transfer movement in the group of planetary gears (6) of the unit labelled fixed movement transmission planetary gear, as shown in figure 8. With this occurrence, we now have a second movement transmission unit, labelled fixed movement transmission planetary gear, as shown in figure 9 which, when it receives potential energy from the unit represented in figure 4 through the moveable toothed wheel with internal teeth (10), also transmits it to the set of output gears (4) and (9) labelled one-way periodic oscillating movement output unit or potential energy inlet, through output gear (9), as shown in figure 9.

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Like the unit labelled moveable movement transmission planetary gear represented in figure 4, which has anti-reverse bearings attached to planetary gears (1) with gears (8), this unit too has anti-reverse bearings attached to planetary gears (6) with gears (7), the difference being that the way in which they are attached is the opposite of the other unit and is normally labelled the left-side way, since the other way is always considered as the right-side way, and whenever the movement of the first unit, labelled movement transmission planetary gear with a moveable toothed wheel having internal teeth (10), is blocked, as shown in figure 5, the movement of this unit labelled fixed movement transmission planetary gear, as shown in figure 10, is unblocked, i.e. whenever the movement of the first unit is unblocked, figure 6, the movement of this unit, figure 11, is blocked.

As previously mentioned, the first unit only transmits potential energy to the driven sprocket (4) when the anti-reverse bearing of planetary gear (1) is blocked with gears (8), as shown in figure 5, otherwise this energy is transmitted to the moveable toothed wheel with internal teeth (10), causing the freewheeling gears (8) to rotate in the opposite direction to their associated planetary gear as a result of the movement conferred by the driven sprocket (4), as shown in figure 6.

- 10 -

Likewise, the second unit only transmits potential energy to the output gear (9) when the anti-reverse bearing of planetary gear (6) is blocked with gears (7), as shown in figure 11, otherwise the energy of the system is transmitted to planetary gear (1), causing the freewheeling gears (7) to rotate in the opposite direction to their associated planetary gear as a result of the movement conferred by output gear (9), as shown in figure 10.

10

In short, the system is innovative in terms of the way in which the pendular-type input movement is converted into one-way or unidirectional rotary oscillating-type output movement, by virtue of the application of the right and left anti-reverse bearings. When the system rotates in one direction, the pendulum transmits potential energy through the unit labelled movement transmission planetary gear with a moveable toothed wheel having internal teeth (10) (figure 4), the unit labelled fixed movement transmission planetary gear (figure 9) being in freewheel mode, and when the system rotates in a backward direction, the pendulum transmits potential energy through the unit labelled fixed movement transmission planetary gear (figure 9), the unit labelled movement transmission planetary gear with a moveable toothed wheel having internal teeth (10) (figure 4) being in freewheel mode.

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This device is highly efficient with a high mechanical output, which can be converted into system energy/power.

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CLAIMS

1. Combined device for converting and inverting
5 the oscillating mechanical pendular movement generated by a
pendulum-type system acting on an input shaft (12) into a
unidirectional rotary output movement harnessed in an
output shaft (13), characterized in that it comprises two
sets of toothed wheels, namely a fixed toothed wheel with
10 internal teeth (2) and a moveable toothed wheel with
internal teeth (10), both of which contain a planetary cage
system, planetary gears (1) and (6), anti-reverse bearings
placed inside toothed wheels (7) and (8) and output gears
(9), the first set transmitting potential energy through a
15 unit labelled movement transmission planetary gear with a
moveable toothed wheel having internal teeth (10) when the
unit labelled fixed movement transmission planetary gear is
in freewheel mode, and when the system rotates in a
retrograde direction, the said pendulum transmits potential
20 energy through the unit labelled fixed movement
transmission planetary gear, the unit labelled movement
transmission planetary gear with a moveable toothed wheel
having internal teeth (10) being in freewheel mode, the
one-way oscillating movement being carried out by toothed
25 wheels (8) or by toothed wheels (7) whenever they are
rotating in the same direction as the blocked anti-reverse
bearings attached to planetary gears (1) or (6).

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2. Device according to the previous claim, characterized in that the movement is always periodic with a positive irregular sinusoidal form.

5 3. Device according to claim 1, characterized in that it transforms a bidirectional oscillating mechanical pendular movement into unidirectional rotary oscillating movement which can be used in devices and structures that are intended to convert mechanical energy
10 into a particular source of energy, as in the case of renewable energies.

4. Device according to claim 1 or 2, characterized by the increase of the output speed in
15 relation to the input speed, as a consequence of the ratio to be applied in the gear train systems resulting from the architecture and dimensions of the system.

5. Device according to any of claims 1, 2, 3 or
20 4, characterized by the compact nature of the system, enabling it to be used in small spaces and to be incorporated into energy conversion equipment, facilitating the design of the external protection structure and allowing the use of standard production equipment with high
25 structural resistance and being economically viable by virtue of this system.

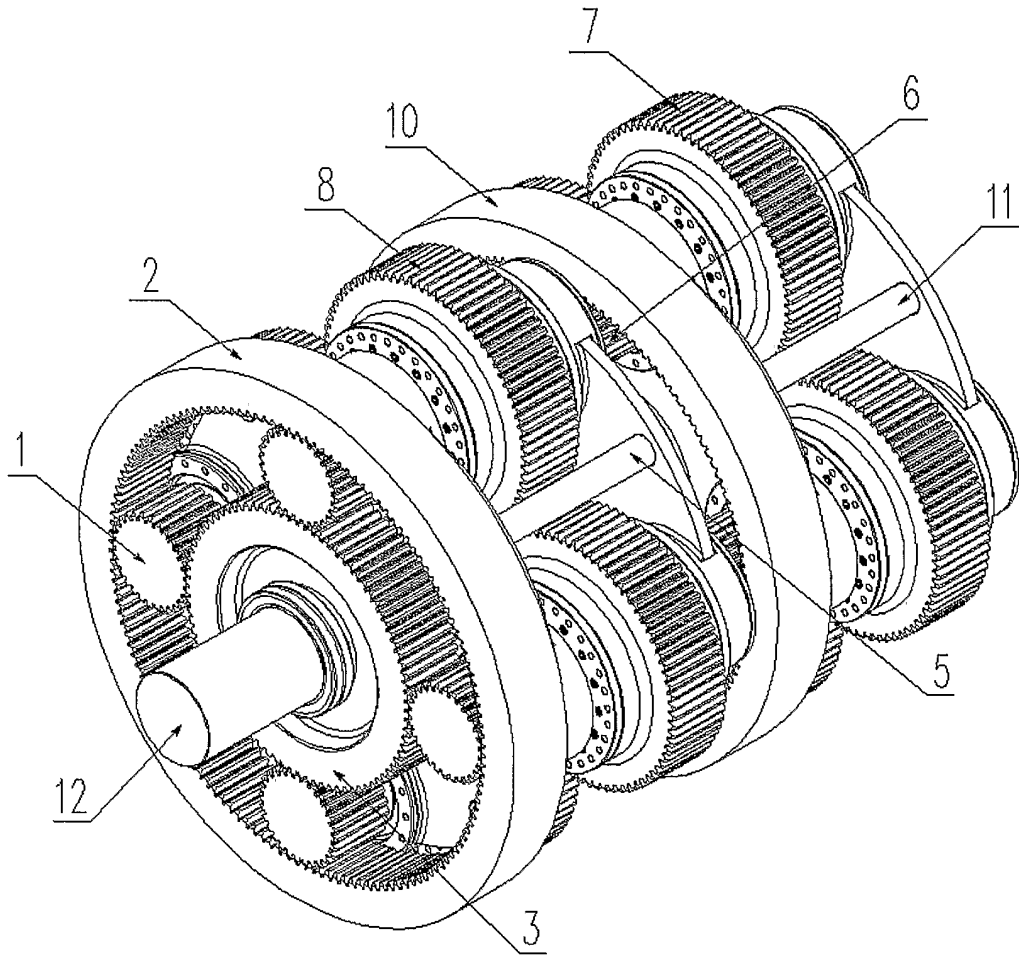


FIG. 1

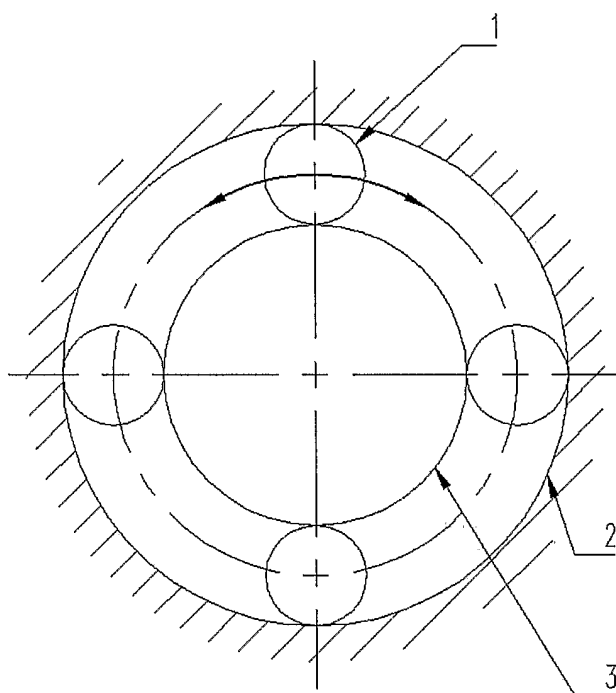


FIG. 2

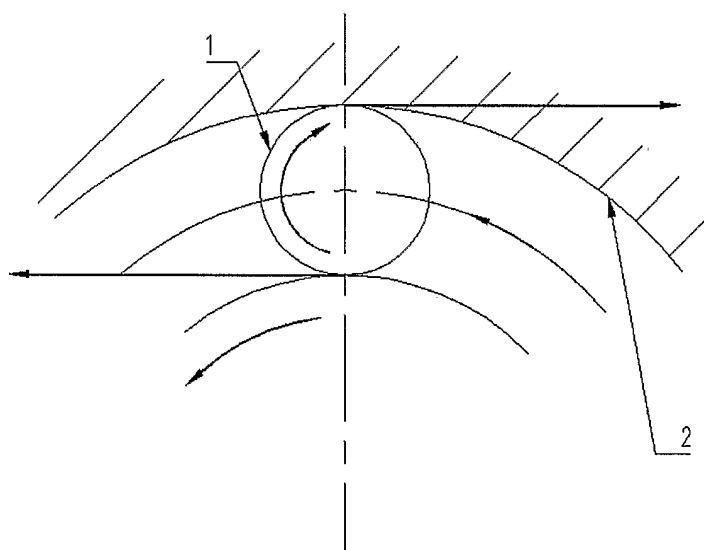


FIG. 3

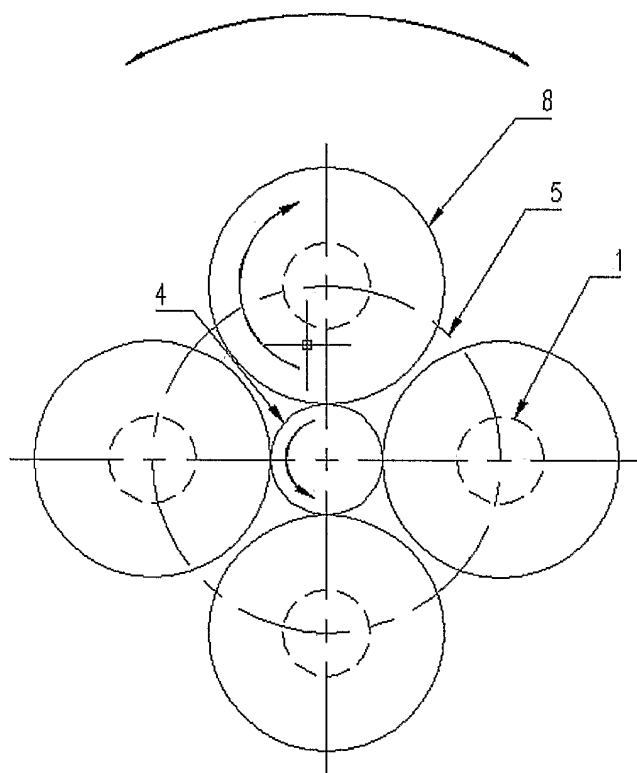


FIG. 5

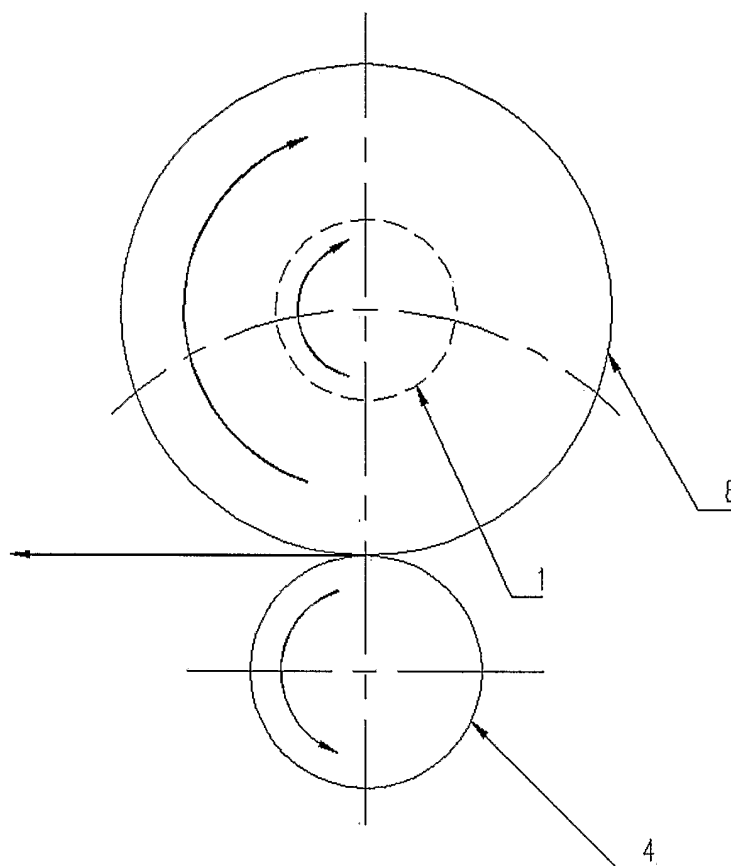


FIG. 5

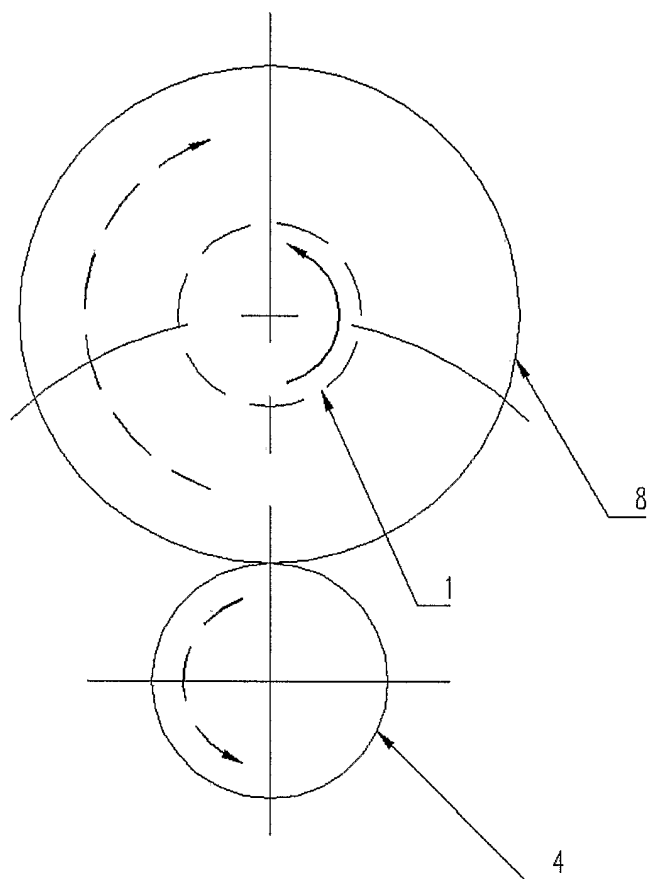


FIG. 6

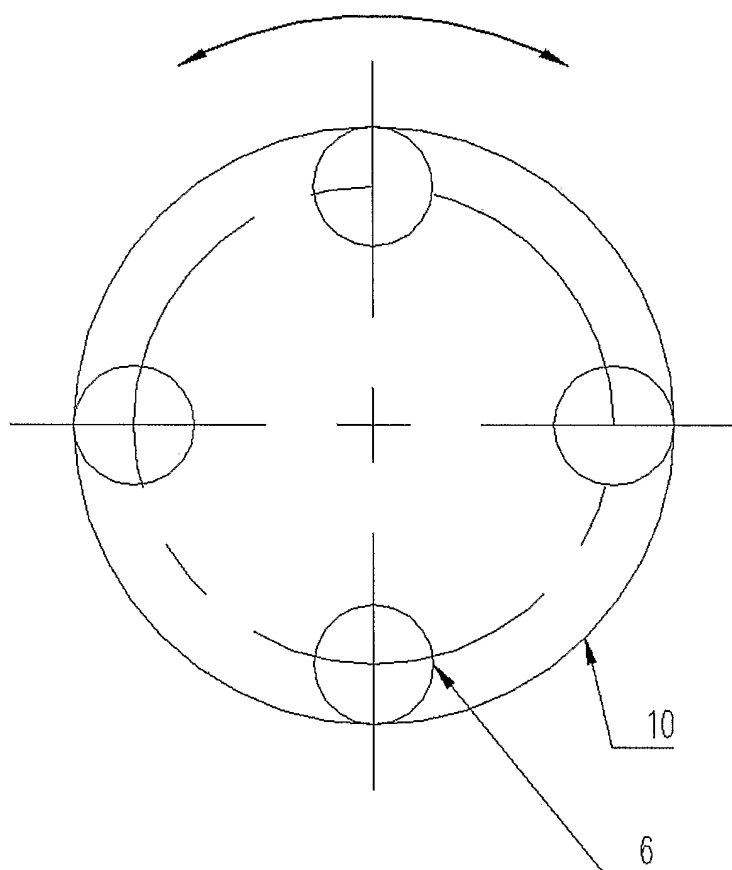


FIG. 7

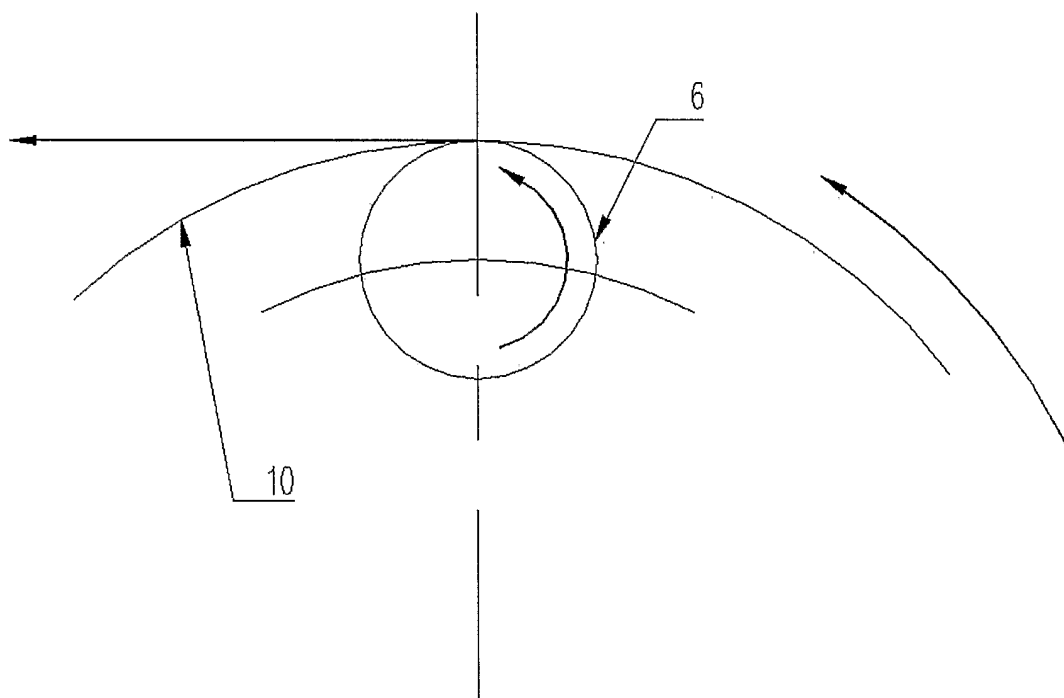


FIG. 8

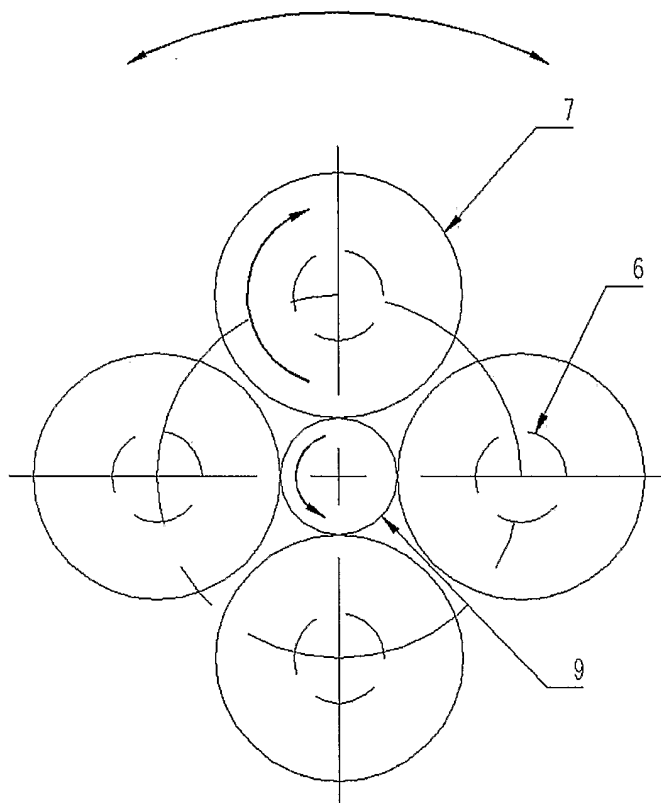


FIG. 9

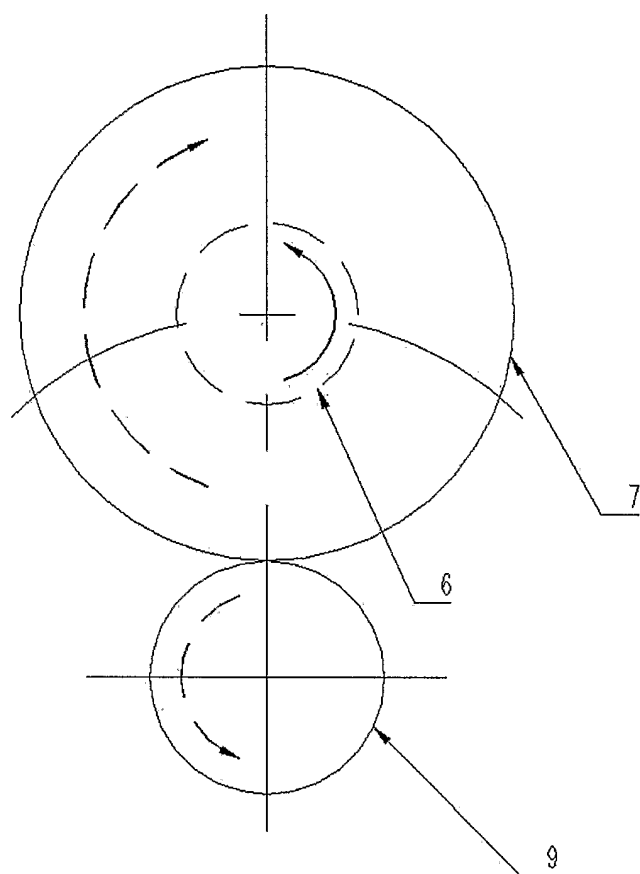


FIG. 10

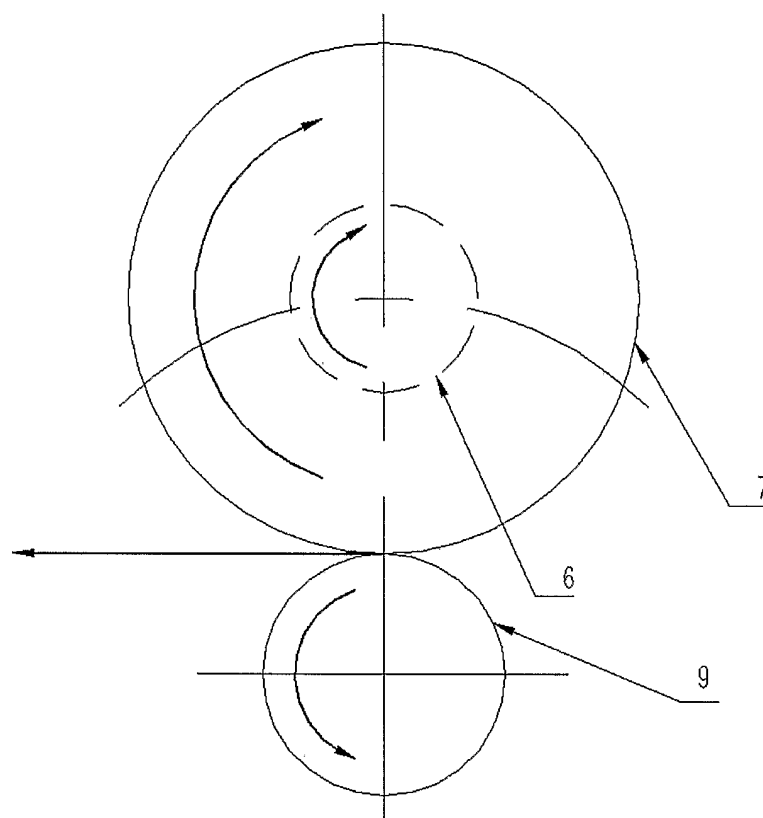


FIG. 11

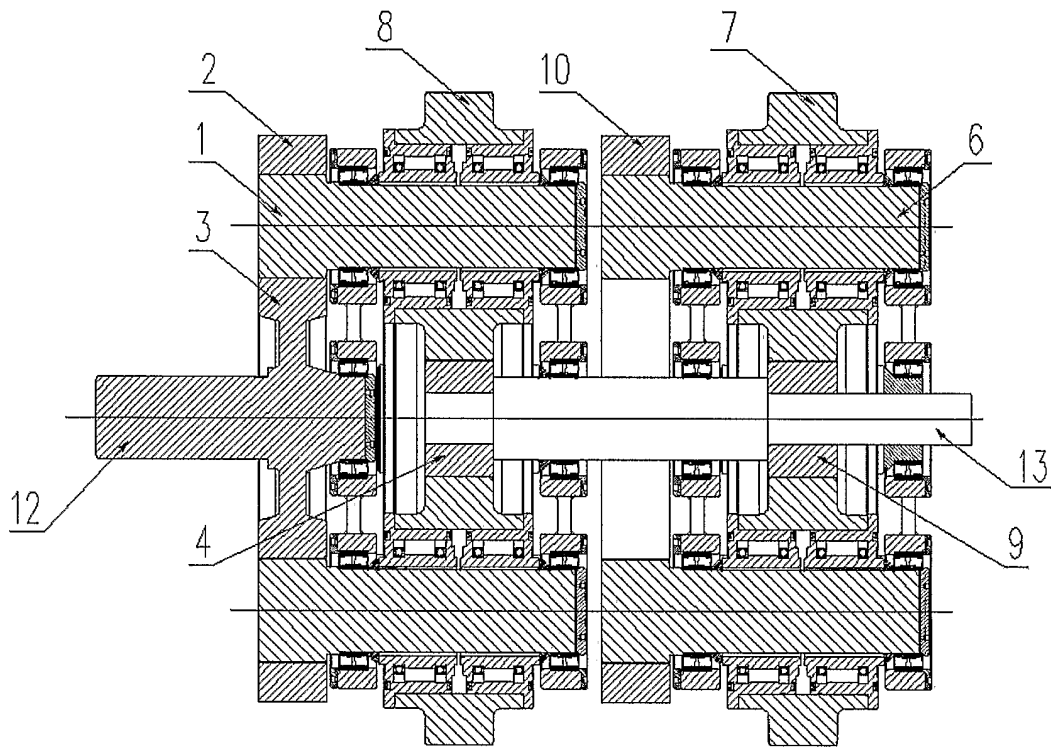


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/PT2006/000013A. CLASSIFICATION OF SUBJECT MATTER
INV. F03B13/14 F03G7/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F03G F03B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 494 144 B1 (PEREZ SANCHEZ ANTONIO M) 17 December 2002 (2002-12-17) the whole document	1
A	US 4 137 005 A (COMSTOCK ET AL) 30 January 1979 (1979-01-30) the whole document	1
A	US 3 641 762 A (JOHN DUMITRIU) 15 February 1972 (1972-02-15) the whole document	1
A	US 4 228 360 A (NAVARRO ET AL) 14 October 1980 (1980-10-14) the whole document	1
A	US 1 667 152 A (HEGGE MARTIN) 24 April 1928 (1928-04-24) the whole document	1

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Date of the actual completion of the international search

9 August 2006

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 4137005	A	NONE	
US 3641762	A	NONE	
US 4228360	A	NONE	
US 1667152	A	NONE	