

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
11 December 2003 (11.12.2003)

PCT

(10) International Publication Number
WO 03/102376 A2

(51) International Patent Classification⁷: **F01C**

MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(21) International Application Number: PCT/YU03/00015

(22) International Filing Date: 28 May 2003 (28.05.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
P - 399/02 31 May 2002 (31.05.2002) YU

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Declaration under Rule 4.17:

— of inventorship (Rule 4.17(iv)) for US only

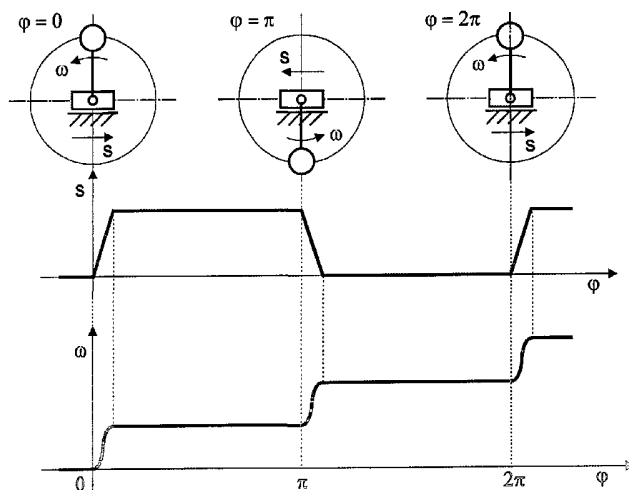
Published:

— without international search report and to be republished
upon receipt of that report

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: INERTIAL MECHANISMS ENABLING TRANSFORMATION OF OSCILLATORY INTO ONE-WAY CIRCULAR MOTION AND THE MODE OF ITS CONTROL



(57) Abstract: This invention solves the problem of transformation of the oscillating into one-way circular motion providing for the high coefficient of efficiency. The base of the mechanism is a pendulum (1) with a movable suspension so that generally speaking the mechanism has two degrees of freedom. Short-lived, impulsive displacement of suspension point for the angle of $\phi = 0, \Pi, 2\Pi \dots$ in the directions reverse to those of the instantaneous velocity of the mass m enables the transformation of motion. The mechanism has a variable structure so that in the intervals of oscillating lever (4) travelling, pendulums have two degrees of freedom, whereas in other intervals the mechanism retains only one degree of freedom. The basic advantage of this mechanism in reference to the existing piston mechanism is its high coefficient of efficiency because the maximum pressure of combustion gases can be brought into harmony with the optimal parameters of the mechanism enabling transformation of motion by appropriate selection of the moment of its application. It is possible to achieve completely dynamically balanced mechanism by symmetrically arranged elements.



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INERTIAL MECHANISMS ENABLING TRANSFORMATION OF OSCILLATORY INTO ONE-WAY CIRCULAR MOTION AND THE MODE OF ITS CONTROL

Field of the application

This invention is applicable to mechanical engineering, i.e. driving machines, or more precisely to the mechanisms providing transformation of oscillatory motion into on-way circular motion. According to the International Classification of Patents this invention is designated as follows: **F01C9/00**.

Technical issue

This invention solves the problem of transformation of oscillatory motion (either a straight-line or circular) into one-way circular motion without any force providing for the high efficiency (mechanical), by means of the newly formed principle of inertial transformation of motion.

State of engineering

The transformation of motion has been performed exclusively by means of mechanisms which were forced to move, i.e., that had only one degree of freedom. One parameter (an angle or movement of some element) is used to describe motion of other elements in the mechanism. The principle of forced motion implies that movement of one element forces the other elements of the mechanism to move according to a previously defined law of motion.

Different mechanisms can be used to provide for the transformation of oscillatory into one way-circular motion, but the best known and most frequently used one is the piston mechanism providing the straight-line oscillatory motion of the piston with a crank-shaft rotation in one direction. The basic disadvantage of such a mechanism is its very low coefficient of efficiency of the transformation. The forcing character of transformation causes it, because the pick value of the curvature defining

the pressure within the cylinder does not coincide with the mechanism optimal angle of transformation.

Essence of invention

The main element of the mechanism is a pendulum with a movable suspension. Generally speaking, the mechanism is characterized by two degrees of freedom: pendulum angle φ and straight-line or circular oscillating suspension displacement s . Short impulsive displacements of a point **A** at the angles of $\varphi=0, \pi, 2\pi...$ in the directions reverse to those of instantaneous velocity of the mass **m** provides one-way rotation of the pendulum of the length **l**. The mechanism has a variable structure therefore it has two degrees of freedom (φ, s) during the interval of the point **A** travelling, both of which are included in the dynamic parameters of the system, whereas in other intervals the mechanism retains only one degree of freedom (φ).

Motion transformation is performed in the intervals with two degrees of freedom (which provides its forceless motion), whereas in the intervals with one degree of freedom the mechanism motion is performed by means of inertia. The transformation of motion can be performed in any plane, however the pendulum motion is the steadiest within the equipotential plane.

Different actuators (pneumatic, hydraulic, piezoelectric, etc.) can be used to provide impulsive oscillating motion, however in practice the most important motion is performed by expansion caused by fuel combustion within the cylinders with straight-line motion.

The major advantage of this mechanism in reference to the existing ones is its high coefficient of efficiency since the maximum pressure of combustion gases can be achieved by selecting the appropriate moment of its application which can coincide with the optimal mechanism parameters, thus enabling motion transformation. The dynamically balanced mechanism can be achieved by means of symmetrically arranged elements in which both the internal the external forces are kept at balance within the designed structure throughout all periods of motion.

Short description of figures

The invention is outlined in details so that:

- Figure 1 - presents the major variant of the mechanism with the straight-line movement of the pendulum suspension.
- Figure 2 - presents the major variant with circular movement of the pendulum suspension.
- Figure 3 - presents the mode of control and the diagrams showing different phases of the mechanism motion.
- Figure 4 - presents a general structural design of the mechanism with flexible fixing of the oscillating and driving levers.
- Figure 5 - presents a structural design of the mechanism with sliding connection between the oscillating and driving levers.
- Figure 6 - presents a partially balanced mechanism, which is realized by means of two pendulums.
- Figure 7 - presents a completely balanced mechanism, which is realized by means of four pendulums.

Detailed description

This inertial mechanism which provides the transformation of the oscillating into one-way circular motion is a combination of a pendulum together with a movable suspension and a planetary gear. The mode of control of the newly formed mechanism with variable structure enables pendulum 1 one-way circular motion during the pendulum suspension oscillating movement. The transformation of motion is carried out so that for an angle of $\varphi=0, \pi, 2\pi...$ defining the position of the pendulum, there is a short-lived displacement of the pendulum suspension of magnitude s in the direction reverse to that of the instantaneous speed of the mass m . In other intervals the displacement of pendulum suspension 1 is prevented by means of control signals and the appropriate elements which provide one-way linear motion of pendulum 1 having angular velocity ω .

The application of the newly formed principle of motion transformation makes possible constructing of the mechanism, which is presented in Figure 4. The pendulum

1 having the mass m and the length l is rigidly attached to the planetary gear 2. These two elements are flexibly connected to the oscillating lever 4 at the point **A**. The planetary gear 2 and a central gear wheel 3 are constantly kinematically coupled, so the gear wheel shaft 4 is considered to be the output shaft of the mechanism which enables transmitting of the transformed motion energy. Driving levers 5 and 6 are flexibly connected at the point **C** to the oscillating lever 4. Travelling of the oscillating lever is prevented by limit stops 7 and 8 and activating the cut-out elements 9 and 10 preventing its travelling by means of their shape enables its resting. Figure 5 presents one variant of the mechanism, which instead of the flexible connection has a sliding connection between the lever 5 and the oscillating lever 4.

To provide partial mechanism balance it is possible to use two pendulums 1 and 11, symmetrically arranged in reference to the central line of the central gear wheel 3, presented in Figure 6. The positions of both pendulums in reference to the oscillating lever are identical, and in case of identical parameters of pendulum 1, the vertical forces of the mechanism are balanced.

To provide complete mechanism balance it is necessary to design a structure presented in Figure 7, which includes two partially, balanced mechanisms. Central gear wheels 3 and 13, of the same dimensions, are constantly kinematically coupled, therefore transmitting of energy can be performed through one of them. Identical parameters of pendulums (m and l), the angle φ and gear wheel dimensions provide for the balancing of both the internal and external forces throughout all intervals of mechanism motion.

Industrial and other applications

The newly formed principle of motion transformation together with the suggested structural design and the mode of control enable modeling of the mechanism providing for the transformation of the oscillating into one-way circular motion which has a high coefficient of efficiency and is expected to be broadly applied to the internal combustion engines. The advantage of this mechanism is especially important in cases of oxygene-hydrogene mixture used as fuel producing power due to its impulsive force action during combustion.

Patent requests

1. The inertial mechanism intended for the transformation of oscillatory into one-way circular motion **marked by** the oscillating lever (4) which has its rotating axis correspondent to that of the output central gear wheel shaft (3) and is attached to the flexibly connected driving levers (5) and (6) and firmly fixed pendulum (1) to the planetary gear wheel (2), where the planetary gear wheel (2) is constantly coupled with the central planetary gear (3), whereas pairs of limit-stops (7) and (8) cut-out elements (9) and (10) alternatively make connection through their end parts with the oscillating lever (4) within the intervals of its resting.

2. The mechanism according to request 1 **marked by** that it has one driving lever (5) movable axially along its own axis, which in combination with the oscillating lever (4) makes a reverse link kinematic pair.

3. According to the request 1 and 2, the mechanism, **marked by** that it includes the oscillating lever (4), with two rigidly attached pendulums (1) to the planetary gear wheel (2) flexibly connected to it and pendulums (11) connected to the planetary gear wheel (12) so that planetary gear wheels (2) and (12) are constantly coupled with the outlet central gear wheel (3), which are located symmetrically in reference to the axis of its rotation.

4. This mechanism includes two mechanisms according to the request 3, **marked by** the mutual constant kinematic mesh of the central gear wheels (3) and (13).

5. The mode of control of the inertial mechanism providing for the transformation of the oscillating into one-way circular motion, is **marked by** the parameter used to control its motion which is defined by the angle φ formed by the pendulum (1) and the oscillating lever (4), whereas the control signals provide variable mechanism structure thus enabling short-lived period of pendulum suspension displacement (1) for the parameters $\varphi=0, \pi, 2\pi...$ in the directions reverse to that of the instantaneous velocity of the mass m , and in other intervals of the basic cycle ($\varphi=0 \div 2\pi$) they provide pendulum suspension (1) resting.

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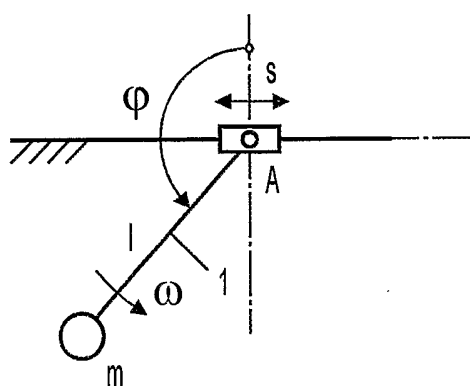


Figure 1

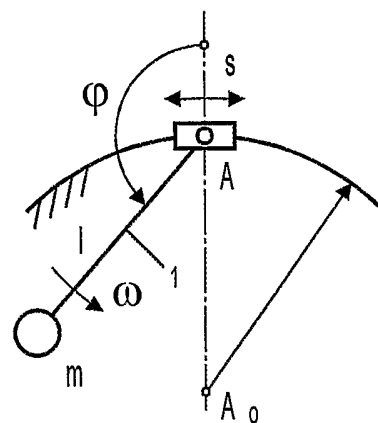


Figure 2

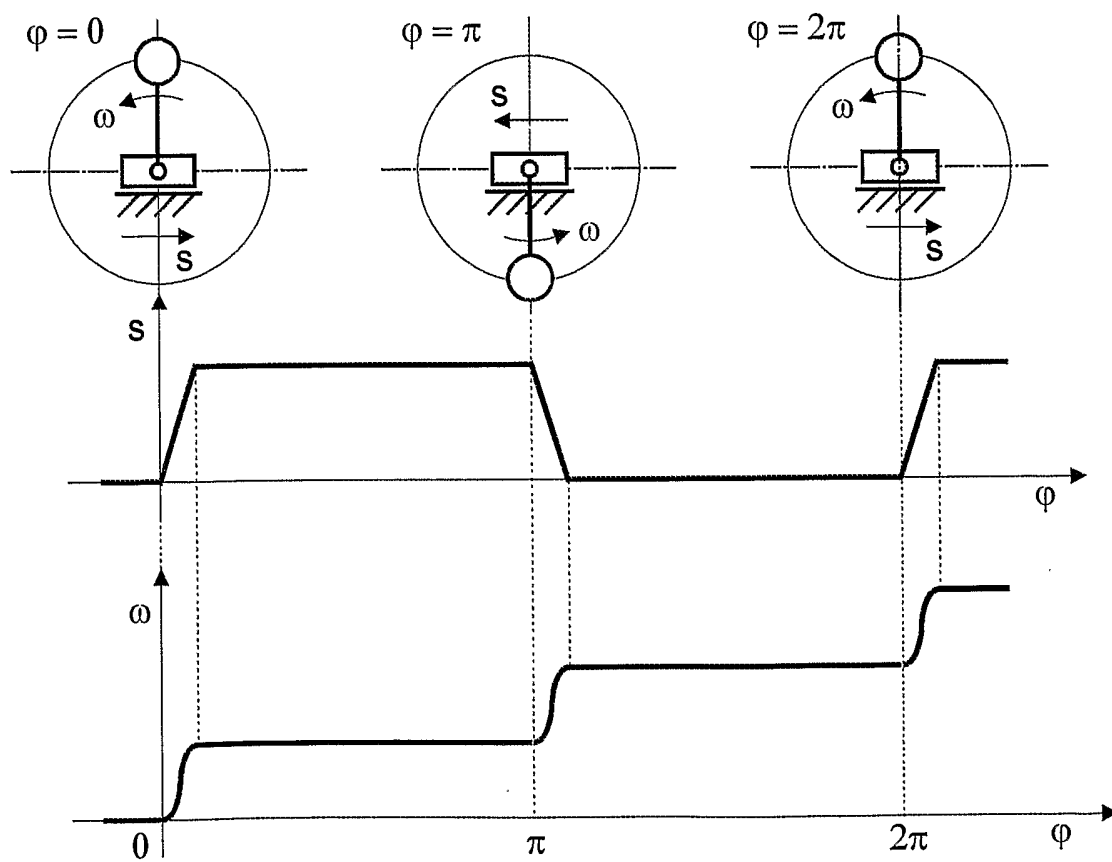


Figure 3

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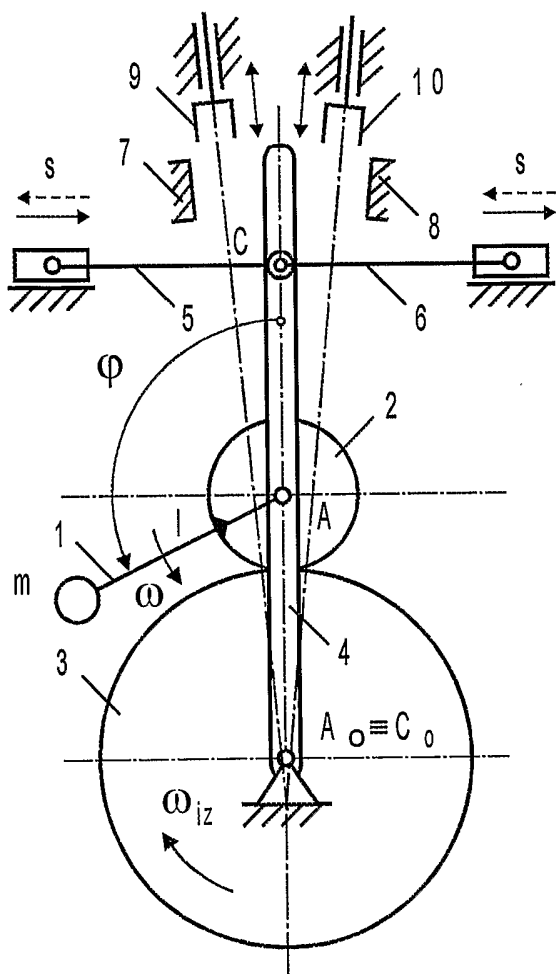


Figure 4

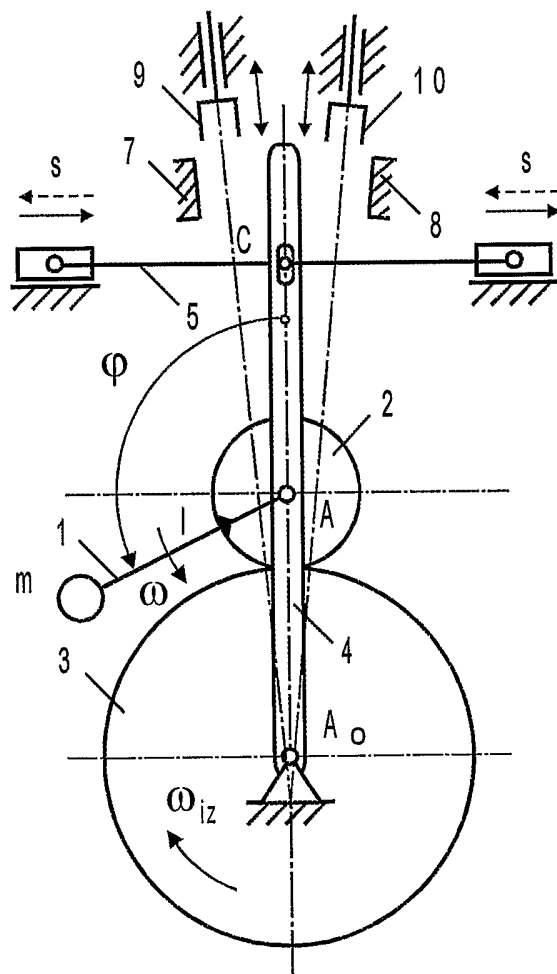


Figure 5

