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[Continued on next page]

(54) Title: DEVICE OF CONTROLLING CRANKSHAFT POSITION AND ENGINE COMPRING THE SAME

(57) Abstract: A device (100) of controlling crankshaft position of an engine (1000) and an engine (1000) including the device (100) are provided. The device (100) includes: a flywheel (1) adapted to be mounted on a crankshaft (900) of the engine (1000) and having a fitting groove (10) formed in an outer peripheral wall of the flywheel (1);a swinging arm (2) defining a first end (201) adapted to pivotally connect to a body (200) of the engine (1000) and a second end (202) having a fitting tooth (20), and the swinging arm (2) can swing around the first end between an engaging position and a disengaging position; and an actuating assembly (3) connected to the swinging arm (2) to drive the swinging arm (2) to swing.

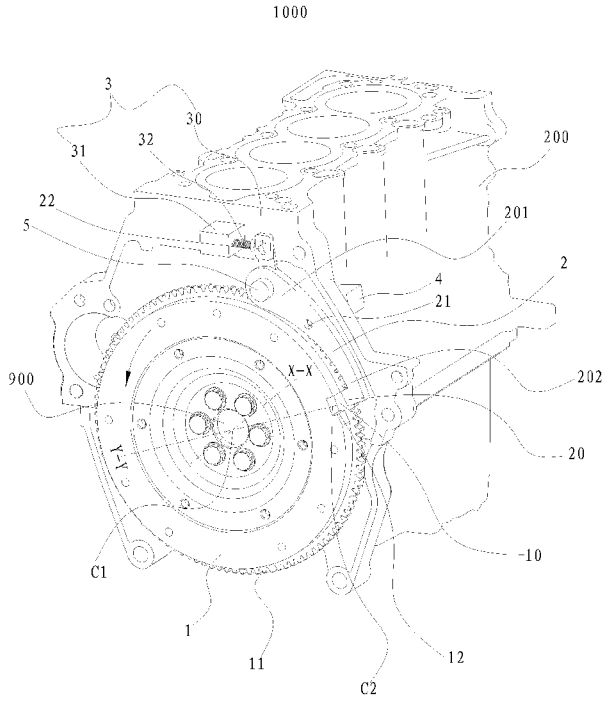

Fig. 1

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DEVICE OF CONTROLLING CRANKSHAFT POSITION AND ENGINE COMPRING THE SAME

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority and benefits of Chinese Patent Application No. 201310105884.2, filed with State Intellectual Property Office of China, on March 28, 2013, the entire content of which is incorporated herein by reference.

FIELD

Embodiments of the present disclosure generally relate to the field of automobiles, more particularly, to a device of controlling crankshaft position of an engine and an engine including the device.

BACKGROUND

Vehicles with hybrid systems have been widely used. The hybrid system is generally equipped with a low-temperature starter to ignite an engine at a low temperature. However, the cost of the hybrid system is increased due to the addition of the low-temperature starter. Furthermore, the low-temperature starter is unnecessary when the engine is started at a normal temperature.

SUMMARY

Embodiments of the present disclosure seek to solve at least one of the problems existing in the related art to at least some extent.

Embodiments of a first aspect of the present disclosure are to provide a device of controlling crankshaft position of an engine, which can control the position of the crankshaft of the engine when the engine stops operation so that at least one of pistons of the engine is positioned in an optimum ignition position.

Embodiments of a second aspect of the present disclosure are to provide an engine having the above device of controlling crankshaft position of an engine.

In some embodiments, the device of controlling crankshaft position includes: a flywheel adapted to be mounted on a crankshaft of the engine and having a fitting groove formed in an outer

peripheral wall of the flywheel; a swinging arm defining a first end adapted to pivotally connect to a body of the engine and a second end having a fitting tooth, in which the swinging arm can swing around the first end between an engaging position in which the fitting tooth is engaged within the fitting groove and a disengaging position in which the fitting tooth is disengaged from the fitting groove; and an actuating assembly connected to the swinging arm to drive the swinging arm to swing.

In some embodiments, the engine includes a body, a crankshaft, and the device of controlling crankshaft position as described above.

With the device of controlling crankshaft position and the engine according to embodiments of the present disclosure, the device can control the stop position of the crankshaft when the engine stops operation such that at least one of pistons of the engine is positioned in the optimum ignition position, thereby the engine can be started successfully next time without the low-temperature starter necessary in the related art, so that the cost is reduced and the structure of the engine is simplified.

Additional aspects and advantages of embodiments of present disclosure will be given in part in the following descriptions, become apparent in part from the following descriptions, or be learned from the practice of the embodiments of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects and advantages of embodiments of the present disclosure will become apparent and more readily appreciated from the following descriptions made with reference to the accompanying drawings, in which:

Fig. 1 is a schematic view of a device of controlling crankshaft position according to an embodiment of the present disclosure, in which the device is mounted on a body of an engine;

Fig. 2 is a schematic view of operation states of an actuating assembly and a swinging arm of the device according to an embodiment of the present disclosure, in which the device is in an unlocked state;

Fig. 3 is a schematic view of operation states of a locking assembly of the device according to an embodiment of the present disclosure, in which the device is in an unlocked state;

Fig. 4 is a schematic view of operation states of an actuating assembly and a swinging arm of the device according to an embodiment of the present disclosure, in which the device is in a state

to be about to be locked;

Fig. 5 is a schematic view of an operation state of a locking assembly of the device according to an embodiment of the present disclosure, in which the device is in a state to be about to be locked;

Fig. 6 is a schematic view of operation states of an actuating assembly and a swinging arm of the device according to an embodiment of the present disclosure, in which the device is in a locked state;

Fig. 7 is a schematic view of an operation state of a locking assembly of the device according to an embodiment of the present disclosure, in which the device is in a locked state;

Fig. 8 is a schematic view of a device of controlling crankshaft position according to another embodiment of the present disclosure, in which the device is in an unlocked state;

Fig. 9 is a schematic view of the device of controlling crankshaft position as shown in Fig. 8, in which the device is in a state to be locked;

Fig. 10 is a schematic view of the device of controlling crankshaft position as shown in Fig. 8, in which the device is in a locked state.

DETAILED DESCRIPTION

Reference will be made in detail to embodiments of the present disclosure. The same or similar elements and the elements having same or similar functions are denoted by like reference numerals throughout the descriptions. The embodiments described herein with reference to drawings are explanatory, illustrative, and used to generally understand the present disclosure. The embodiments shall not be construed to limit the present disclosure.

In addition, terms such as "first" and "second" are used herein for purposes of description and are not intended to indicate or imply relative importance or significance. Thus, features limited by "first" and "second" are intended to indicate or imply including one or more than one these features. In the description of the present disclosure, "a plurality of" relates to two or more than two.

In the description of the present disclosure, unless specified or limited otherwise, it should be noted that, terms "mounted," "connected" "coupled" and "fastened" may be understood broadly, such as permanent connection or detachable connection, electronic connection or mechanical connection, direct connection or indirect connection via intermediary, inner communication or

interreaction between two elements. These having ordinary skills in the art should understand the specific meanings in the present disclosure according to specific situations.

In the description of the present disclosure, a structure in which a first feature is "on" a second feature may include an embodiment in which the first feature directly contacts the second feature, and may also include an embodiment in which an additional feature is formed between the first feature and the second feature so that the first feature does not directly contact the second feature, unless otherwise specified. Furthermore, a first feature "on," "above," or "on top of" a second feature may include an embodiment in which the first feature is right "on," "above," or "on top of" the second feature, and may also include an embodiment in which the first feature is not right "on," "above," or "on top of" the second feature, or just means that the first feature has a sea level elevation larger than the sea level elevation of the second feature. While first feature "beneath," "below," or "on bottom of" a second feature may include an embodiment in which the first feature is right "beneath," "below," or "on bottom of" the second feature, and may also include an embodiment in which the first feature is not right "beneath," "below," or "on bottom of" the second feature, or just means that the first feature has a sea level elevation smaller than the sea level elevation of the second feature.

A device of controlling crankshaft position for an engine according to embodiments of the present disclosure will be described in detail with reference to Figs.1 to 10.

In some embodiments, the engine may include a crankshaft 900, a body 200 and pistons (not shown). The operating principle of the engine, being well known in the art, will not be described in detail here. An optimum ignition position of the engine refers to a position in which the engine is most easily ignited, in other words, an optimum ignition is a position in which a piston is in the top dead center position and the rotational angle of the crankshaft is between 90 to 105 degrees.

In some embodiments, the device of controlling crankshaft position100, as shown in Figs.1-10, includes a flywheel 1, a swinging arm 2 and an actuating assembly 3. The flywheel 1 is adapted to be mounted on a crankshaft 900 of the engine 1000 and has a fitting groove 10 formed in an outer peripheral wall of the flywheel 1. The flywheel 1 can be driven to rotate through a rotation of the crankshaft 900, and the crankshaft 900 can be also driven to rotate through a rotation of the flywheel 1. The swinging arm 2 has a first end 201 adapted to pivotally connect to a body 200 of the engine 1000 and a second end 202 having a fitting tooth 20.

The swinging arm 2 is pivotally connected to the body 200 via a pivot shaft 5 parallel to a

central axis X-X of the flywheel 1.

The swinging arm 2 can swing around the first end between an engaging position, in which the fitting tooth 20 is engaged within the fitting groove 10, and a disengaging position, in which the fitting tooth 20 is disengaged from the fitting groove 10. More particularly, a width W1of the tooth 20 is smaller than a width W2 (size in the circumferential direction of the flywheel) of the fitting groove 10.

The actuating assembly 3 is connected to the swinging arm 2 to drive the swinging arm 2 to swing. Those having ordinary skill in the art will appreciate that the actuating assembly 3 may be electrically connected with a control apparatus (such as ECU) of the vehicle to drive the swinging arm 2 according to the operating state of the engine 1000.

There, the flywheel 1 shall be broadly understood, in other words, the flywheel 1 may be a conventional flywheel mounted on the crankshaft of the engine. As shown in Fig. 1, the outer peripheral surface of the flywheel 1 is formed with teeth 11which are configured to connect to a starter for igniting the engine. Alternately, if there is no starter, the engine may be ignited via injecting air-fuel mixture from a compression tank additionally provided to a cylinder which is in a compression stroke. Accordingly, the flywheel 1 may not have teeth on the outer periphery thereof, and the flywheel may be configured as a plate-shaped element different from the flywheel in the related art, as long as the position of the crankshaft can be detected by the flywheel, so as to detect the strokes of the cylinders of the engine.

In some embodiments, in the engaging position, the fitting tooth 20 is engaged within the fitting groove 10 to stop the rotation of the flywheel 1, so as to stop the crankshaft 900, and the device 100 is in a locked state.

In the disengaging position, the fitting tooth 20 is disengaged from the fitting groove 10, so that the flywheel 1 and the crankshaft 900 are rotatable, and the device 100 is in an unlocked state.

Those having ordinary skill in the art will appreciate that, when the swinging arm 2 swings to the engaging position, it can be designed that at least one of the pistons is just in the optimum ignition position as the crankshaft 900 is stopped.

When the engine is ignited, the actuating assembly 3 drives the swinging arm 2 to swing to the disengaging position, then the swinging arm 2 is held in the disengaging position. The fitting tooth 20 is disengaged from the fitting groove 10, so that the flywheel 1 and the crankshaft 900 are free to rotate. The device 100 is in the unlocked state.

When the engine is about to be stopped, the rotation speed of the flywheel 1 is decreased gradually. The actuating assembly 3 drives the swinging arm 2 to swing from the disengaging position to the engaging position. The fitting tooth 20 is contacted with the outer peripheral wall of the flywheel 1, thus, the device 100 is about to be locked, that is, the device 100 is in a state to be about to be locked.

When the fitting groove 10 moves across the fitting tooth 20, the second end 202 of the swinging arm 2 tends to move toward a center C1 of the flywheel 1 by a certain distance. The moving distance of the swinging arm 2 depends on a width difference between the fitting groove 10 and the fitting tooth 20 and the rotation speed of the flywheel 1.

As the width difference is a fixed value, the higher the rotation speed of the flywheel 1, the shorter the moving distance of the fitting tooth 20 is, on the contrary, the slower rotation speed of the flywheel 1, the longer the moving distance of the fitting tooth 20 is.

Moreover, the flywheel 1 rotates with a high speed, the fitting tooth 20 cannot be engaged within the fitting groove 10. When the rotation speed of the flywheel 1 is lower than a critical rotation speed, the fitting tooth 20 can be engaged within the fitting groove 10, so that the device 100 is locked (that is, the device 100 is in the locked state), the crankshaft 900 is stopped, and at least one of the pistons of the engine is in the optimum ignition position for igniting the engine 1000 next time. It is noted that the critical rotation speed refers to a speed at which the fitting tooth 20 can be just engaged within the fitting groove 10. In the present disclosure, by designing a proper width difference between the fitting groove 10 and the fitting tooth 20, the critical rotation speed of the engine can be as slow as possible, thus, an impact of engagement between the fitting groove 10 and the fitting tooth 20 can be reduced.

With the device of controlling crankshaft position according to embodiments of the present disclosure, the stop position of the crankshaft 900 can be controlled to ensure that at least one of the pistons is positioned in the optimum ignition position when the engine stops operation, thus ensuring the engine can be started successfully next time without the low-temperature starter, in addition, the cost of the engine may be reduced, and the structure of the engine can be simplified.

As shown in Fig. 1, in some embodiments, surfaces of side walls 12 of the fitting groove 10 are planar and parallel to a line Y-Y passing through the center C1 of the flywheel 1 and the center C2 of the fitting groove 10, thereby the fitting groove 10 and the fitting tooth 20 are easily engaged.

Furthermore, upstream side walls 13 of the fitting grooves 10 in a rotation direction of the flywheel 1 are transitioned into an outer peripheral wall of the flywheel 1 via bevels respectively. Thus, when the device 100 is about to be locked (that is, the device 100 is in a state to be about to be locked), one side wall 12 of the fitting groove 10, which is contacted with the fitting tooth 20 in advance, is higher than the other side wall 12 of the fitting groove 10, and the moving distance of the fitting tooth 20 is greater than the height difference between the two sidewalls 12 of the fitting groove 10, the fitting tooth 20 can be engaged with the fitting groove 10. In the present disclosure, the critical rotation speed of the engine can be reduced by designing the height difference between the two side walls 12 of the fitting groove 10, thus, the engagement impact between the fitting groove 10 and the fitting tooth 20 may be further increased and the fitting groove 10 and the fitting tooth 20 are engaged more conveniently .

Implementation 1:

As shown in Figs. 1 to 7, the actuating assembly 3 includes a first inductive member 30, a first electromagnetic coil 31 and a first spring 32.

The first inductive member 30 is connected to the swinging arm 2 and may be an armature. The first electromagnetic coil 31 is configured to actuate the first inductive member 30 to drive the swinging arm 2 to swing toward one of the disengaging position and the engaging position.

Specifically, the first electromagnetic coil 31may be disposed in a housing to facilitate the mounting of the first electromagnetic coil 31on the body 200, and the first electromagnetic coil 31 is connected with a power source of the engine 1000.

The first spring 32 is disposed between the body 200 and the first inductive member 30, so as to normally push the first inductive member 30 to drive the swinging arm 2 to swing toward the other of the disengaging position and the engaging position. That is, a direction of the force applied to the first inductive member 30 by the first spring 32 is opposite to a direction of the driving force applied to the first inductive member 30 by the first electromagnetic coil 31.

For example, when the first electromagnetic coil 31 is energized to drive the first inductive member 30 to swing the swinging arm 2 toward the disengaging position, the first spring 32 is normally push the first inductive member 30 to drive the swinging arm 2 to swing toward the engaging position.

The first spring 32 may be configured as a compression spring or an extension spring. Those having ordinary skill in the art will appreciate that the operation principle of the actuating

assembly 3 with the first spring being the extension spring is the same as that of the actuating assembly with the first spring being the extension spring. Thus, the detailed operation of the actuating assembly 3 with the first spring being a compression spring will be described below.

As shown in Figs.1-7, a first end of the first inductive member 30 is inserted into the first electromagnetic coil 31, and a second end of the first inductive member 30 is connected to the swinging arm 2. When the device 100 is in the unlocked state and the first electromagnetic coil 31 is energized, the first inductive member 30 is driven to move along a direction toward the first electromagnetic coil 31 by the electromagnetic force generated by the first electromagnetic coil 31. During the movement of the first inductive member 30, the first inductive member 30 actuates the swinging arm 2 to swing toward the disengaging position and the swinging arm 2 is held in the disengaging position. Meanwhile, the first spring 32 is compressed.

When the device 100 is about to be locked, the first electromagnetic coil 31 is energized, no electromagnetic force is generated. The first inductive member 30 is pushed to move in the direction away from the first electromagnetic coil 31 by the spring force of the first spring 32. During the movement of the first inductive member 30, the first inductive member 30 actuates the swinging arm 2 to swing towards the engaging position, so that the fitting tooth 20 is contacted with the outer peripheral wall of the flywheel 1 until the fitting tooth 20 is engaged within the fitting groove 10.

When the device 100 is locked, the first electromagnetic coil 31 is still energized, so that the first inductive member 30 is pushed along the direction away from the first electromagnetic coil 31 by the spring force of the first spring 32, so as to hold the swinging arm 2 in the engaging position.

Specifically, as shown in Fig.1, Fig. 2, Fig.4 and Fig. 6, a sliding groove 300 is formed in an end of the first inductive member 30, and the swinging arm 2 has a connecting shaft 22 movably fitted within the sliding groove 300. In other words, the swinging arm 2 is connected with the first inductive member 30 via the connecting shaft 22. During the movement of the first inductive member 30, the first inductive member 30 drives the connecting shaft 22 to move, so that the swinging arm 2 is driven to swing about the pivot shaft 5.

More specifically, as shown in Fig. 1, Fig. 2, Fig. 4 and Fig. 6, the swinging arm 2 has a connecting lug 23 at the first end 201 of the swinging arm 2, and the connecting shaft 22 is disposed on a free end of the connecting lug 23. The connecting lug 23, the connecting shaft 22 and the swinging arm 2 may be formed integrally.

Furthermore, in some embodiments, the device 100 further includes a locking assembly 4 used to lock the swinging arm 2 in the disengaging position. The locking assembly 4 can prevent the swinging arm 2 from releasing from the disengaging position, thus, improving the reliability of the device 100.

The swinging arm 2 has a locking hole 21 penetrating therethrough in a thickness direction of the swinging arm 2. The locking assembly 4 includes a second inductive member 40, a second electromagnetic coil 41 and a second spring 42, as shown in Figs. 3, 5 and 7. The second inductive member 40 has a first end and a second end inserted into the second electromagnetic coil 41. The second inductive member 40 is movable between a locked position in which the first end thereof is engaged into the locking hole 21 and a releasing position in which the first end thereof is disengaged from the locking hole 21. The second inductive member 40 may be a pin armature.

The second electromagnetic coil 41 is used to actuate the second inductive member 40 to move toward one of the locked position and the releasing position.

The second electromagnetic coil 41 may be disposed in a housing such that the second electromagnetic coil 41 is easy to mount on the body 200. The second electromagnetic coil 41 is connected with a power source of the engine 1000.

The second spring 42 is disposed between the body 200 and the second inductive member 40 and used to normally push the second inductive member 40 to move toward the other of the locked position and the releasing position. That is, a direction of the spring force applied to the second inductive member 40 by the second spring 42 is opposite to a direction of driving force applied to the second inductive member 40 by the second electromagnetic coil 41.

For example, when the second electromagnetic coil 41 is energized to drive the second inductive member 40 to move toward the releasing position, the second spring 42 normally push the second inductive member 40 to move toward the locked position.

According to the moving direction of the second inductive member 40 driven by the second electromagnetic coil 41, the second spring 42 may be a compression spring or an extension spring. Those having ordinary skill in the art will appreciate that the operation principle of the locking assembly 4 with the second spring 42 being the compression spring is the same as that of the locking assembly with the second spring 42 being the extension spring. Thus, the detailed operation of the locking assembly 4 with the second spring 42 being the compression spring will be described below.

When the device 100 is in the unlocked state, the actuating assembly 3 drives the swinging arm 2 to swing to the disengaging position. The second electromagnetic coil 41 is deenergized, no electromagnetic force is generated. The second inductive member 40 is moved toward the locking position by a spring force of the second spring 42. The first end of the second inductive member is inserted into the locking hole 21 of the swinging arm 2, meanwhile the swinging arm 2 is positioned and held in the releasing position.

When the device 100 is going to the locked state, the second electromagnetic coil 41 is energized. The second inductive member 40 is driven to move toward the releasing position under the electromagnetic force of the second electromagnetic coil 41, that is, the first end of the second inductive member 40 is disengaged from the locking hole 21. The actuating assembly 3 drives the swinging arm 2 to swing toward the engaging position in the mean time.

Implementation 2:

As shown in Figs. 8 - 10, in some embodiments, the actuating assembly 3 includes a first rod 33, a second rod 34 and an actuating member 35.The first rod 33 has first and second ends and the first end of the first rod 33 is pivotally connected to the body 200. The second rod 34 has a first end pivotally connected to the second end of the first rod 33 and a second end connected to the swinging arm 2. The actuating member 35 is connected to a joint between the first rod 33 and the second rod 34 to drive the first rod 33 and the second rod 34 to rotate. Thus, the structure of the actuating assembly 3 is simple and reliable.

Specifically, when the engine operates, the actuating member 35 drives the first rod 33 and the second rod 34 to rotate and a predetermined angle between the first rod 33 and the second rod 34 is formed. At this time, as shown in Fig. 8, the second rod 34 drives the swinging arm 2 to swing to the disengaging position and holds the swinging arm 2 in the disengaging position.

As shown in Figs 9 and 10, when the engine is going to stop, the actuating member 35 drives the first rod 33 and second rod 34 to rotate until the first rod 33 and second rod 34 are collinear. During this process, the second rod 34 drives the swinging arm 2 to swing toward the engaging position so that the fitting tooth 20 of the swinging arm 2 is contacted with the outer peripheral wall of the flywheel 1until the fitting tooth 20 is engaged in the fitting groove 10. Thus, the flywheel 1 stops rotating and the crankshaft 900 is stopped in the stop position where at least one of the pistons of the engine is positioned in the optimum ignition position.

Furthermore, the actuating assembly 3 may further include a third spring 36.The third spring 36 is fitted over the second rob 34 to normally drive the swinging arm 2 toward the engaging position, thus improving the reliability of the actuating assembly 3, and avoiding the fitting tooth 20 releasing from the fitting groove 10.

Implementation 3:

In some embodiments, the engine 1000 including the device 100 is described above. As shown in FIG. 1, the engine 1000 may include a body 200, a crankshaft 900 and the device 100 as described above.

With the device 100 of controlling crankshaft position according to embodiments of the present disclosure, the stop position of the crankshaft can be controlled, such that at least one of the pistons is positioned in the optimum ignition position when the engine stops operation, thereby the engine can be started successfully next time without the low-temperature starter, so that the cost of the engine can be reduced and the structure of the engine is simplified.

Reference throughout this specification to “an embodiment,” “some embodiments,” “an example,” “a specific example,” or “some examples,” means that a particular feature, structure, material, or characteristic described in connection with the embodiment or example is included in at least one embodiment or example of the present disclosure. The appearances of the phrases throughout this specification are not necessarily referring to the same embodiment or example of the present disclosure. Furthermore, the particular features, structures, materials, or characteristics may be combined in any suitable manner in one or more embodiments or examples.

Although explanatory embodiments have been shown and described, it would be appreciated by those skilled in the art that the above embodiments cannot be construed to limit the present disclosure, and changes, alternatives, and modifications can be made in the embodiments without departing from spirit, principles and scope of the present disclosure.

What is claimed is:

1. A device of controlling crankshaft position of an engine, comprising:

a flywheel adapted to be mounted on a crankshaft of the engine and having a fitting groove formed in an outer peripheral wall of the flywheel;

a swinging arm defining a first end adapted to pivotally connect to a body of the engine and a second end having a fitting tooth, the swinging arm being able to swing around the first end between an engaging position in which the fitting tooth is engaged within the fitting groove and a disengaging position in which the fitting tooth is disengaged from the fitting groove; and

an actuating assembly connected to the swinging arm to drive the swinging arm to swing.

2. The device of claim 1, wherein the actuating assembly comprises:

a first inductive member connected to the swinging arm;

a first electromagnetic coil configured to actuate the first inductive member to swing the swinging arm toward one of the disengaging position and the engaging position; and

a first spring disposed between the body and the first inductive member and configured to normally drive the first inductive member to swing the swinging arm toward the other of the disengaging position and the engaging position.

3. The device of claim 1 or 2, further comprising a locking assembly configured to lock the swinging arm in the disengaging position.

4. The device of claim 3, wherein the swinging arm has a locking hole penetrating therethrough in a thickness direction of the swinging arm; and

wherein the locking assembly comprising:

a second inductive member defining first and second ends and movable between a locked position in which the first end is engaged within the locking hole and a releasing position in which the first end is disengaged from the locking hole;

a second electromagnetic coil configured to actuate the second inductive member to move toward one of the locked position and the releasing position; and

a second spring disposed between the body and the second inductive member and configured to normally drive the second inductive member to move toward the other of the locked position

and the releasing position.

5. The device of any one of claims 2-4, wherein a sliding groove is formed in the first inductive member, the swinging arm has a connecting shaft movably fitted within the sliding groove.

6. The device of claim 5, wherein the swinging arm has a connecting lug at the first end of the swinging arm and the connecting shaft is disposed on a free end of the connecting lug.

7. The device of any one of claims 1-6, wherein the actuating assembly comprises:

a first rod pivotally connected to the body and defining first and second ends;

a second rod defining a first end pivotally connected to the second end of the first rod and a second end connected to the swinging arm; and

an actuating member connected to a joint between the first rod and the second rod to drive the first rod and the second rod to rotate.

8. The device of claim 7, wherein the actuating assembly further comprises a third spring fitted over the second rob to normally push the swinging arm toward the engaging position.

9. The device of any one of claims 1-8, wherein surfaces of side walls of the fitting groove are planar and parallel to a line passing through centers of the flywheel and the fitting groove.

10. The device of any one of claims 1-9, wherein an upstream side wall of the fitting groove in a rotation direction of the flywheel are transitioned into an outer peripheral wall of the flywheel via bevels respectively.

11. The device of any one of claims 1-10, wherein the swinging arm is pivotally connected to the body by means of a pivot shaft parallel to a central axis of the flywheel.

12. The device of any one of claims 1-11, wherein a width of the fitting tooth is smaller than a width of the fitting groove.

13. The device of claim 2, wherein the first spring is configured as a compression spring.

14. The device of claim 4, wherein the second spring is configured as a compression spring.

15. An engine, comprising a body, a crankshaft and a device of any one of claims 1-14.

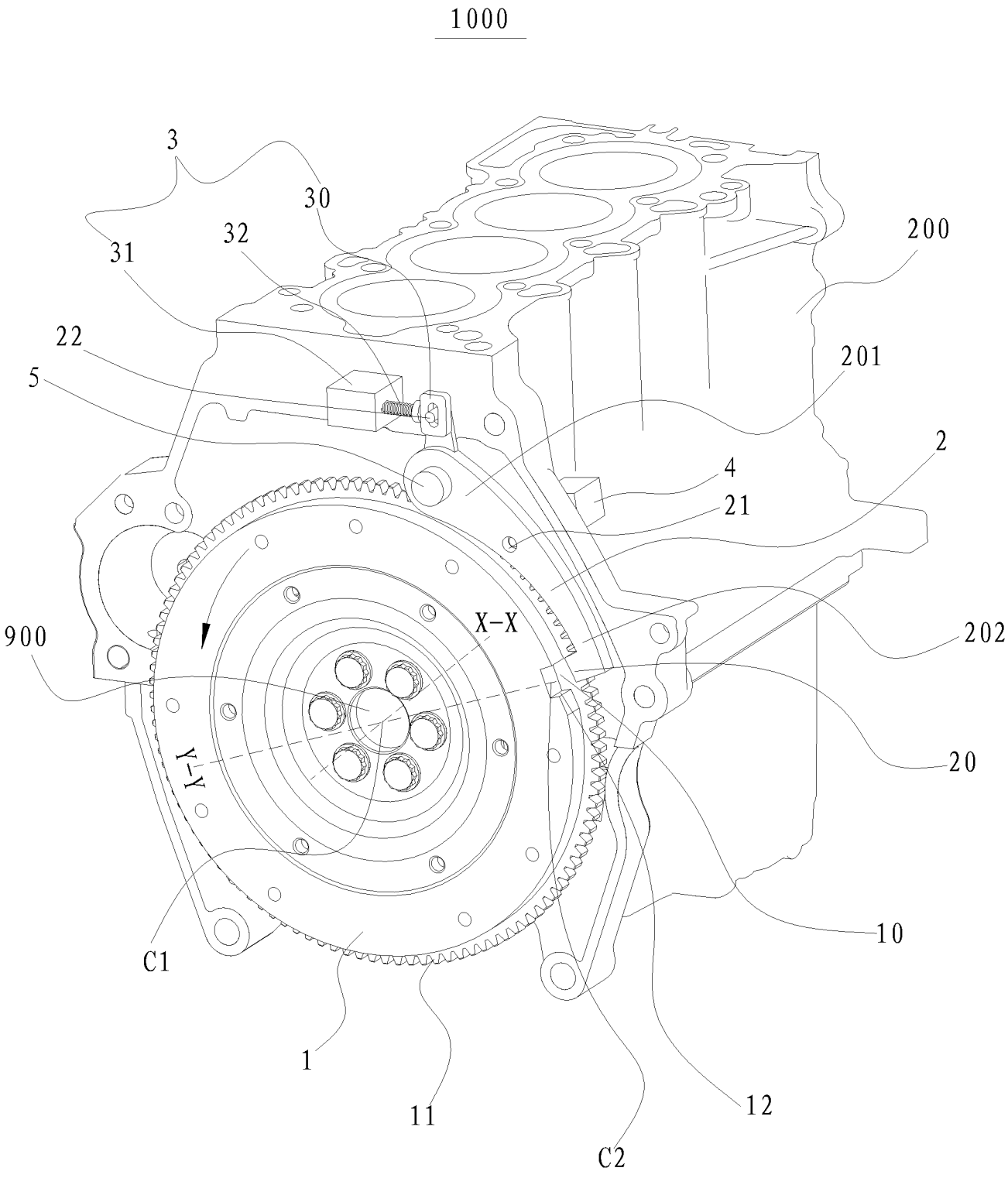

Fig. 1

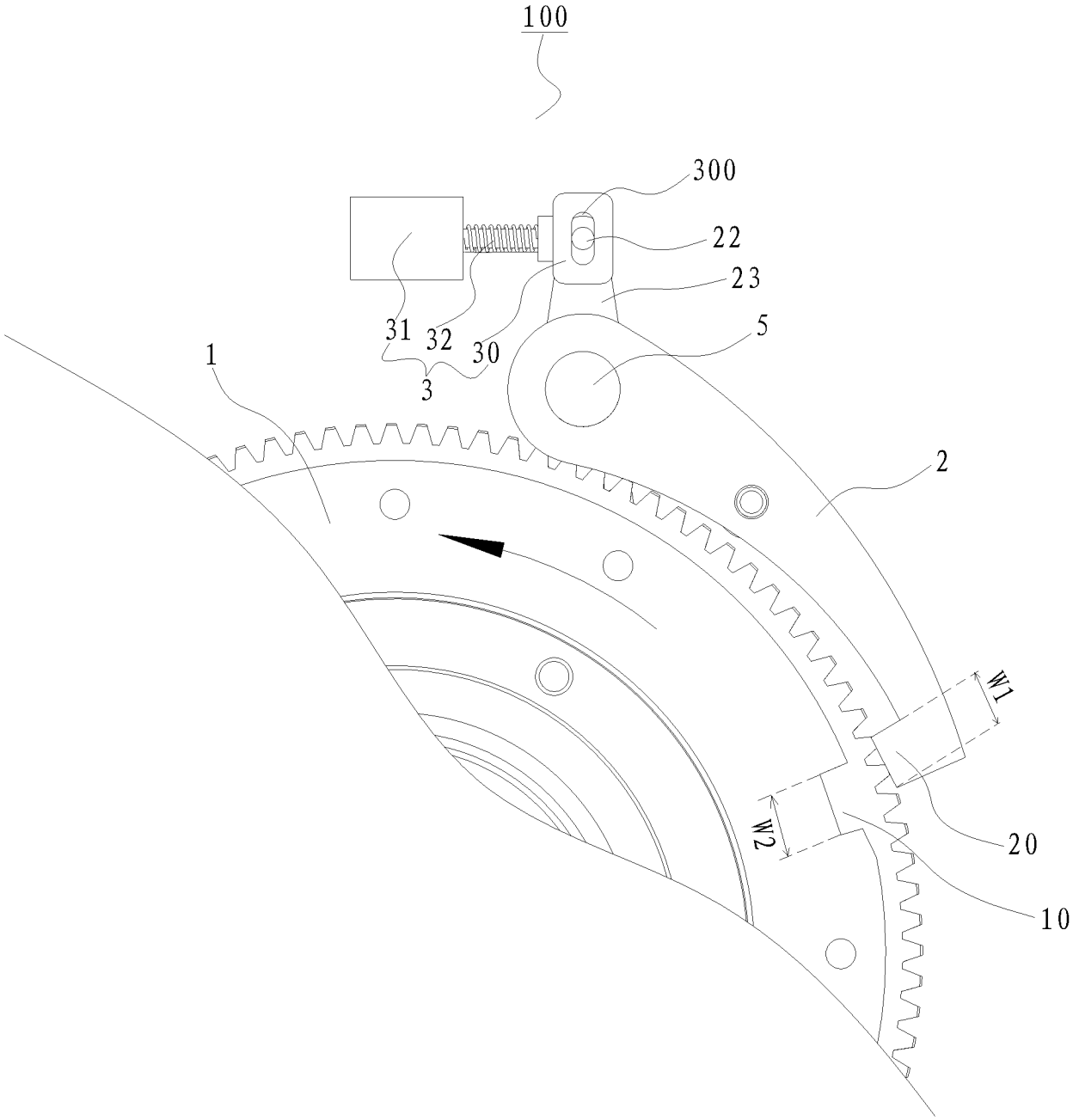

Fig. 2

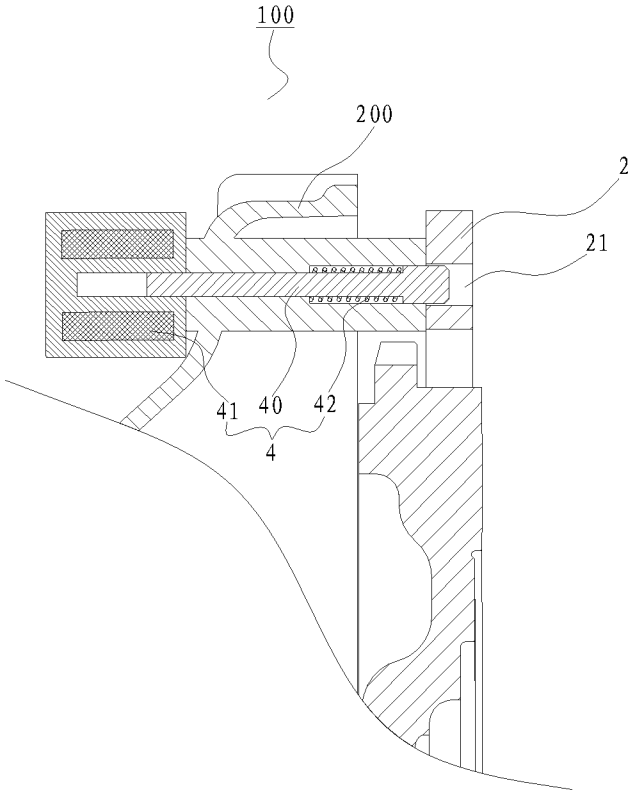

Fig. 3

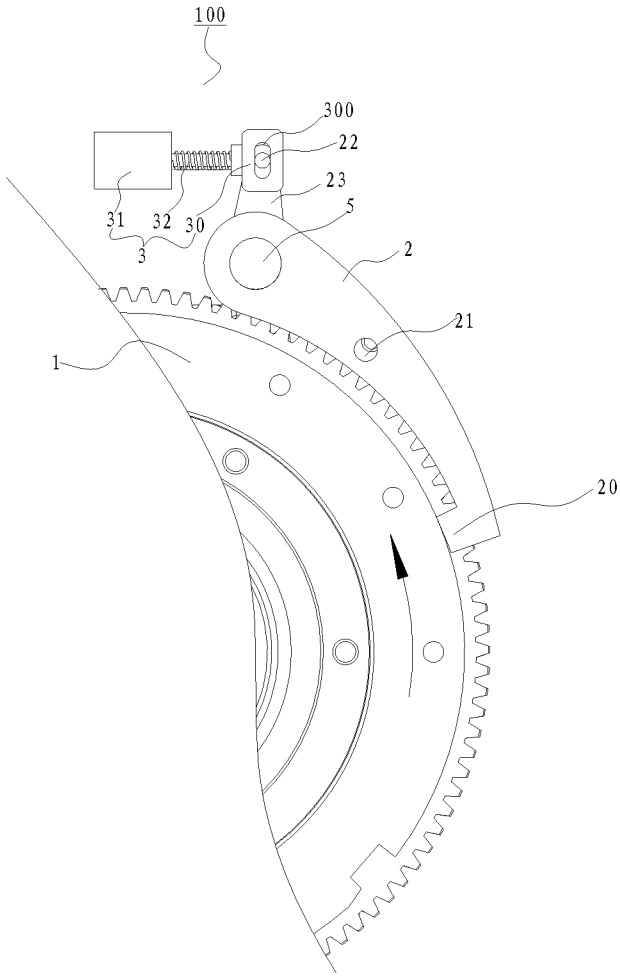

Fig. 4

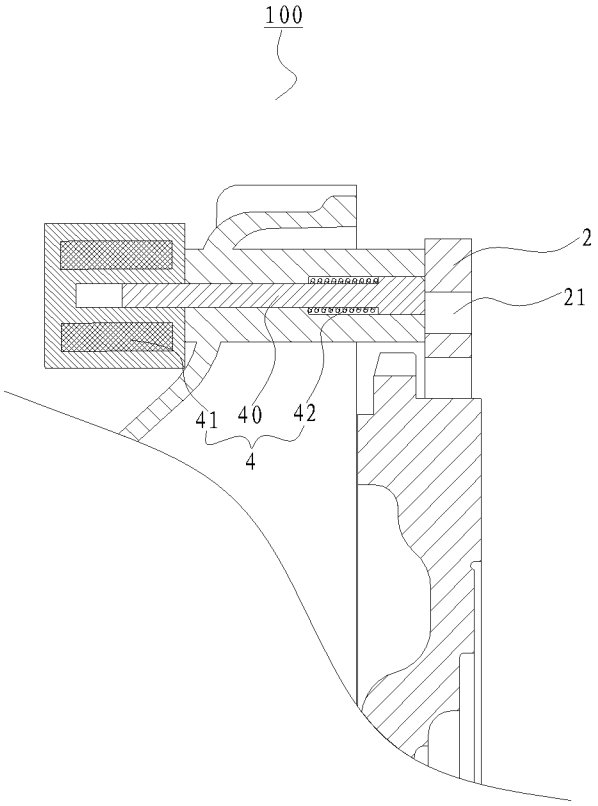

Fig. 5

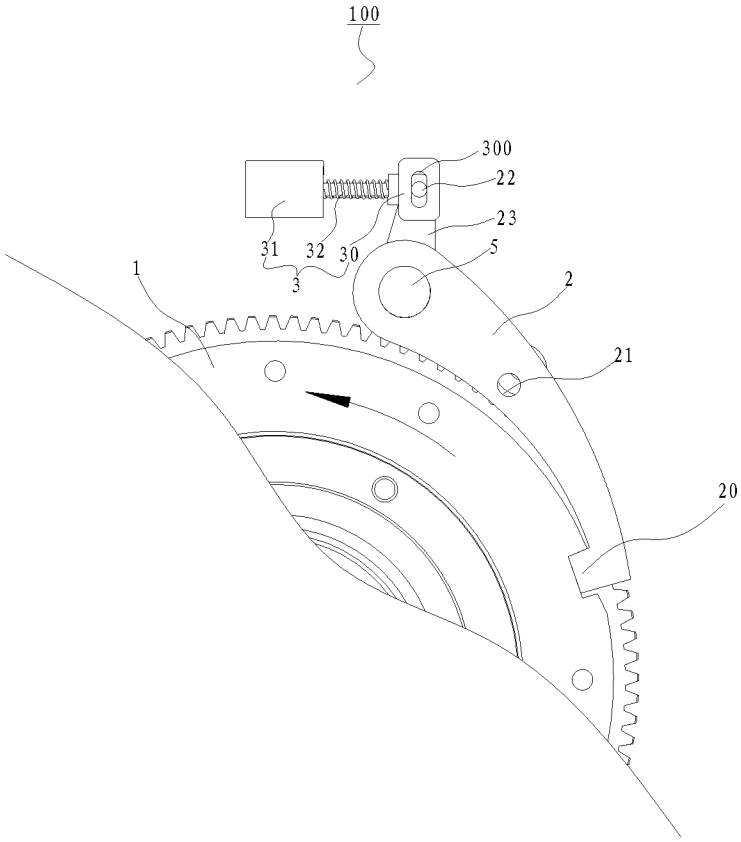

Fig. 6

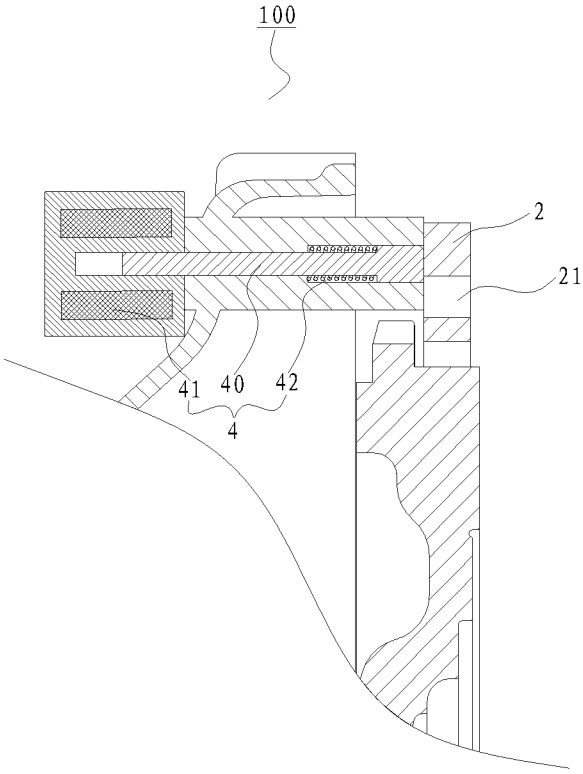

Fig. 7

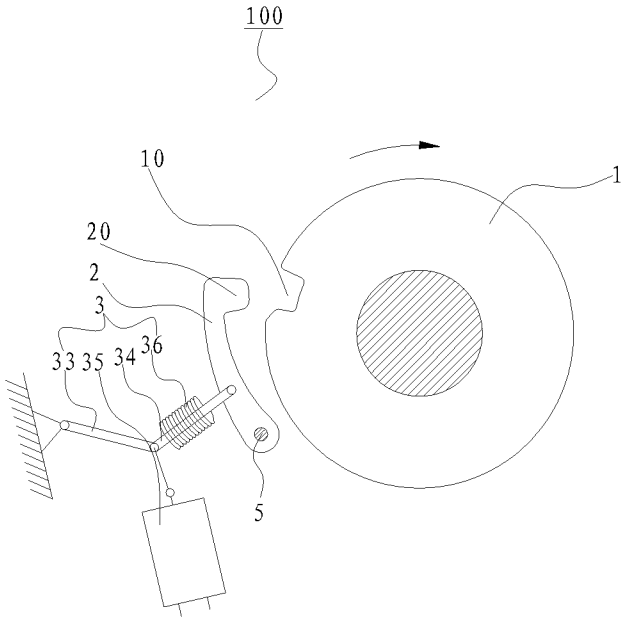

Fig. 8

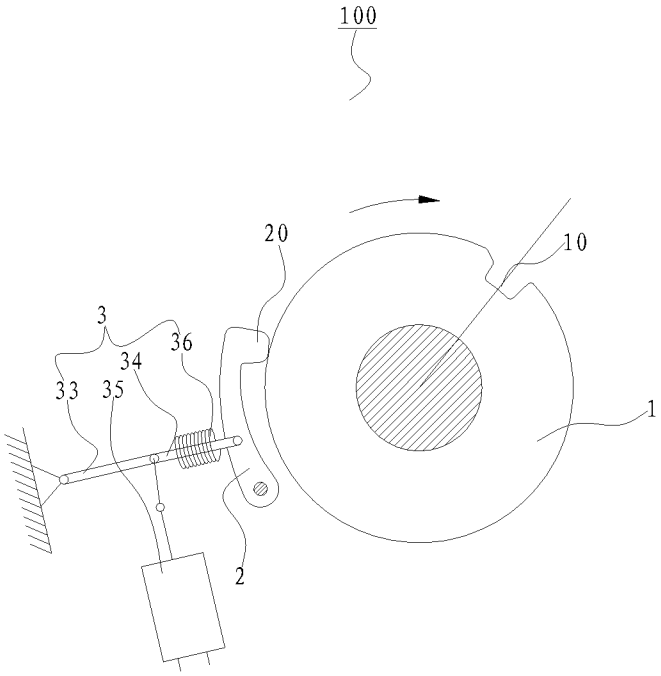

Fig. 9

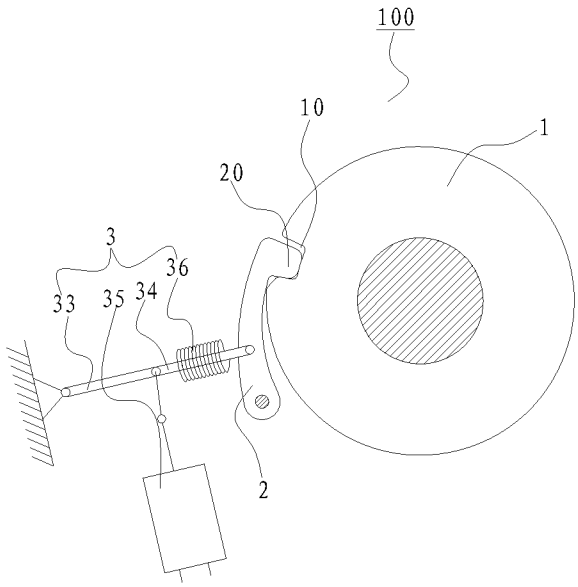

Fig. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/074310

A. CLASSIFICATION OF SUBJECT MATTER

F02D 35/00(2006.01)i

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)

F02D, F02B, F01L

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 practicable, search terms used)

CNABS;VEN:slot?, trough, groove?, tooth, teeth, positon+, crankshaft, flywheel?, rocker?, swing+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 716151A (TAYLOR & CHALLEN LTD) 29 September 1954 (1954-09-29)	1-15
A	US 5259269A (SWENSON SR ROGER M) 09 November 1993 (1993-11-09) the whole document	1-15
A	EP 1302630A2 (INA SCHAEFFLER KG) 16 April 2003 (2003-04-16) the whole document	1-15
A	CN 103388527A (GREAT WALL MOTOR CO LTD) 13 November 2013 (2013-11-13) the whole document	1-15
A	CN 202468128U (CHONGQING XINYUAN AGRIC MACHINE CO LTD) 03 October 2012 (2012-10-03) the whole document	1-15

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 June 2014	**27 June 2014**

Name and mailing address of the ISA/	Authorized officer
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Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)62085292**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/074310

Patent document cited in search report		Publication date (day/month/year)	Patent family member(s)		Publication date (day/month/year)
GB	716151A	29 September 1954		None	
US	5259269A	09 November 1993	US	5457883A	17 October 1995
EP	1302630A2	16 April 2003	JP	2003120231A	23 April 2003
			US	6805080B2	19 October 2004
			EP	1302630A3	26 November 2003
			ES	2324598T3	11 August 2009
			US	2003084863A1	08 May 2003
			DE	50213520D1	18 June 2009
			DE	10150856A1	24 April 2003
			EP	1302630B1	06 May 2009
			DE	10150856B4	11 August 2005
CN	103388527A	13 November 2013		None	
CN	202468128U	03 October 2012		None	