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(54) Title: AN ELECTROMAGNETIC RECIPROCATING ENGINE WITH VARIABLE STROKE LENGTH

(57) Abstract: Present disclosure discloses an electromagnetic reciprocating engine. The engine (100) includes a casing (122) defined with a bore (101). The engine (100) further includes a first permanent magnet (102) and a second permanent magnet (103) movably coupled at two opposite ends (104a, 104b) of the bore (101). One of the first permanent magnet (102) and the second permanent magnet (103) is movable to vary a stroke length. Furthermore, the engine (100) includes an electromagnet (105) movably positioned within the bore (101) between the first permanent magnet (102) and the second permanent magnet (103). Additionally, the engine (100) includes a crankshaft (110), defined with a provision (111) at a central portion and a connecting rod (109). The connecting rod (109) is defined with a first end (109a) coupled to the electromagnet (105), and a second end (109b) extends through the provision (111) for coupling with the crankshaft (110). The second end (109b) is slidable within the provision (111) to change position of contact with the crankshaft (110), corresponding to change in the stroke length.

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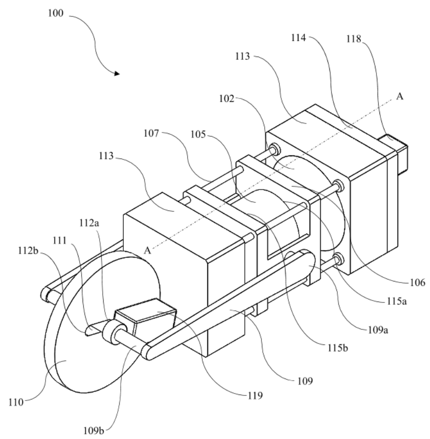

Figure. 1

FORM 2

THE PATENTS ACT 1970
(39 OF 1970)
&
The Patent Rules, 2003

Complete Specification

(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

AN ELECTROMAGNETIC RECIPROCATING ENGINE WITH VARIABLE STROKE LENGTH

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification describes the invention and the manner in which it is to be performed

DESCRIPTION

TECHNICAL FIELD

This disclosure relates generally to engines, and more particularly to an electromagnetic reciprocating engine. Further, embodiments of the disclosure discloses the electromagnetic reciprocating engine capable of varying stroke length and torque requirements.

BACKGROUND

Majority of vehicles are powered by internal combustion engines which are run by fossil fuels. With increasing awareness of the environmental impact of burning fossil fuels combined with the increasing cost of such fuels has led to greater desire for alternative power sources such as electric energy to power the vehicles. This has led to development of electric vehicles and hybrid electric vehicles (HEVs), which include one or more traction motors for generating necessary power for driving the vehicle. While the electric vehicles include only traction motors, the hybrid electric vehicles (HEVs) are powered by an internal combustion engine in combination with traction motors or electric motors. The traction motors or the electric motors use energy stored in a power source such as battery modules or fuel cell and generate necessary power for driving the vehicle. Also, the electrical vehicle uses an induction motor which consumes more energy and power to operate a propulsion unit of the vehicle, thereby increasing the time required to recharge the battery and which leads to frequent replacement of battery. Further, the traction/electric motors tend to consume more power for driving and requires further separate configuration within the vehicle to function, which results in complex construction and maintenance.

[001] Considering the above, electromagnetic engines have been evolved. Electromagnetic engines convert electrical energy to mechanical energy through the use of electromagnets. Conventional electromagnetic engines generate substantially constant torque, which thereby needs an external gearbox to cater different torque demands. Such arrangement makes the transmission bulky, escalates cost of the transmission and maintenance, which is undesired.

SUMMARY OF THE INVENTION

In an embodiment, an electromagnetic reciprocating engine is disclosed. The engine includes a casing defined with a bore. The engine further includes a first permanent magnet and a second permanent magnet movably coupled in the casing at two opposite ends of the bore. One of the first permanent magnet and the second permanent magnet is movable relative to the ends of the bore to vary a stroke length. Furthermore, the engine includes an electromagnet which is movably positioned within the bore between the first permanent magnet and the second permanent magnet. The electromagnet is configured to reciprocate with the bore. Additionally, the engine includes a crankshaft which is defined with a provision at a substantially central portion and at least one connecting rod. The at least one connecting rod is defined with a first end which is coupled to the electromagnet, and a second end extending through the provision for coupling with the crankshaft. The second end is slidable within the provision to change a position of contact with the crankshaft, corresponding to change in the stroke length. Stroke length may be defined as total travel length or reciprocating length of an electromagnet between the ends of the bore.

In an embodiment, the casing is defined with guideways. The guideways are configured to movably support sides of the first permanent magnet and the second permanent magnet, and guide the first permanent magnet and the second permanent magnet during displacement of the first permanent magnet and the second permanent magnet.

In an embodiment, the engine includes a second actuator coupled to a second end of the at least one connecting rod. The second actuator is configured to slide the second end along the provision to change the position of contact with the crankshaft.

In an embodiment, the engine includes a first actuator coupled to one of the first permanent magnet and the second permanent magnet. The first actuator is configured to displace at least one of the first permanent magnet and the second permanent magnet, corresponding to change in the position of contact with the crankshaft, to vary the stroke length.

In an embodiment, the engine includes a control unit which is communicatively coupled to the first actuator and the second actuator. The control unit is configured to receive a signal from one or more sensors or encoders, which corresponds to torque and speed requirement. Further, the control unit operates the second actuator to slide the second end of the at least one connecting rod within the provision to change the point of contact with the crankshaft. Furthermore, the control unit operates the first actuator to displace one of the first permanent magnet and the second permanent magnet in relation to the ends of the bore, corresponding to the change the position of contact with the crankshaft, to meet the torque and speed requirement.

In an embodiment, operating the first actuator to displace one or both of the first permanent magnet and the second permanent magnet closer to each other and operating the second actuator to slide the second end towards a first end of the provision, decreases the stroke length.

In an embodiment, operating the first actuator to displace one or both of the first permanent magnet and the second permanent magnet away from each other and operating the second actuator to slide the second end towards a second end of the provision, increases the stroke length.

In an embodiment, the engine comprises one or more sensors or encoders communicatively coupled to the control unit. The control unit is configured to sense a position of the electromagnet in the bore based on a signal from the one or more sensors and deactivates operation of the first actuator and the second actuator corresponding to signal received from the one or more sensors about the electromagnet reaching a desired position in the bore corresponding to the torque and speed requirement.

In an embodiment, the engine comprises a power source electrically coupled to the electromagnet and communicatively coupled to the control unit. The power source is configured to energize the electromagnet and the control unit is configured to change a polarity of the electromagnet at a predefined frequency to generate opposite magnetic poles at a first side and a second side of the electromagnet. The change in polarity of the electromagnet triggers reciprocating movement of the electromagnet between the first permanent magnet and the second permanent magnet.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary embodiments and, together with the description, serve to explain the disclosed principles.

Figure 1 illustrates a perspective of an electromagnetic reciprocating engine, in accordance with an embodiment of the present disclosure;

Figure 2 illustrates a front view of the electromagnetic reciprocating engine of Figure 1;

Figure 3 illustrates a perspective view of the electromagnetic reciprocating engine depicting a change in position of contact of a connecting rod with a crankshaft, in accordance with an embodiment of the present disclosure;

Figure 4 illustrates a front view of the electromagnetic reciprocating engine of Figure 3; and

Figure 5 illustrates a block diagram of a control unit interfaced with the electromagnetic reciprocating engine, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

Exemplary embodiments are described with reference to the accompanying drawings. Wherever convenient, the same reference numbers are used throughout the drawings to refer to the same or like parts. While examples and features of disclosed principles are described herein, modifications, adaptations, and other implementations are possible without departing from the scope of the disclosed embodiments. It is intended that the following detailed description be considered as exemplary only, with the true scope being indicated by the following claims. Additional illustrative embodiments are listed.

Embodiment of the present disclosure disclose the electromagnetic reciprocating engine, which can be used in vehicles. The electromagnetic reciprocating engine of the present disclosure has the capability of catering different torque and speed requirements, thereby eliminates the need of gearbox, thereby making the vehicle compact and lesser cost. The electromagnetic reciprocating engine with includes less number of moving components and is inexpensive.

The following paragraphs describe the present disclosure with reference to **Figures.1 to 5**. In the figures, the same element or elements which have similar functions are indicated by the same reference signs.

Referring to **Figure. 1** and **Figure. 2** which are exemplary embodiments of the present disclosure illustrating an electromagnetic reciprocating engine (100) [also referred as “engine (100)”]. In an embodiment, the electromagnetic reciprocating engine (100) may be installed in but not limiting to vehicles. As will be understood, the electromagnetic reciprocating engine (100) may be configured as a single cylinder or multi cylinder engine and may be employed in any type of vehicle ranging from two-wheeled vehicle, three wheeled vehicle to four or more wheeled vehicles or any other applications across various domains.

As shown in **Figure. 2**, the engine (100) may include a casing (122), which may be defined with a bore (101) having a first end (104a) and a second end (104b). In an embodiment, the casing (122) may have a hollow cylindrical body defining a top wall, a bottom wall and the bore (101) defined between the top wall and the bottom wall. In an embodiment, the casing (122) may have a hollow square body, hollow rectangular body or any other geometrical shapes based on the requirement. The casing (122) may be made of but not limiting to non-ferrous material. In an embodiment, the engine (100) may include at least one plate (114) which may fixed at ends of the casing (122). The at least one plate (114) may be configured to support various components of the engine (100). Further, as apparent from **Figure. 2**, the engine (100) may include a first permanent magnet (102) and a second permanent magnet (103) which may be movably disposed in the casing (122) at the first and second ends (104a, 104b) of the bore (101). At least one of the first permanent magnet (102) and the second permanent magnet (103) may be movable relative to the first end (104a) and the second end (104b) of the bore (101) to vary a stroke length. In an embodiment, the first permanent magnet (102) and the second permanent magnet (103) may be fixed on a bracket (113) disposed at the first end (104a) and the second end (104b) of the bore (101). The bracket (113) may be movably positioned in the casing (122) and may be configured to move relative to the first end (104a) and the second end (104b) of the bore (101), such that, the movement of the corresponding bracket (113) may cause the one or both of the first permanent magnet (102) and the second permanent magnet (103) to move relative to the first and second ends (104a, 104b) of the bore (101), to vary the stroke length.

In an embodiment, each of the first permanent magnet (102) and the second permanent magnet (103) may be secured at the ends (104a, 104b) of the bore (101) such that, like magnetic poles of the first permanent magnet (102) and the second permanent magnet (103) face each other. For example, a north pole of the first permanent magnet (102) and the north pole of the second permanent magnet (103) may face towards the first end (104a) and second end (104b) of the bore (101), respectively. The first permanent magnet (102) and the second permanent magnet (103) may be secured within the casing (122) with suitable mounting arrangement such as mechanical joining with the brackets to allow secured positioning of the first permanent magnet (102) and the second permanent magnet (103) within the bore (101). The mounting arrangement for securing the first permanent magnet (102) and the second permanent magnet (103) may be made of non-ferrous material. In an embodiment, the first permanent magnet (102) and the second permanent magnet (103) may be but not limiting to neodymium magnets. The first permanent magnet (102) and the second permanent magnet (103) may have configuration of but not limiting to cube, cuboid, or cylindrical, elliptical or polygonal-shape and the like. The size of the casing (122) may also vary depending on the application. For example, in heavy duty vehicles, the casing (122) may be larger in size to accommodate bigger first permanent magnet and the second permanent magnet.

In an embodiment, the engine (100) may include a plurality of guide rods (107) disposed within the bore (101). The plurality of guide rods (107) may be disposed in the bore (101) such that, ends of each of the plurality of guide rods (107) are supported by the at least one plate (114) fixed at the ends of the casing (122). Each of the plurality of guide rods (107) may be configured to movably support the bracket (113) [thus, the first permanent magnet (102) and the second permanent magnet (103)] and guide the bracket (113) during displacement of the bracket (113) relative to the first end (104a) and the second end (104b) of the bore (101), to vary the stroke length. As an example, the plurality of guide rods (107) may be linear bearings, which may aid in frictionless linear movement of the bracket (113).

In an embodiment, an inner surface of the casing (122) may be defined with guideways or slots, and the sides (i.e., top and bottom side) may include rollers. The rollers may be accommodated within the guideways and the rollers may rotate along the guideways to facilitate frictionless linear movement of the bracket (113) within the bore (101) to vary the stroke length.

Referring now to **Figures. 1 and 2,** the engine (100) may include an electromagnet (105) which may be movably positioned within the bore (101) and between the first permanent magnet (102) and the second permanent magnet (103). In an embodiment, the electromagnet (105) may be configured to reciprocate within the bore (101) between the between the first permanent magnet (102) and the second permanent magnet (103). The electromagnet (105) may be defined with a first side (115a) and a second side (115b) positioned such that, each of the sides of the electromagnet (105) faces the first permanent magnet (102) and the second permanent magnet (103). The electromagnet (105) may be positioned preferably in an axial alignment with the first permanent magnet (102) and the second permanent magnet (103). Further, the engine (100) may include a power source (117) [as seen in **Figure. 5**] which may be electrically coupled to the electromagnet (105). The power source (117) may be configured to energize the electromagnet (105). In an embodiment, the engine (100) may include a control unit (120) and the power source (117) may be communicatively coupled to the control unit (120). The control unit (120) may be configured to regulate the power source (117) to change a polarity of the electromagnet (105) at a predefined frequency to generate opposite magnetic poles at a first side (115a) and a second side (115b) of the electromagnet (105). The change in polarity of the electromagnet (105) triggers reciprocating movement of the electromagnet (105) between the first permanent magnet (102) and the second permanent magnet (103). When the power is supplied from the power source (117), the processor energizes the electromagnet (105) and produces a magnetic field having opposite poles at each side which are facing the first permanent magnet (102) and the second permanent magnet (103). In an embodiment, the first permanent magnet (102) and the second permanent magnet (103) are secured within the bore (101) of the cylinder and orientated to present the same magnetic pole towards the electromagnet (105). When the electromagnet (105) is energized, depending on the polarity on each side of the electromagnet (105), the first side (115a) of the electromagnet (105) gets attracted towards the permanent magnet having opposite polarity. Similarly, a second side (115b) of the electromagnet (105) repels away from the permanent magnet having same polarity. Further, the polarity of electromagnet (105) can be reversed using the driver circuit causing switching of the attraction or repulsion of the sides of the electromagnet (105) against the first permanent magnet (102) and the second permanent magnet (103). The attraction and repulsion of the electromagnet (105) causes the reciprocating movement within of the electromagnet (105) within the bore (101), in between the first permanent magnet (102) and the second permanent magnet (103). This reciprocating movement of the electromagnet (105) may be along the horizontal axis A-A, unlike movement along a vertical axis prevents uneven stroke forces due to a gravitational pull and thus consumes less power to operate. In an embodiment, the electromagnet (105) moves in a frictionless sliding movement along the horizontal axis A-A.

In an embodiment, the electromagnet (105) may be movably positioned within the bore (101) by a frame (106) which may be coupled to the guide rods (107). The frame (106) may be coupled to displace within the bore (101) along the guide rods (107) to aid frictionless movement (thus, reciprocation) of the electromagnet (105) within the bore (101).

In an embodiment, one or more bushes (123) may be interposed between the electromagnet (105) and each of the first and the second permanent magnets (102, 103). The one or more bushes (123) may prevent direct contact of the electromagnet (105) with each of the permanent magnets (102, 103) during reciprocating motion of the electromagnet (105) within the bore (101). In an embodiment, the one or more bushes (123) may be positioned at each end of the guide rods (107). As such, in some example embodiments, the one or more bushes (123) may be manufactured from a suitable elastic polymer-based material to prevent direct contact of the electromagnet (105) with the first permanent magnet (102) and the second permanent magnet (103).

Referring again to **Figures. 1 and 2**, the engine (100) may include a crankshaft (110) which may be disposed out of the casing (122). The crankshaft (110) includes a substantially cylindrical or a disk profile and may be defined with a provision (111). The provision (111) may include a first end (112a) and a second end (112b). In an embodiment, the provision (111) may be a through provision (111) extending for a predefined length and may be defined at a substantially central portion of the crankshaft (110). In an embodiment, a length of the provision (111) defined may dependent on the torque output required from the engine (100). Further, as seen in **Figures. 1 and 2**, the engine (100) may include at least one connecting rod (109). In an illustrated embodiment, the engine (100) includes a pair of connecting rods. However, the same cannot be construed as a limitation since the engine (100) may include more or less than the pair of connecting rods, based on the requirement. The at least one connecting rod (109) may be defined with a first end (109a) coupled to the electromagnet (105) (thus, the frame (106) supporting the electromagnet (105)), and a second end (109b) which may extend through the provision (111) for coupling with the crankshaft (110). In an embodiment, the second end (109b) of the at least one connecting rod (109) may securely fit within the provision (111) such that, the linear movement of the at least one connecting rod (109) in response to reciprocation of the electromagnet (105), causes rotational movement of the crankshaft (110). As seen in **Figures. 3 and 4**, the second end (109b) may be configured to slide within the provision (111) to change the position of contact of the second end (109b) with the crankshaft (110), to facilitate change in the stroke length. In an embodiment, the at least one connecting rod (109) may be manufactured from a non-ferrous material.

In an embodiment, as seen in **Figures. 1 and 2**, the engine (100) may include a first actuator (118) which may be coupled to the one of the first permanent magnet (102), the second permanent magnet (103) or both. The first actuator (118) may be configured to displace the first permanent magnet (102) and/or the second permanent magnet (103) relative to the ends (104a, 104b) of the bore (101). In an illustrated embodiment, the first actuator (118) is supported by the at least one plate (114) and is coupled to the first permanent magnet (102) [thus, the bracket (113) accommodating the first permanent magnet (102)]. However, the same cannot be construed as a limitation since the first actuator (118) may be coupled to the second permanent magnet (103), too. Further, the engine (100) may include a second actuator (119) which may be coupled to the second end (109b) of the at least one connecting rod (109). The second actuator (119) may be configured to slide the second end (109b) along the provision (111) to change the position of contact with the crankshaft (110). In an embodiment, displacing the one or both of the first permanent magnet (102) and the second permanent magnet (103) and changing the position of contact with the crankshaft (110) may aid in changing the stroke length and torque output by the engine (100).

As an example, the first actuator (118) and the second actuator (119) may be but not limiting to a hydraulic actuator, a pneumatic actuator, a rotary actuator, an electric actuator and the like.

Referring now to **Figure. 5**, the engine (100) may include a control unit (120) which may be communicatively coupled to the first actuator (118) and the second actuator (119). The control unit (120) may be configured to operate the first actuator (118) and the second actuator (119) and to displace the first permanent magnet (102) and/or the second permanent magnet (103), and slide the second end (109b) of the at least one connecting rod (109) within the provision (111), respectively, based on a signal from one or more sensors or encoders (121), which may correspond to torque and speed requirement by an operator. As an example, the one or more sensors or encoders (121) may be but not limiting to a mechanical encoder such as a linear, a rotary and an angular encoder, an optical encoder, a magnetic encoder and an electromagnetic induction encoder and the like, which may be associated with a lever or a knob [not shown in Figures], which may be operated by the user to change speed and torque requirements based on the operating conditions. In other words, based on the torque and speed requirement, the operator may actuate the lever to a desired position, which may be sensed by the one or more sensors or encoders (121) and generate a signal corresponding to the torque and speed requirement. The signal from the one or more sensors or encoders (121) may be received by the control unit (120), which may selectively operate the first actuator (118) and the second actuator (119). In an embodiment, upon receiving the signal from the one or more sensors or encoders (121), the control unit (120) may initially operate the second actuator (119) to slide the second end (109b) of the at least one connecting rod (109) within the provision (111). Displacing the second end (109b) of the at least one connecting rod (109) within the provision (111) may cause the electromagnet (105) [thus, the frame (106) supporting the electromagnet (105)] to limit the displacement within the bore (101). Further, the control unit (120) may operate the first actuator (118) to displace one of or both of the first permanent magnet (102) and the second permanent magnet (103). The sliding of the second end (109b) of the at least one connecting rod (109) and displacing one of or both of the first permanent magnet (102) and the second permanent magnet (103) to vary the stroke length and the torque requirement.

In an embodiment, the control unit (120) may include a processor (not shown) and a memory unit (not shown) communicatively coupled to the processor. The processors may be implemented as one or more microprocessors, microcomputers, microcontrollers, digital signal processors, central processing units, state machines, logic circuitries, and/or any devices that manipulate signals based on operational instructions. The memory unit stores processor-executable instructions, which, on execution, causes the processor to receive one or more command signals. In an embodiment, the command signal may be provided by the way of user input through a suitable hardware components like a touch sensor, position detection sensors such as Potentiometric Position Sensors, Inductive Position Sensors, and the like.

In an operational embodiment, if an input signal received by the control unit (120) corresponds to less speed and high torque requirement, the control unit (120) may operate the second actuator (119) such that, the second actuator (119) slides the second end (109b) of the at least one connecting rod (109) within the provision (111) towards a second end (112b) of the provision (111). Corresponding to sliding of the second end (109b) of the at least one connecting rod (109), the electromagnet (105) (thus, frame (106) of the electromagnet (105)) may adjust its position within the bore (101). Upon sliding of the second end (109b) of the at least one connecting rod (109) to a desired location in the provision (111), the control unit (120) may operate the first actuator (118) to displace one of the first permanent magnet (102) or the second permanent magnet (103). In an illustrated embodiment, as seen in **Figures. 1 and 2** corresponding to sliding of the second end (109b) of the at least one connecting rod (109) towards the second end (112b) of the provision (111), the first actuator (118) displaces the first permanent magnet (102) away from the second permanent magnet (103) for a predefined distance for increasing the stroke length. Increasing the stroke length and sliding the second end (109b) of the at least one connecting rod (109) away from the first end (112a) of the provision (111) may result in slower reciprocating cycles of the electromagnet (105), thereby decreasing the speed and increasing the torque output.

In another operational embodiment, if the input signal received by the control unit (120) corresponds to a high speed, low torque requirement, the control unit (120) may operate the second actuator (119) such that, the second actuator (119) slides the second end (109b) of the at least one connecting rod (109) within the provision (111) towards the first end (112a) of the provision (111) [as seen in **Figures. 3 and 4**]. Corresponding to sliding of the second end (109b) of the at least one connecting rod (109), the electromagnet (105) [thus, frame (106) of the electromagnet (105)] may adjust its position within the bore (101). Upon sliding of the second end (109b) of the at least one connecting rod (109) to a desired location in the provision (111) towards the first end (112a), the control unit (120) may operate the first actuator (118) to displace one of the first permanent magnet (102) or the second permanent magnet (103). In an illustrated embodiment, as seen in **Figures. 3 and 4** corresponding to sliding of the second end (109b) of the at least one connecting rod (109) towards the first end (112a) of the provision (111), the first actuator (118) displaces the first permanent magnet (102) towards the second permanent magnet (103) for a predefined distance for decreasing the stroke length. Decreasing the stroke length and sliding the second end (109b) of the at least one connecting rod (109) towards the first end (112a) of the provision (111), may result in faster reciprocating cycles of the electromagnet (105), thereby increasing the speed and decreasing the torque output.

In an embodiment, the engine (100) may include one or more sensors or encoders (121) which may be communicatively coupled to the control unit (120). The one or more sensors (125) may be configured to generate a signal corresponding to the electromagnet (105) and the second end (109b) of the at least one connecting rod (109) reaching a desired position in the bore (101) and the provision (111), respectively based on the signal received from the one or more sensors or encoders (121) which corresponds to the speed and torque requirement. In an embodiment, the position of the first permanent magnet (102) and/or the second permanent magnet (103) in the bore (101) and position of the second end (109b) of the at least one connecting rod (109) corresponding to various speed and torque requirement may be predetermined based on the configuration of the engine (100) and may be fed into the control unit (120). Upon receiving the signal from the one or more sensors or encoders (121) corresponding to the torque and speed requirement, the control unit (120) may displace the first permanent magnet (102) and/or the second permanent magnet (103), and slide the second end (109b) of the at least one connecting rod (109) for a predefined positions in the bore (101) and the provision (111), respectively. The control unit (120) may continuously monitor the signals from the one or more sensors (125) and determine about the first permanent magnet (102) and/or the second permanent magnet (103) reaching the predetermined position in the bore (101) and the second end (109b) of the at least one connecting rod (109) reaching the predetermined position in the provision (111). Upon determining the position of the first permanent magnet (102) and/or the second permanent magnet (103) and the second end (109b) of the at least one connecting rod (109), the control unit (120) may deactivate operation of the first actuator (118) and the second actuator (119).

The above subject matter discloses an electromagnetic reciprocating engine (100) which is capable of operating on single cylinder and multicylinder engines. Further, the engine (100) possess the capability of altering the speed and torque output, thereby eliminates the need of requirement of external gearbox. Thus, the configuration of the engine (100) makes the transmission compact, lesser weight and reduces manufacturing and maintenance cost.

It is intended that the disclosure and examples be considered as exemplary only, with a true scope of disclosed embodiments being indicated by the following claims.

WE CLAIM:

1. An electromagnetic reciprocating engine (100), the engine (100) comprising:

   a casing (122) defined with a bore (101);

   a first permanent magnet (102) and a second permanent magnet (103) movably coupled in the casing (122) at two opposite ends (104a, 104b) of the bore (101), wherein at least one of the first permanent magnet (102) and the second permanent magnet (103) is movable relative to the ends (104a, 104b) of the bore (101) to vary a stroke length;

   an electromagnet (105) movably positioned within the bore (101) between the first permanent magnet (102) and the second permanent magnet (103), the electromagnet (105) is configured to reciprocate with the bore (101);

   a crankshaft (110) defined with a provision (111) at a substantially central portion; and

   at least one connecting rod (109) defined with a first end (109a) coupled to the electromagnet (105) and a second end (109b) extending through the provision (111) for coupling with the crankshaft (110), the second end (109b) is slidable within the provision (111) to change a position of contact with the crankshaft (110), corresponding to change in the stroke length.

2. The engine (100) as claimed in claim 1, wherein the casing (122) is defined with guideways, wherein the guideways are configured to movably support and guide the first permanent magnet (102) and the second permanent magnet (103), during displacement of the first permanent magnet (102) and the second permanent magnet (103).

3. The engine (100) as claimed in claim 1, comprising a second actuator (119) coupled to a second end (109b) of the at least one connecting rod (109), the second actuator (119) is configured to slide the second end (109b) along the provision (111) to change the position of contact with the crankshaft (110).

4. The engine (100) as claimed in claim 3, comprising a first actuator (118) coupled to one of the first permanent magnet (102) and the second permanent magnet (103), the first actuator (118) is configured to displace at least one of the first permanent magnet (102) and the second permanent magnet (103), corresponding to change in the position of contact with the crankshaft (110), to vary the stroke length.

5. The engine (100) as claimed in claim 4, comprising a control unit (120) communicatively coupled to the first actuator (118) and the second actuator (119), the control unit (120) is configured to:

   receive, a signal from one or more sensors or encoders (121), corresponding to torque and speed requirement;

   operate, the second actuator (119) to slide the second end (109b) of the at least one connecting rod (109) within the provision (111) to change the point of contact with the crankshaft (110); and

   operate, the first actuator (118) to displace one of the first permanent magnet (102) and the second permanent magnet (103) in relation to the end of the bore (101), corresponding to the change the position of contact with the crankshaft (110), to meet the torque and speed requirement.

6. The engine (100) as claimed in claim 5, wherein the one or more sensors or encoders (121) generate a signal to the control unit (120), corresponding to torque and speed requirement input by an operator

7. The engine (100) as claimed in claim 5, wherein operating the first actuator (118) to displace one or both of the first permanent magnet (102) and the second permanent magnet (103) closer to each other and operating the second actuator (119) to slide the second end (109b) towards a first end (112a) of the provision (111), decreases the stroke length.

8. The engine (100) as claimed in claim 5, wherein operating the first actuator (118) to displace one or both of the first permanent magnet (102) and the second permanent magnet (103) away from each other and operating the second actuator (119) to slide the second end (109b) towards a second end (112b) of the provision (111), increases the stroke length and provides higher torque and lesser speed.

9. The engine (100) as claimed in claim 5, comprising one or more sensors or encoders (121) communicatively coupled to the control unit (120) and the control unit (120) is configured to sense a position of the electromagnet (105) in the bore (101) based on a signal from the one or more sensors (125) and deactivates operation of the first actuator (118) and the second actuator (119) corresponding to signal received from the one or more sensors (125).

10. The engine (100) as claimed in claim 5, comprising a power source (117) electrically coupled to the electromagnet (105) and communicatively coupled to the control unit (120), the power source (117) is configured to energize the electromagnet (105) and the control unit (120) is configured to change a polarity of the electromagnet (105) at a predefined frequency to generate opposite magnetic poles at a first side (115a) and a second side (115b) of the electromagnet (105), and wherein the change in polarity of the electromagnet (105) triggers reciprocating movement of the electromagnet (105) between the first permanent magnet (102) and the second permanent magnet (103).

Dated this 13th day of March 2023

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ABSTRACT

AN ELECTROMAGNETIC RECIPROCATING ENGINE WITH VARIABLE STROKE LENGTH

Present disclosure discloses an electromagnetic reciprocating engine. The engine (100) includes a casing (122) defined with a bore (101). The engine (100) further includes a first permanent magnet (102) and a second permanent magnet (103) movably coupled at two opposite ends (104a, 104b) of the bore (101). One of the first permanent magnet (102) and the second permanent magnet (103) is movable to vary a stroke length. Furthermore, the engine (100) includes an electromagnet (105) movably positioned within the bore (101) between the first permanent magnet (102) and the second permanent magnet (103). Additionally, the engine (100) includes a crankshaft (110), defined with a provision (111) at a central portion and a connecting rod (109). The connecting rod (109) is defined with a first end (109a) coupled to the electromagnet (105), and a second end (109b) extends through the provision (111) for coupling with the crankshaft (110). The second end (109b) is slidable within the provision (111) to change position of contact with the crankshaft (110), corresponding to change in the stroke length.

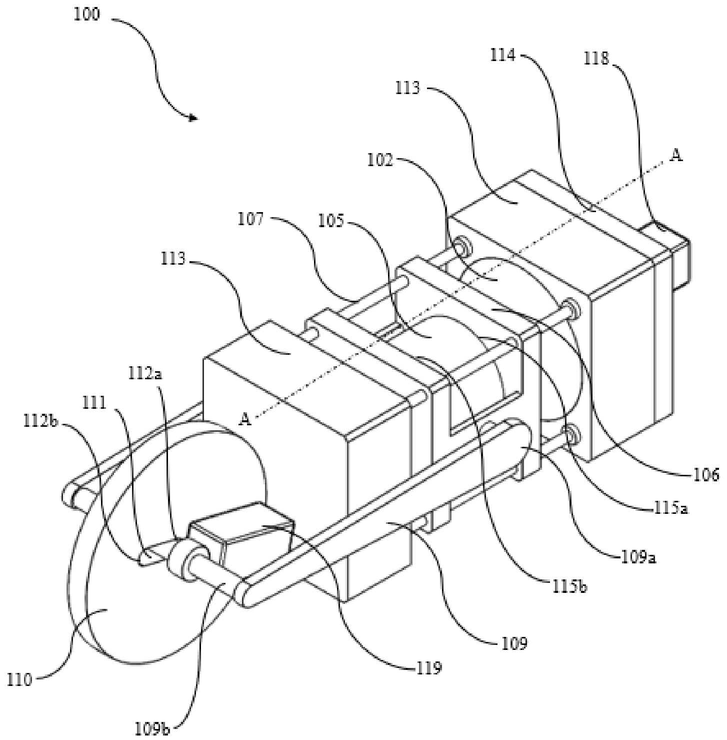

Figure 1

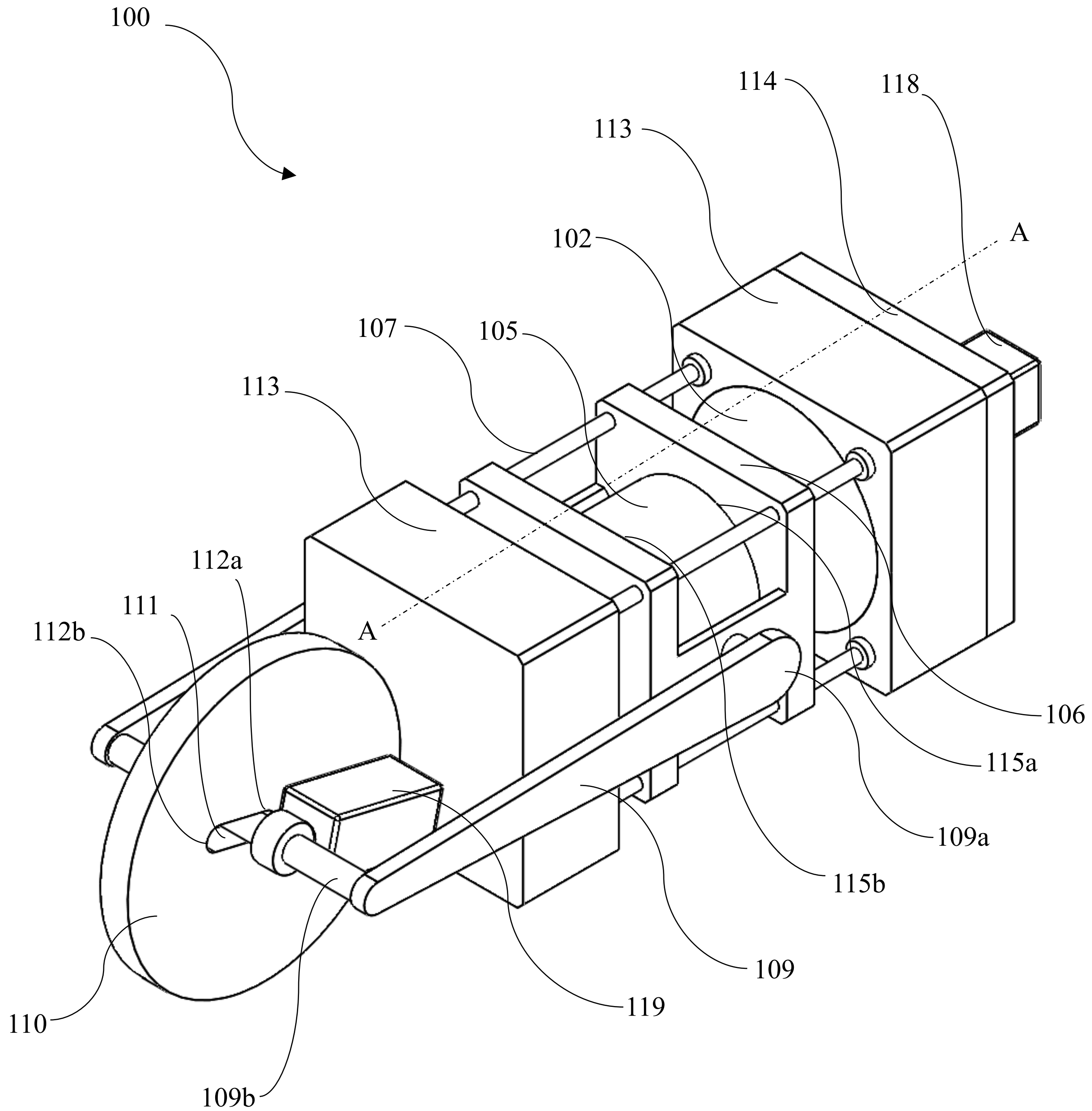

Figure. 1

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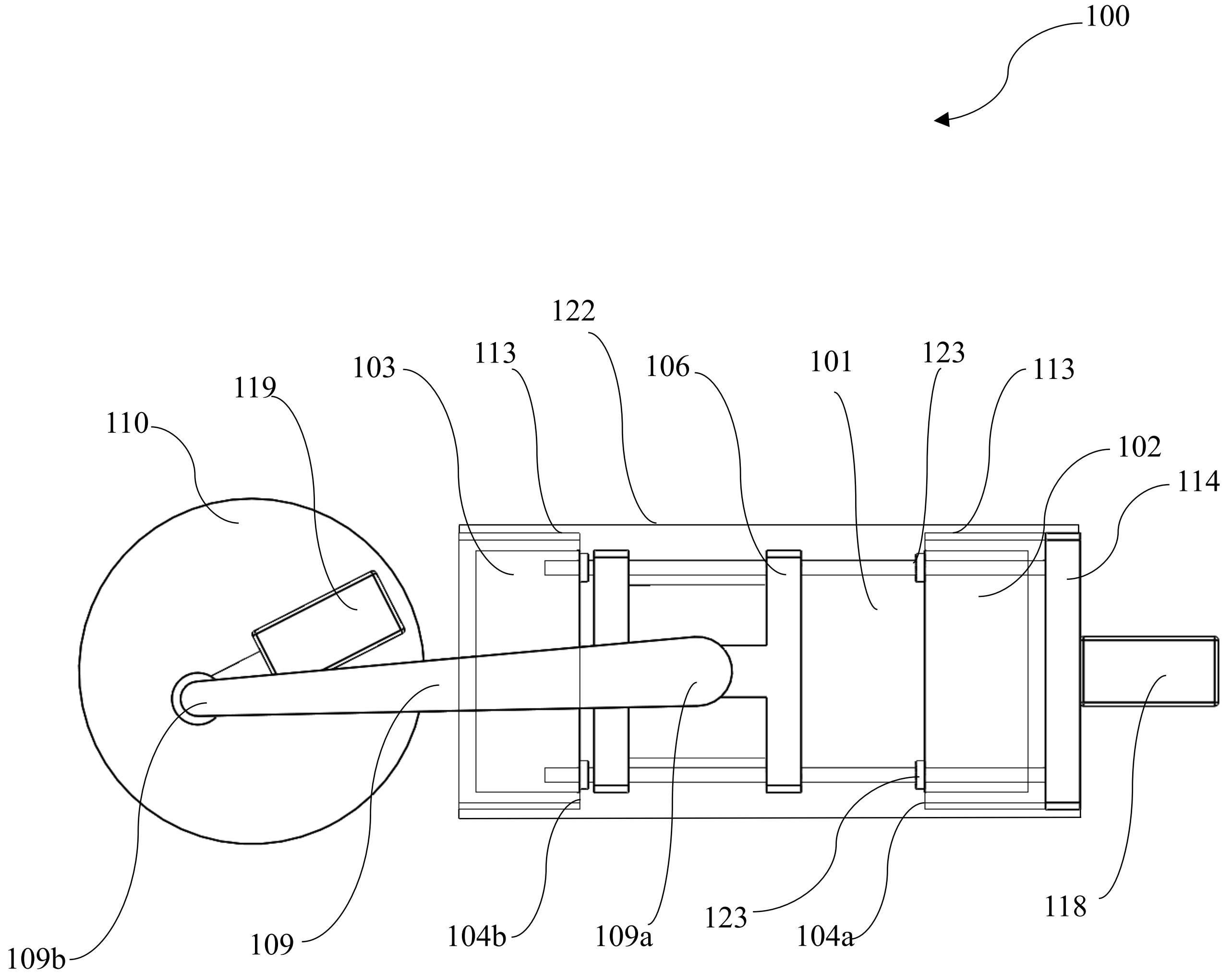

Figure. 2

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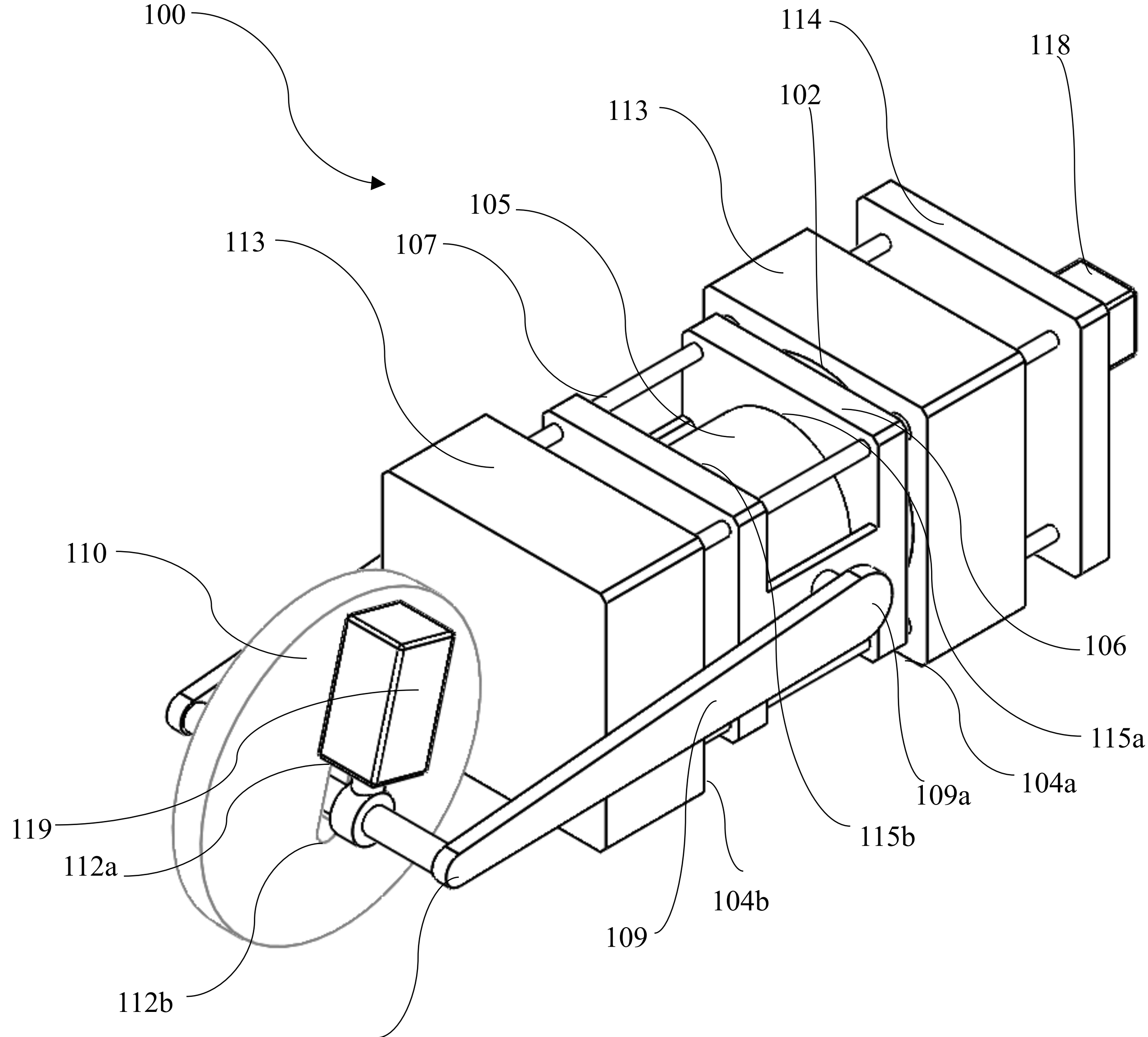

Figure. 3

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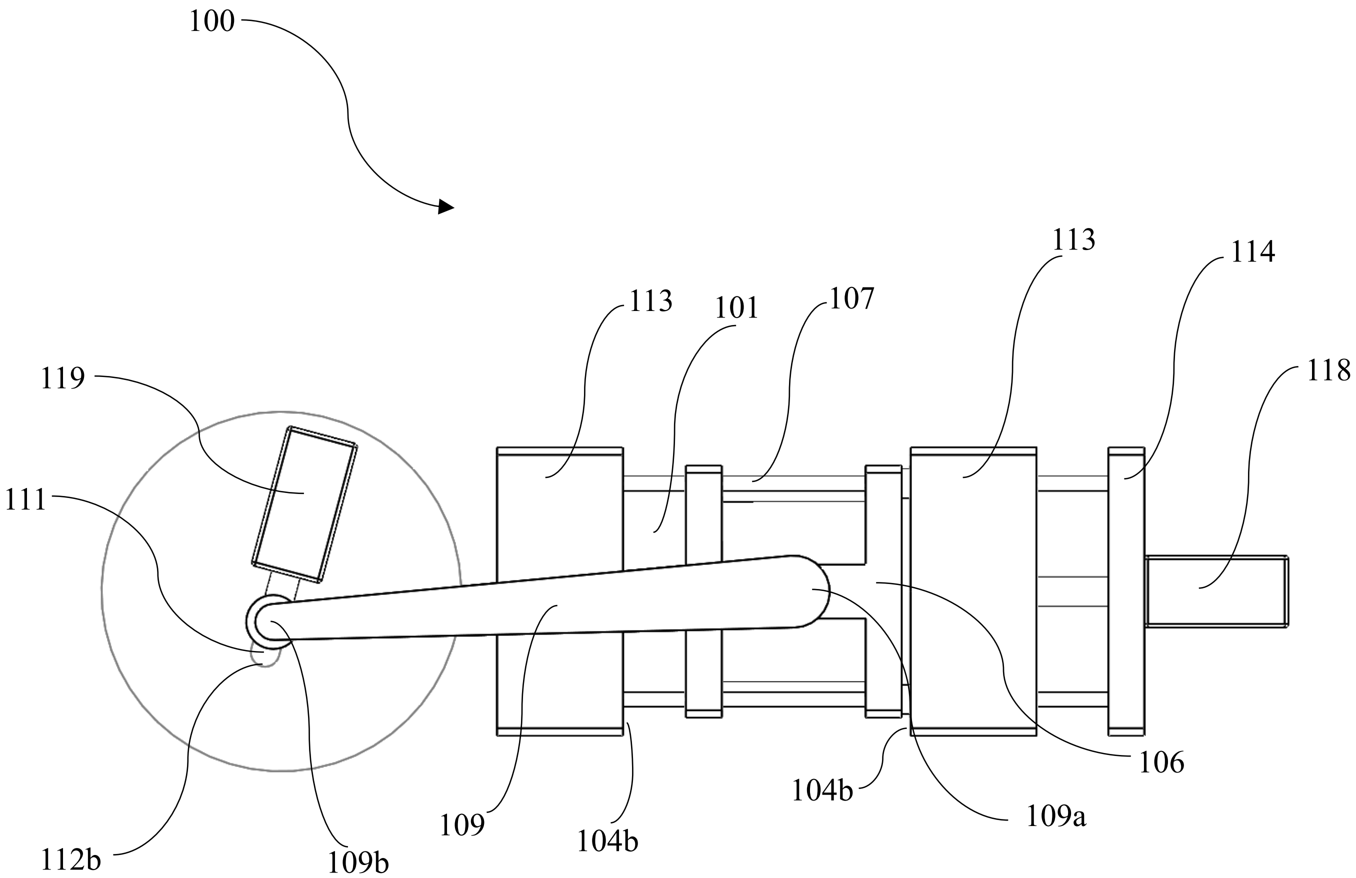

Figure. 4

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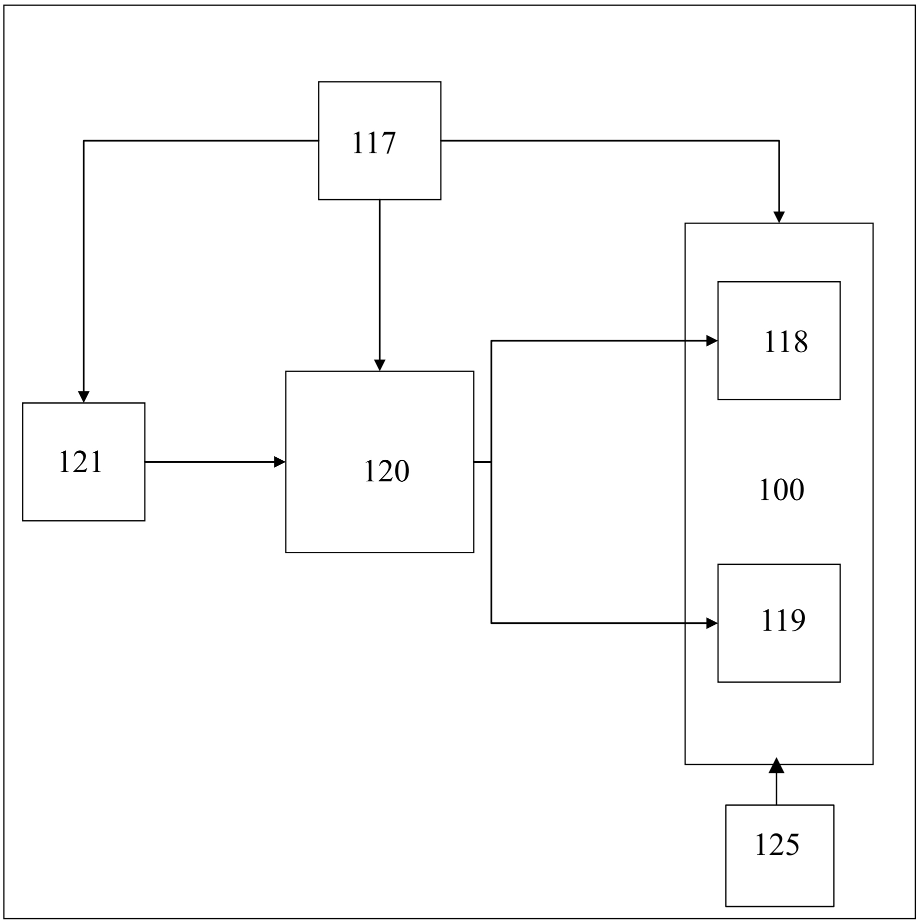

Figure. 5

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