

(12) Indian Patent Application

(21) Application Number: 202241014115

(22) Filing Date: 15/03/2022 (43) Publication Date: 22/09/2023

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(51) International Classifications: H02K 7/075 F02F 1/18 C02F 1/48 H01F 7/20 B66C 1/06

(54) Title: AN ELECTROMAGNETIC RECIPROCATING ENGINE

(57) Abstract: An electromagnetic reciprocating engine is disclosed. The engine includes a casing defined with a bore. A first permanent magnet and a second permanent magnet are secured in the casing at two opposite ends such that like magnetic poles of the first and the second permanent magnet face each other. Further, an electromagnet is movably positioned in the bore between the first and second permanent magnets and at least one connecting rod is coupled to the electromagnet with a crankshaft. The engine includes a control unit communicatively coupled to the electromagnet to selectively change a polarity of the electromagnet at a predefined frequency to generate opposite magnetic poles at each side of the electromagnet. This change in polarity of the electromagnet triggers reciprocating movement of the electromagnet between the first and second permanent magnets for the connecting rod to translate reciprocating motion of the electromagnet to rotary motion of the crankshaft.

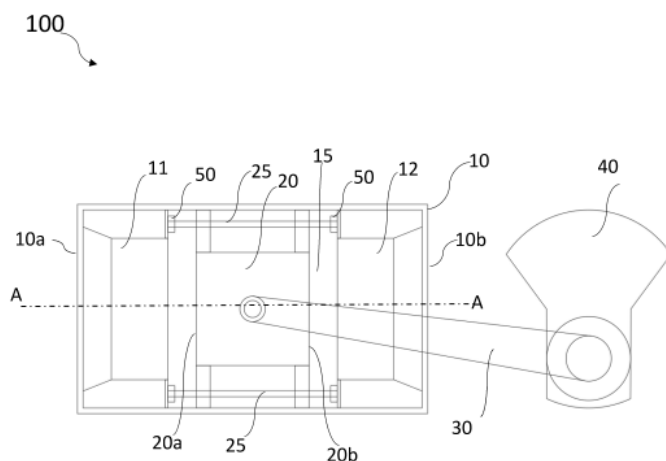


Figure 1

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

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

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

TECHNICAL FIELD

[001] The present disclosure relates generally to liquid quality monitoring, and more particularly to liquid quality monitoring using an unmanned vehicle.

DESCRIPTION

Technical Field

[001] This disclosure relates generally to engines, and more particularly to an electromagnetic reciprocating engine to produce driving power due to a reciprocating movement of electromagnet which generates electromagnetic force.

BACKGROUND

[002] Vehicles such as electric vehicles and hybrid electric vehicles (HEVs) include one or more traction motors which generate 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 power source such as battery module and generate necessary power for driving the vehicle. Conventional, electric motors are designed to pick up rotational energy of a rotor as a power by rotating the rotor. Further, the rotor of the electric motor is subjected to limited application due to belt slip and also inflict a heavy load on peripheral connected components such as shafts and bearings. Also, the electrical vehicle may use an induction motor which consumes more energy and power to operate a propulsion unit of the vehicle, thereby increasing the time required to charge the battery and 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. Conventionally, there have been development of reciprocating type of engine arrangement in order to replace the traction/electric motor. However, such conventional arrangements of the engine include combination of an electromagnet with one permanent magnet to use the magnetic field to operate a piston. The conventional arrangement further includes combination of magnetic field and charging of the batteries within the same setup. This affects the motion of piston and reduces the efficiency of the engine due to induced EMF. Furthermore, this leads to increased usage of battery. Additionally,

there is high probability of metallic interference with the magnetic field to operate these conventional engines.

SUMMARY OF THE INVENTION

[003] In an embodiment, an electromagnetic reciprocating engine is disclosed. The engine may include a casing defined with a bore. The engine further includes a first permanent magnet and a second permanent magnet secured in the casing at two opposite ends of the bore. The first permanent magnet and the second permanent magnet are secured such that like magnetic poles of the first permanent magnet and the second permanent magnet face each other. The engine also include an electromagnet movably positioned in the bore between the first permanent magnet and the second permanent magnet. Further, at least one connecting rod is provided to couple the electromagnet with a crankshaft. The engine may include a control unit communicatively coupled to the electromagnet. The control unit comprises a power source. The control unit is configured to selectively 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 and the second permanent magnets. Thus, causing the connecting rod to translate reciprocating motion of the electromagnet to rotary motion of the crankshaft.

[004] In an embodiment, the casing and the connecting rod are made of non-ferrous material.

[005] In an embodiment, the first and the second permanent magnets are strong magnets such as neodymium magnets.

[006] In an embodiment, the engine includes a position detection sensor to detect a position of at least one of the electromagnet, the connecting rod, and the crankshaft. The position detection sensor is communicatively coupled to the control unit, and the control unit is configured to sense a position of the electromagnet in the bore based on a signal from the position detection sensor.

[007] In an embodiment, the engine includes one or more bushes interposed between the electromagnet and each of the first and the second permanent magnets. The one or more bushes prevent direct contact of the electromagnet with each of the permanent magnets.

[008] In an embodiment, the control unit comprises a processor and

a memory unit communicatively coupled to the processor. The memory unit may store processor-executable instructions, which, on execution, causes the processor to energize the electromagnet using a driver circuit coupled to the power source. Further, the processor is configured to change the polarity of the electromagnet at the predefined frequency. In an embodiment, the engine is configured such that a speed of the reciprocatory movement of the electromagnet is variable by adjusting the predefined frequency, using an encoder communicatively coupled to the control unit. Further, one end of the at least one connecting rod is rotatably coupled to electromagnet and extends from at least one side of the casing.

BRIEF DESCRIPTION OF THE DRAWINGS

[009] 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.

[010] **Figure 1** illustrates a schematic front view of an electromagnetic reciprocating engine, in accordance with an embodiment of the present disclosure;

[011] **Figure 2** illustrates a schematic top view of the electromagnetic reciprocating engine of Figure. 1; and

[012] **Figure 3** illustrates a schematic block diagram of a control unit interfaced with an electromagnet of the electromagnetic reciprocating engine of Figure. 1, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

[013] 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.

[014] Embodiment of the present disclosure disclose electromagnetic reciprocating engine for an electric vehicle or a hybrid vehicle which is efficient and use less power from the power source for driving the vehicle. The electromagnetic reciprocating engine is also compact and can be

accommodated in the vehicle with ease as it is light in weight. The electromagnetic reciprocating engine includes less number of moving components and is inexpensive.

[015] The following paragraphs describe the present disclosure with reference to Figures.1 to 3. In the figures, the same element or elements which have similar functions are indicated by the same reference signs.

[016] 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”] for vehicle. As will be understood, the electromagnetic reciprocating engine 100 may be configured for 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. Further, the electromagnetic reciprocating engine 100 may be employed in electric or hybrid electric vehicles.

[017] As shown in Figure. 1, the engine 100 may include a casing 10 defined with a bore 15. In an embodiment, the casing 10 may have a hollow cylindrical body defining the bore 15, a top wall and a bottom wall. In an embodiment, the casing may be positioned along a horizontal axis (A-A) as shown in Figure 1. However, the casing may be positioned in any other orientation including vertical, inclined/angular orientation. The casing 10 may be made of non-ferrous material.

[018] The engine 100 may further include a first permanent magnet 11 and a second permanent magnet 12 [also referred as “PM”] secured within the casing 10 at two opposite ends of the bore 15. The first permanent magnet 11 may be secured at the first end 10a and the second magnet 12 may be secured at a second end 10b of the bore 15. Each of the first magnet 11 and the second magnet 12 may be secured at first end 10a and the second end 10b of the bore 15 such that like magnetic poles of the first permanent magnet 11 and the second permanent magnet 12 face each other. For example, if a north pole of the first PM 11 and the north pole of the second PM 12 are facing towards the first end 10a and second end 10b of the bore 15, respectively, then the south pole of the first PM 11 and the south pole of the second PM 12 face each other. The first permanent magnet 11 and the second permanent magnet 12 may be secured within the casing 10 suitable mounting arrangement such as mechanical joining or receivable within a provision to allow secured positioning of the first permanent magnet 11 and the second permanent magnet 12 within the bore 15. The mounting arrangement for securing the first and the second permanent magnets 11,12 may be made of non-ferrous material. In an embodiment the first and the second permanent magnets 11,12 are strong magnets. In preferred embodiment, the first and the second permanent magnets 11,12 are

neodymium magnets. The first and the second permanent magnets 11,12 may have configuration of cube, cuboid, or cylindrical, elliptical or polygonal-shape. Although, it is within the purview of a person skilled in the art to modify the shape of first and the second permanent magnets 11,12. The size of the casing 10 may also vary depending on the application. For example, in heavy duty vehicles, the casing 10 may be larger in size to accommodate one or more first and the second permanent magnets 11,12.

[019] The engine may further include an electromagnet 20 movably positioned in the bore 15 between the first permanent magnet 11 and the second permanent magnet 12. In an embodiment, the electromagnet 20 is slidably positioned in the bore 15. The electromagnet 20 is defined with a first end 20a and a second end 20b positioned such that each of the sides of the electromagnet faces the first and the second permanent magnet 11,12. The electromagnet 20 is positioned preferably in axial alignment with the first and the second permanent magnet 11,12. In an embodiment, one or more guide rods 25 is provided within the bore 15 to extend between the first and the second permanent magnet 11,12. As shown in Figure. 1, the one or more guide rods 25 may be defined at top wall and a bottom wall of the casing.

[020] The electromagnet may be coupled with one or more guide rods 25 to allow linear displacement of the electromagnet 20 with the casing 10. It should be noted that the guide rods 25 may have a cylindrical or a polygonal cross section. Further, each of the guide rods 25 may be made from non-ferrous material.

[021] In an embodiment, one or more bushes 50 may be interposed between the electromagnet 20 and each of the first and the second permanent magnets 11,12. The one or more bushes 50 may prevent direct contact of the electromagnet 20 with each of the permanent magnets 11, 12 during reciprocating motion of the electromagnet 20 within the bore 15. Further, the electromagnet 20 is configured to be linearly displaced in the reciprocating movement of along the horizontal axis A-A via the guide rods 25. The reciprocating movement of the electromagnet 20 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.

[022] The one or more bushes 50 may be positioned at each end of the guide rods 25. As such, in some example embodiments, the bush 50 may be manufactured from a suitable elastic polymer-based material to prevent direct contact of the electromagnet 20 with the first and second PM 11,12.

[023] The engine 100 of the present disclosure may include at least one connecting rod 30 coupling the electromagnet 20 with a crankshaft 40. As will be understood from Figure 2, one end of the connecting rod 30 is rotatably coupled to electromagnet 20 and extends from at least one side of the casing 10 to couple other end to the crankshaft 40. The connecting rod 30 is configured to translate reciprocating motion of the electromagnet 20 to rotary motion of the crankshaft 40. The connecting rod 30 may also be manufacture from a non- ferrous material.

[024] Referring now to **Figure. 3**, a schematic view of control unit 110 being coupled to the electromagnet 20 is illustrated, in accordance with an embodiment of the present disclosure. As shown in **Figure. 3**, the control unit 110 is communicatively coupled to the electromagnet 20. In an embodiment, the control unit 110 is coupled with the electromagnet 20 via a driver circuit 113. The engine 100 may include a position detection sensor 114 to detect a position of at least one of the electromagnet 20, the connecting rod 30, and the crankshaft 40. The control unit 110 further is coupled to a power source 111. In an embodiment, the power source 111 is a battery module configured to supply power to the electromagnet 20 through the control unit 110. The position detection sensor 114 is communicatively coupled to the control unit 110 and the control unit 110 is configured to sense a position of the electromagnet 20 in the bore 15 based on a signal from the position detection sensor 114.

[025] Further, the control unit 110 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 accelerator pedal or accelerator bar. Based on the command or the user input the processor changes a polarity of the electromagnet 20 at a predefined frequency to generate opposite magnetic poles at the first side 20a and the second side 20b of the electromagnet 20. In an embodiment, the based on the inputs received from the user the processor is configured to energize the electromagnet 20 using the driver circuit 113 coupled to the power source 111. Further, the control unit 110 is configured to selectively change the polarity of the electromagnet 20 at a predefined frequency based on the signals sent from the processor to the driver circuit 113. The change in polarity of the electromagnet 20 triggers reciprocating movement of the electromagnet 20 between the first and the

second permanent magnets 11,12. Further, a speed of the reciprocatory movement of the electromagnet 20 is variable by varying the predefined frequency, using an encoder 112 communicatively coupled to the control unit 110. The encoder receives the signals directly or indirectly from the hardware components like accelerator pedal or accelerator bar.

[026] The electromagnetic reciprocating engine 100 is driven by a magnetic field produced by the electromagnet 20. When the power is supplied from the power source 111, the processor energizes the electromagnet 20 and produces a magnetic field having opposite poles at each end 20a, 20b which are facing the first and the second permanent magnets 11 and 12. The first and the second permanent magnets 11 and 12 are secured within the bore 15 of the cylinder 10 and orientated to present the same magnetic pole towards the electromagnet 20. When the electromagnet 20 is energized, depending on the polarity on each side of the electromagnet 20, the first side 20a of the electromagnet 20 gets attracted towards the permanent magnets 11 having opposite polarity. Similarly, second side 20b of the electromagnet 20 repels away from the permanent magnet 12 having same polarity. Further, the polarity of electromagnet 20 can be reversed using the driver circuit 113 causing switching of the attraction or repulsion of the sides of the electromagnet 20 against the first and the second permanent magnets 11 and 12. The attraction and repulsion of the electromagnet 20 causes the reciprocating movement within of the electromagnet 20 within the bore 15 in between the first and the second permanent magnets 11 and 12. This reciprocating movement of the electromagnet 20 is along the horizontal axis A-A. In an embodiment, the electromagnet 20 moves in a frictionless sliding movement along the horizontal axis A-A . The electromagnet 20 is coupled to the crankshaft 40 via the connecting rod 30 such that the reciprocating movement of the electromagnet 20 causes the crankshaft 40 to rotate. This rotation of the crankshaft 40 is used to drive the vehicle. Further, an encoder 112 communicatively coupled to the control unit 110 can be used to adjust the predefined frequency for varying the speed of the reciprocatory movement of the electromagnet 20.

[027] The above subject matter discloses an electromagnetic reciprocating engine 100 which is capable of operating on single cylinder and multicylinder engines. Further, engine 100 includes a fewer number of moving parts, that are easy to assembly thereby reducing the overall manufacturing and operating cost. Further, the electromagnetic 20 reciprocating can replace the existing IC engine or electrical motor of EV's. Moreover, by employing the electromagnet 20 for operation of the engine enables less consumption of energy and power to drive the electric vehicle.

[028] 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.

CLAIMS

We Claim:

1. An electromagnetic reciprocating engine (100), the engine (100) comprising:
 - a casing (10) defined with a bore (15);
 - a first permanent magnet (11) and a second permanent magnet (12) secured in the casing (10) at two opposite ends of the bore (15) such that like magnetic poles of the first permanent magnet (11) and the second permanent magnet (12) face each other;
 - an electromagnet (20) movably positioned in the bore 15 between the first permanent magnet (11) and the second permanent magnet (12);
 - at least one connecting rod (30) coupling the electromagnet (20) with a crankshaft (40); and
 - a control unit (110) communicatively coupled to the electromagnet (20) and the control unit (110) comprises a power source (111), wherein the control unit (110) is configured to selectively change a polarity of the electromagnet (20) at a predefined frequency to generate opposite magnetic poles at a first side (20a) and a second side (20b) of the electromagnet (20), and wherein the change in polarity of the electromagnet (20) triggers reciprocating movement of the electromagnet (20) between the first and the second permanent magnets (11,12) and wherein the connecting rod (30) translates reciprocating motion of the electromagnet (20) to rotary motion of the crankshaft (40).
2. The engine (100) as claimed in claim 1, wherein the casing (10) and the connecting rod (30) are made of non-ferrous material.
3. The engine (100) as claimed in claim 1, wherein the first and the second permanent magnets (11,12) are strong magnets.
4. The engine (100) as claimed in claim 3, wherein the first and the second permanent magnets (11,12) are neodymium magnets

5. The engine (100) as claimed in claim 1, comprises a position detection sensor (114) to detect a position of at least one of the electromagnet (20), the connecting rod (30), and the crankshaft (40).
6. The engine (100) as claimed in claim 5, wherein the position detection sensor (114) is communicatively coupled to the control unit (110) and the control unit (110) is configured to sense a position of the electromagnet (20) in the bore (15) based on a signal from the position detection sensor (114).
7. The engine (100) as claimed in claim 1, comprises one or more bushes (50) interposed between the electromagnet (20) and each of the first and the second permanent magnets (11,12), wherein the one or more bushes (50) is structured to prevent direct contact of the electromagnet (20) with each of the first and second permanent magnets (11,12).
8. The engine (100) as claimed in claim 1, wherein the control unit (110) comprises:
 - a processor; and
 - a memory unit communicatively coupled to the processor, wherein the memory unit stores processor-executable instructions, which, on execution, causes the processor to:
 - energize the electromagnet (20) using a driver circuit (113) coupled to the power source (111);
 - change the polarity of the electromagnet (20) at the predefined frequency.
9. The engine (100) as claimed in claim 1, wherein a speed of the reciprocatory movement of the electromagnet (20) is variable by adjusting the predefined frequency, using an encoder (112) communicatively coupled to the control unit (110).

10. The engine (100) as claimed in claim 1, wherein one end of the at least one connecting rod (30) is rotatably coupled to electromagnet (20) and extends from at least one side of the casing (10).

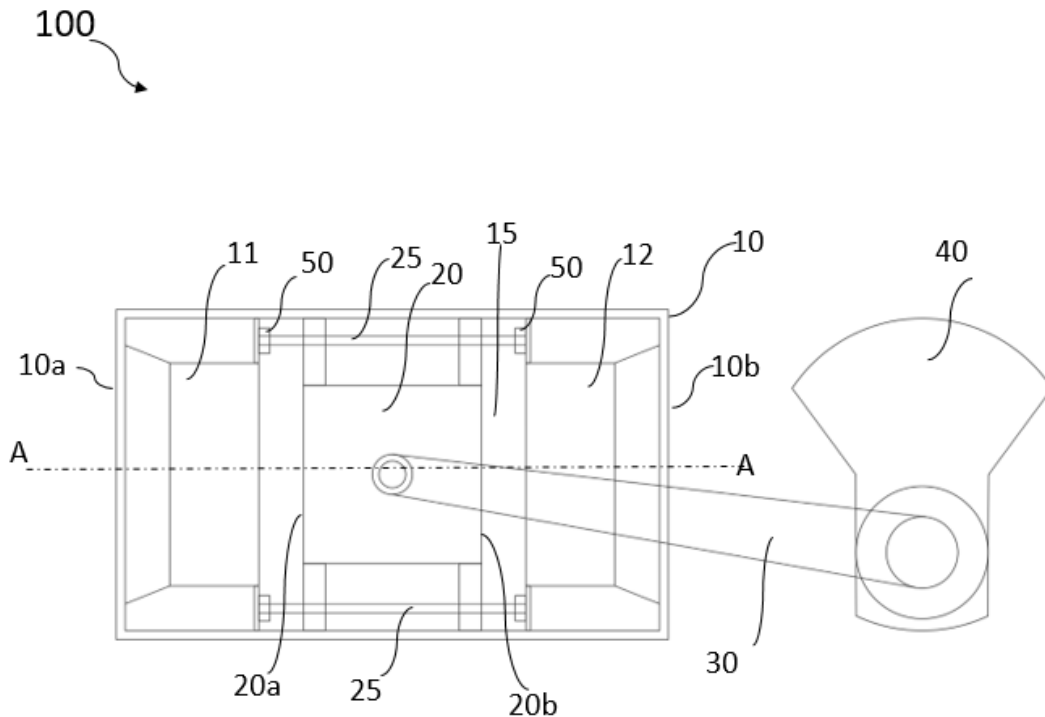
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AN ELECTROMAGNETIC RECIPROCATING ENGINE

ABSTRACT

An electromagnetic reciprocating engine is disclosed. The engine includes a casing defined with a bore. A first permanent magnet and a second permanent magnet are secured in the casing at two opposite ends such that like magnetic poles of the first and the second permanent magnet face each other. Further, an electromagnet is movably positioned in the bore between the first and second permanent magnets and at least one connecting rod is coupled to the electromagnet with a crankshaft. The engine includes a control unit communicatively coupled to the electromagnet to selectively change a polarity of the electromagnet at a predefined frequency to generate opposite magnetic poles at each side of the electromagnet. This change in polarity of the electromagnet triggers reciprocating movement of the electromagnet between the first and second permanent magnets for the connecting rod to translate reciprocating motion of the electromagnet to rotary motion of the crankshaft.



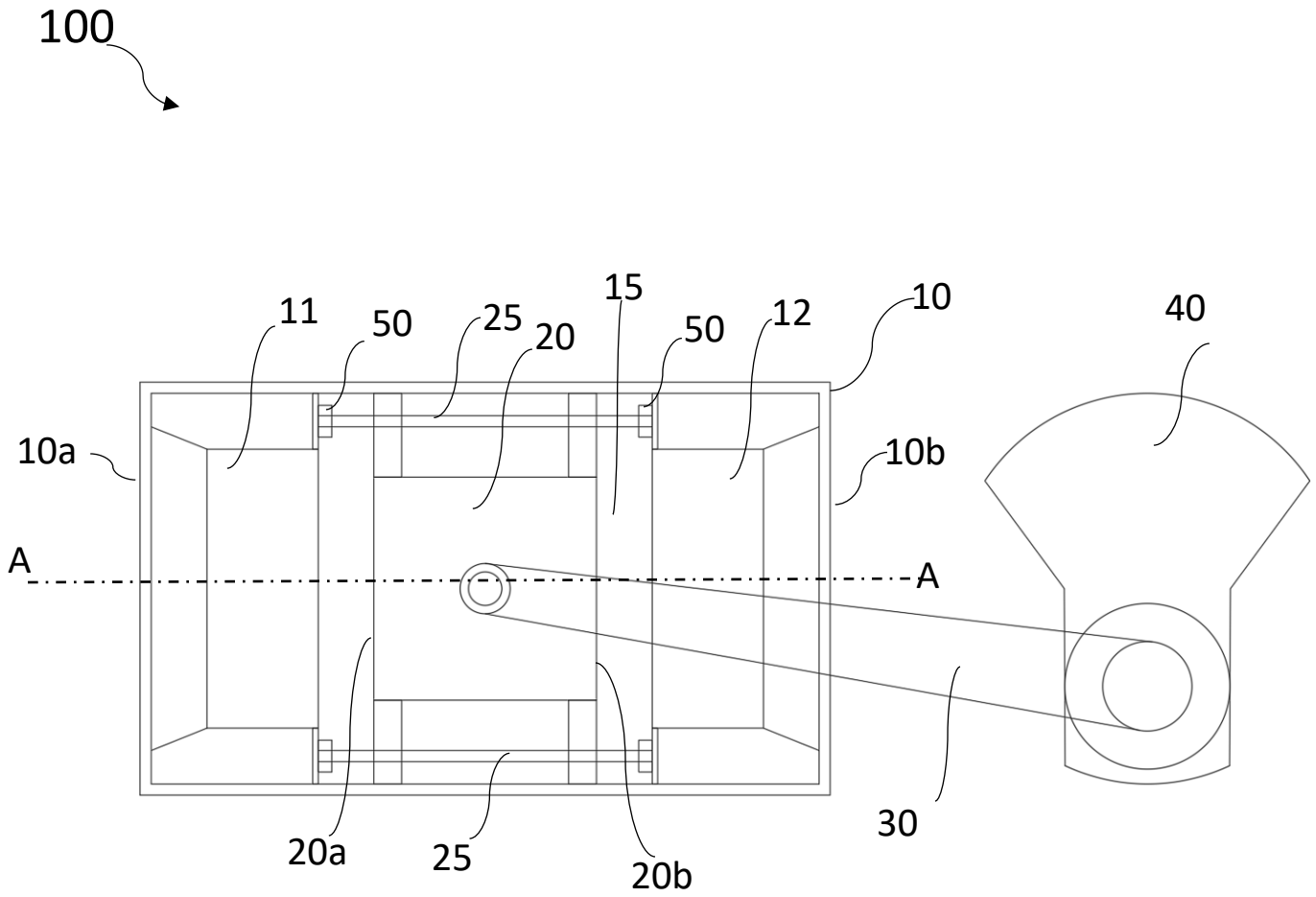


Figure 1

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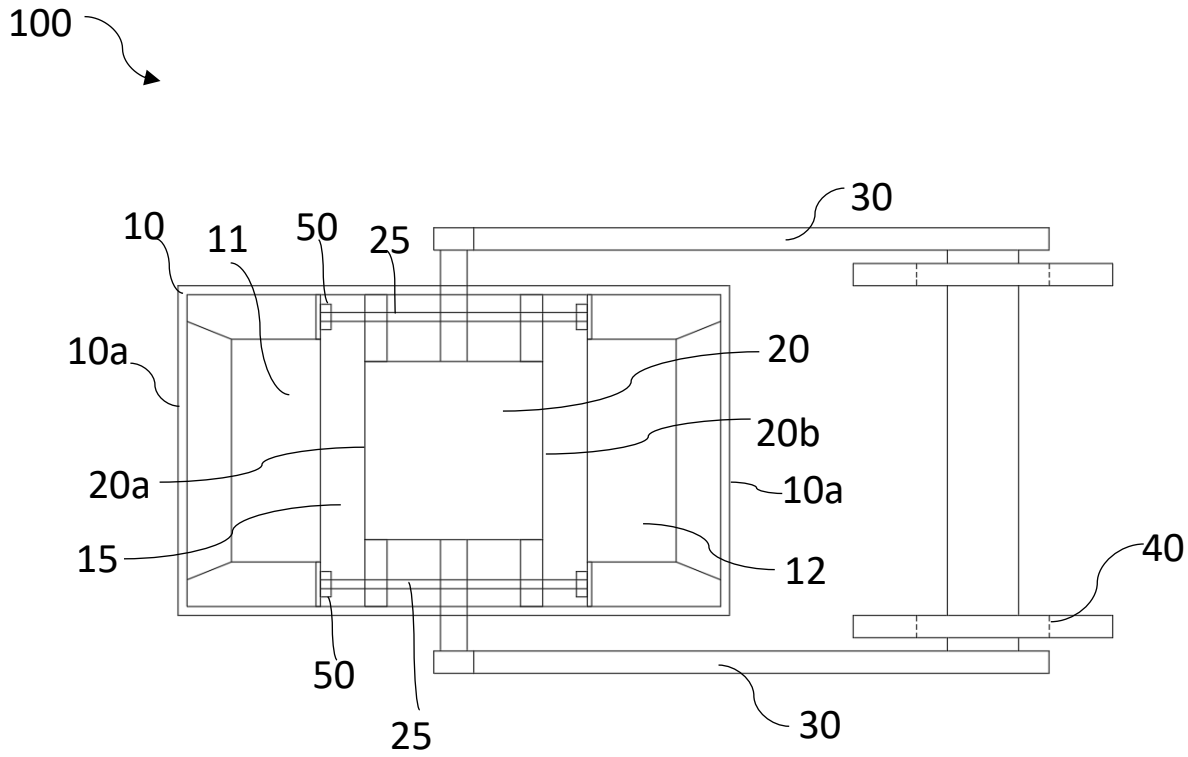


Figure 2

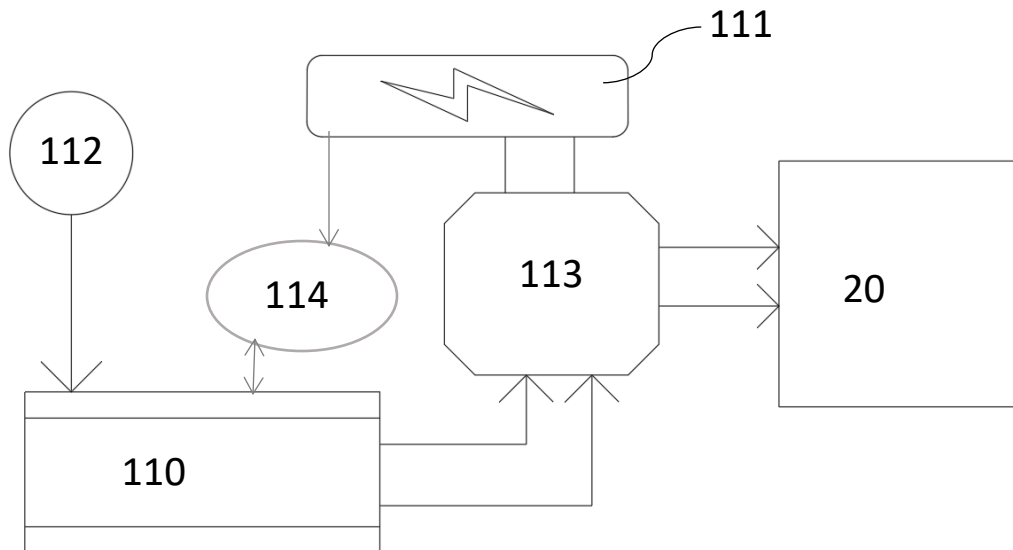


Figure 3

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