

[54] ROTARY-TO-RECIPROCATING DEVICE

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[51] Int. Cl. **H02k 7/06**

[58] Field of Search **310/24, 103, 80, 190**

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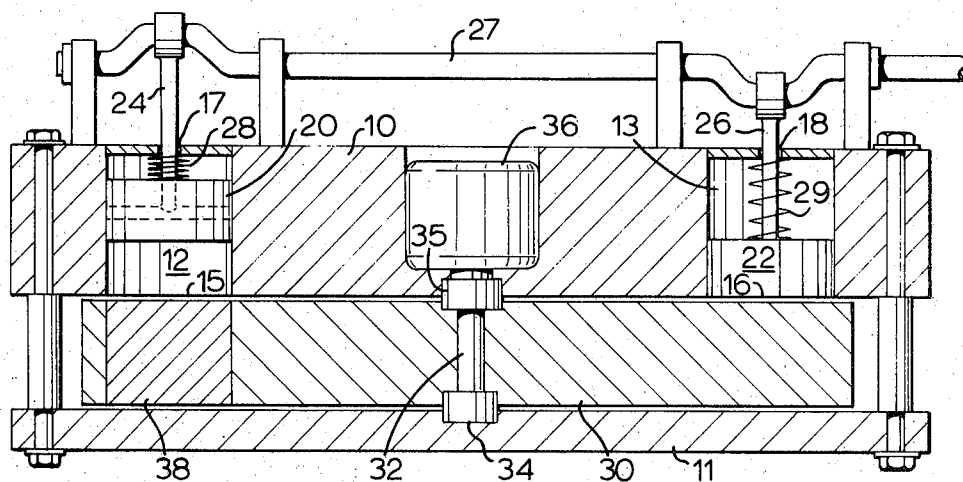
Primary Examiner—D. F. Duggan

[57]

ABSTRACT

A reciprocating device is disclosed which converts the magnetic force of permanent magnets into reciprocating motion. The reciprocating device comprises at least one cylinder chamber formed in an engine block. The cylinder chamber is open-bottomed. A piston which is made of a magnetic material having a predetermined polarization is slidably disposed in the cylinder chamber. A disc is rotatably mounted to the engine block. The disc has a surface therein movable relative to the open bottom of the cylinder chamber. At least one permanent magnet having a magnetic polarization identical to that of the piston is mounted on the surface of the disc. The disc is rotatable selectively to align the permanent magnet with the piston periodically. The repulsion force between the piston and the permanent magnet causes the piston to reciprocate in the cylinder chamber.

9 Claims, 5 Drawing Figures



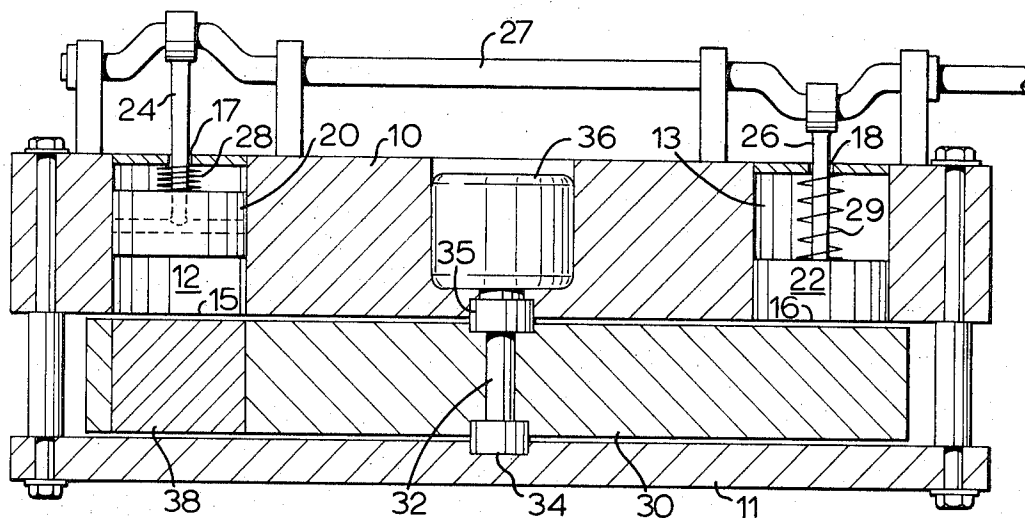


FIG. 1

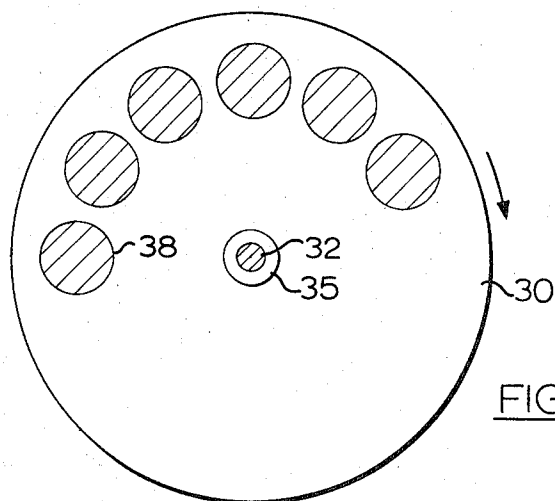


FIG. 2

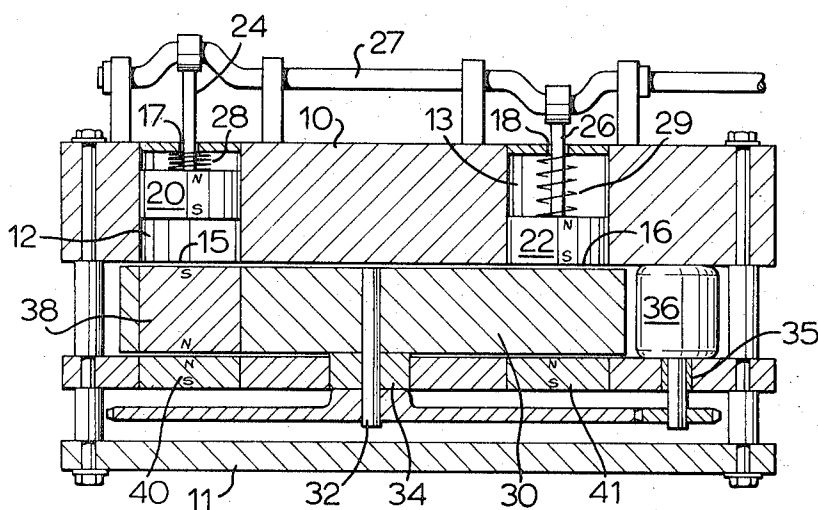


FIG. 3

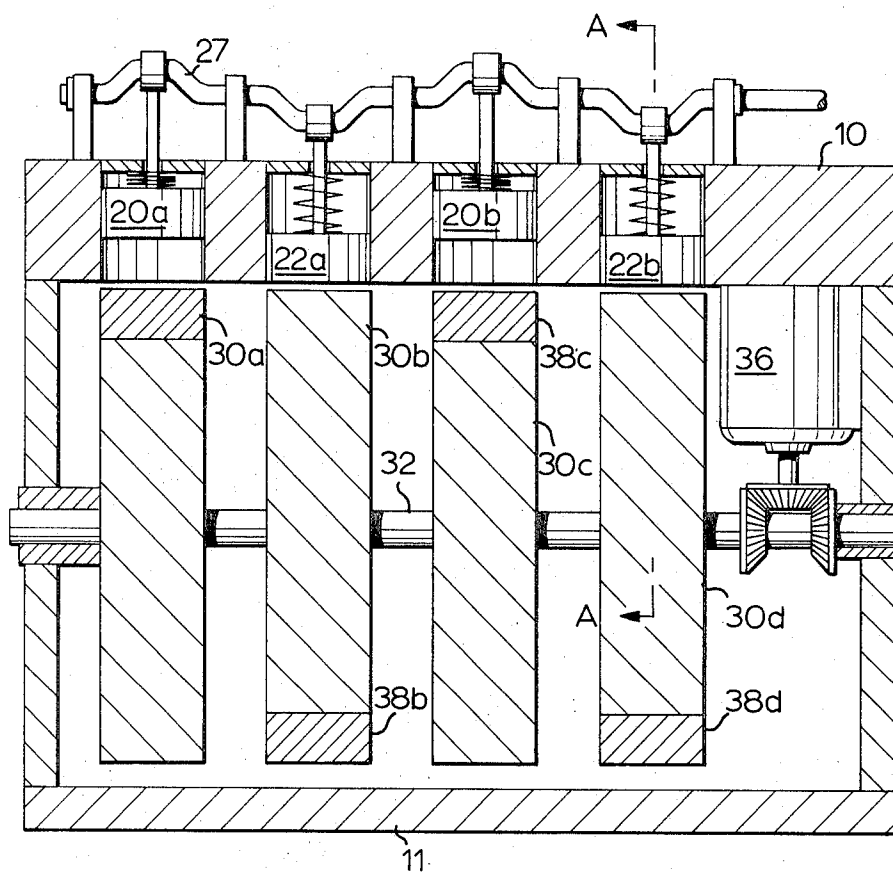


FIG. 4

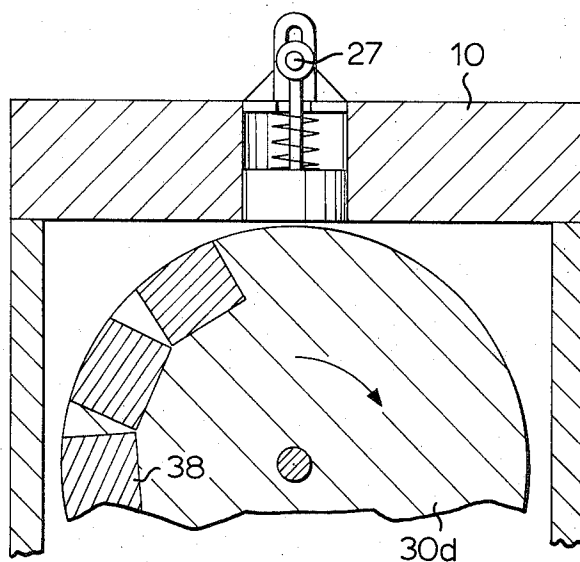


FIG. 5

ROTARY-TO-RECIPROCATING DEVICE

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to a reciprocating device and particularly relates to a device for converting magnetic force into reciprocating motion.

Reciprocating devices are well known in which a piston is slidably disposed within a cylinder chamber. A driving force is periodically generated in the cylinder chamber to drive the piston into reciprocating motion. Reciprocating engines such as internal combustion engines, steam engines are operated in this manner. Such reciprocating engines require a constant supply of fuel to operate and the combustion of the fuel creates exhaust emission which pollutes the atmosphere and is harmful to human health.

Electromagnetic force has been utilized to provide the driving force for reciprocating engines or devices. In such devices, a plurality of electrical coils surrounding the engine cylinder chamber are provided. The electrical coils are actuated by electrical currents so that an electromagnetic force is developed in the cylinder chamber to drive the piston into a reciprocating motion. However, electromagnetic reciprocating devices are usually very complex in structure and very elaborate control means must be incorporated in the structure to operate the device in a controlled and useful manner. Furthermore, a constant supply of large electrical current must be fed to the coils in order to develop a useful reciprocating motion.

I have discovered that the magnetic energy stored in permanent magnetic materials such as permanent magnets may be utilized to provide the driving force necessary for reciprocating devices. Such energy source is constant and has a long operating life. The energy can be converted into mechanical force by the co-action of the magnetic element with a magnetizable element or between two magnetic elements. The repulsion or attraction force between two magnetic elements is very strong which can be expressed by the equation:

$$\text{Magnetic force} = \mu (q_1 q_2 / r^2)$$

in which q_1, q_2 are the magnetic strength of each magnet element respectively; r is the distance between the magnet elements; and μ is the permeability of the conducting medium between the magnet elements, which for vacuum and/or air is approximately equal to 1.

When two magnets having similar magnetic polarity are juxtaposed to each other, and if one of the magnets is held fixed, the other magnet will be driven away from the fixed magnet by the repulsion force.

The magnetic force radiated from a magnetic material is normally proportional to the size of the material and therefore is indirectly proportional to the weight of the material. It has been observed that the repulsion force between two magnets is large enough to repel 500 times their own weight. That is, when two magnets weighing one pound each are juxtaposed to each other, a repulsion force of 500 pounds is created between them to drive the magnets apart. Such high repulsion force is particularly found in magnetic materials such as strontium ferrite alloy. The repulsion magnetomotive force is useful for driving the piston of reciprocating devices.

It is therefore a principal object of the present invention to provide a device which converts magnetic energy into reciprocating motion.

It is another object of the present invention to provide a rotary engine which is driven by magnetic force.

It is yet another object of the present invention to provide a reciprocating system which requires a low external energy input to provide a large energy output.

It is still another object of the present invention to provide a reciprocating system which is simple in structure and is simple to operate.

According to the present invention, the reciprocating device comprises an engine block having at least one cylinder chamber formed therein, a piston slidably disposed within the cylinder chamber, the piston consisting of a magnetic element having a predetermined magnetic polarity and positioned normally immediate an opening of the cylinder chamber, a movable member disposed in a spaced relation to the cylinder block and having a surface therein movable perpendicular to the longitudinal axis of the cylinder chamber, at least one fixed magnetic element fixedly mounted on the movable member, the fixed magnetic element having a magnetic polarity identical to the magnetic polarity of the piston, the movable member being movable selectively to align the magnetic element to the piston so as to drive the piston to move in a reciprocating motion within the cylinder chamber.

These and other objects of the invention together with its advantages will be more apparent from the following description and drawings, which illustrate specific embodiments by way of example and in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional side view of the reciprocating device according to the present invention;

FIG. 2 is a top elevation of the rotatable disc of the reciprocating device according to the present invention;

FIG. 3 is a sectional side view of an alternate embodiment of the reciprocating device;

FIG. 4 is a sectional side view of another alternate embodiment of the reciprocating device; and

FIG. 5 is another sectional side view of the embodiment shown in FIG. 4 taken along line A—A.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in which all parts unless otherwise indicated are made of non-magnetizable material and in which like numerals indicate like parts, FIG. 1 shows a reciprocating device having an engine block 10 mounted in a spaced relation to a mounting base 11. Two vertical cylinder chambers 12 and 13 are formed in the block 10 and are located 180° from each other. The cylinder chambers 12 and 13 preferably have a circular cross-section and the walls therein are coated with a coating of a material having a low surface friction such as Teflon (a trade mark of E.I. Du Pont). The cylinder chambers have bottom openings 15 and 16 respectively facing downwards. Two top openings 17 and 18 are formed respectively in the centre of the top wall of the cylinder chambers.

Two pistons 20 and 22 are slidably disposed within the cylinder chambers. The pistons are made of a ferro-

magnetic material such as strontium ferrite alloy which has a high magnetic property. The bottom surface of the pistons is of an identical magnetic polarity either both of north or south magnetic pole. Connecting rods 24 and 26 are movably connected to the pistons in a conventional manner. Connecting rods 24 and 26 extend through the top openings 17 and 18 and are movably mounted to two U-shaped sections of a crank shaft 27 which is rotatably mounted on top of the engine block 10.

Due to the weight of the pistons, they tend to fall to the lower section of the cylinder chambers and are normally held near the bottom openings 15 and 16 by the connecting rods so that their bottom edges are preferably flush with the edge of the openings when the respective U-shaped section of the crank shaft is at the bottom dead centre position. The configuration of the crank shaft 27 is such that when one of the U-shaped sections is at the top dead centre position the other U-shaped section is at the bottom dead centre position. As shown in FIGS. 1 and 3, the U-shaped section coupled with connecting rod 24 is at the top dead centre position and the U-shaped section coupled to the connecting rod 26 is at the bottom dead centre position. Therefore, connecting rod 26 maintains the piston 22 at the normal position immediate bottom opening 16 of cylinder chamber 13, while connecting rod 24 raises piston 20 to the upper position close to the top wall in cylinder chamber 12. Two biasing means such as coil springs 28 and 29 may be provided in the cylinder chambers to assist the pistons to return to the normal lower position.

A movable member such as a disc 30 is mounted in the space between the engine block 10 and the mounting base 11. The disc 30 is preferably circular in shape and is rotatably mounted to the mounting base 11 and engine block 10 through a central shaft 32 which is rotatable with respect to bearings 34 and 35 as best shown in FIG. 1. A prime mover such as an electric motor 36 is coupled to the central shaft 32 to rotate the disc with respect to the engine block. The central shaft 32 is located midway between the vertical axes of cylinder chambers 12 and 13 and the top surface of the disc is in close proximity to the lower surface of the engine block 10.

A magnet 38 is mounted fixedly in a circular locus in disc 30 directly under the magnetic pistons 20 or 22. The top surface of magnet 38 has a magnetic polarity identical to the bottom surface of the magnetic pistons 20 and 22. Thus, when the disc 30 is rotated by the electric motor 36, the magnet 38 is periodically aligned directly under the magnetic pistons. As shown in FIG. 1, magnet 38 is aligned with piston 20, and the repulsion force developed therein forces piston 20 upwards. The upward thrust on piston 20 is transmitted through the connecting rod 24 to turn the crank shaft 27. The size of the magnet 38 and the rotational speed are timed such that magnet 38 commences alignment under magnetic piston 20 when the U-shaped section of the crank shaft is slightly passed the bottom dead centre position in its rotation, and magnet 38 will go out of alignment with magnetic piston 20 completely when the U-shaped section of the crank shaft is rotated slightly past the top dead centre; therefore, the inertia of the rotating crank shaft, the gravitational force of the magnetic piston 20 and the expansion force of the biasing spring 28 are combined together to pull the

magnetic piston 20 downwards to return it to the lower position. A flywheel (not shown) is mounted on the crank shaft to maintain the inertia of its rotation. Similar operations occur in magnetic piston 22 when the magnet 38 is aligned therewith. Thus, magnetic pistons 20 and 22 are alternately actuated to reciprocate within the respective cylinder chamber and the reciprocating motion is converted to rotational motion in the crank shaft.

It can be appreciated that only a low power electric motor is required to rotate the disc 30 so as to develop a large rotational force in the crank shaft because only about one pound force is required to rotate the disc in order to develop a 500 pound reciprocating thrust in each cylinder. Therefore, a relatively small electrical energy is required to operate the system to obtain a large power output therefrom.

The timing of the operation of magnetic pistons 20 and 22 is dependent on the rotational speed of the disc. A plurality of magnets 38 may be mounted in the disc 30 over an arc slightly less than 180 degrees as best shown in FIG. 2 to provide a constant upward thrust force on the piston over the entire period when the U-shaped section of the crank shaft is rotating from the bottom dead centre piston to the top dead centre position. Thus, pistons 20 and 22 are alternately forced upwards by a constant repulsion force over the entire period to provide a constant output in the crank shaft. Although a plurality of magnets 38 is shown, it can be appreciated that a single arcuate magnetic element may be used for the same purpose.

FIG. 3 shows an alternate embodiment in which the motor 36 is mounted on the side portion of the mounting base. A gear arrangement is coupled between the motor and the central shaft 32 to rotate the disc 30. This embodiment facilitates easy access to the motor 30 for adjustment or repair purposes.

Two cylinders are shown in the above embodiments. However it can be appreciated that more than two cylinders may be provided to rotate the crank shaft. For example, at least one more cylinder may be incorporated between the cylinders 12 and 13 in a smaller distance away from the central shaft 32, and at least one magnet may be mounted in the disc in the similar manner as described above to operate the magnetic piston in the additional cylinder.

The disc 30 may be mounted sideways with respect to the cylinder chambers as shown in FIG. 4. Four discs are shown, however, it is apparent that the system may be operated with any number of discs and associated cylinders. The fixed magnets 38a through 38d are mounted at the edge portion of the disc and as the discs are rotated by the motor 36, the magnets 38a through 38d are alternately aligned to the respective piston in the respective cylinder. Similarly, a series of magnets may be mounted in each disc as shown in FIG. 5 to provide a constant upward thrust to rotate the crank shaft over the entire period when its respective U-shaped sections are rotating from the bottom dead centre position to the top dead centre position in order to provide a constant energy output in the crank shaft.

Two magnets 40 and 41 may be mounted in the mounting base 11 directly opposite to cylinder chambers 12 and 13 as shown in FIG. 1 to counter balance the reaction force pressing downwardly on the disc 30 due to the repulsion force between the magnet 38 and magnetic pistons 20 and 22. Alternatively, the mount-

ing base 11 may be replaced by another engine block having two cylinder chambers directly opposite to cylinder chambers 12 and 13, and similar magnetic pistons are provided therein to rotate a crank shaft mounted on the bottom surface of the additional engine block. Thus, a pair of pistons will be actuated by the same magnet 38 to turn both the upper and lower crank shaft.

It can be appreciated from the above illustrations that the devices according to the present invention convert magnetic energy to reciprocating and rotational motion with an extremely high efficiency due to that it only requires a very small electrical energy input to rotate the disc to provide an extremely powerful output rotational motion.

While illustrative forms of the system in accordance with the present invention have been described and shown herein, it will be understood that numerous changes may be made without departing from the general principles and scope of the invention.

What I claim as new and desire to protect by Letters Patent of the United States is:

1. A reciprocating device comprising: an engine block having at least one cylinder chamber formed therein; a piston slidably disposed within said cylinder chamber; said piston consisting of a magnetic element having a predetermined magnetic polarity and having a magnetic surface therein normally disposed immediately a bottom opening of said cylinder chamber a disc member movably coupled to said engine block and said disc member being rotatable with respect to said engine block and having a selected surface therein movable in a spaced relation relative to said bottom opening of said cylinder chamber; at least one fixed magnetic element fixedly mounted on said selected surface; said fixed magnetic element having a magnetic polarity identical to the magnetic polarity of said piston and said disc member being rotatable selectively to align said fixed magnetic element with said piston periodically so as to drive said piston to move in a reciprocating motion.

2. A reciprocating device according to claim 1 wherein said piston is normally positioned in a lower section of said cylinder chamber and said magnetic surface is a bottom surface therein normally positioned flush with the edge of said bottom opening.

3. A reciprocating device according to claim 2, wherein a plurality of said fixed magnetic elements are mounted in a locus of slightly less than 180 degrees on said surface of said disc member.

4. A reciprocating device according to claim 2 including connecting rod means coupled between said piston and a U-shaped section of a crank shaft rotatably mounted on said engine block whereby said crank shaft is rotated by the reciprocating motion of said piston.

5. A reciprocating device according to claim 2 wherein said piston and said fixed magnetic element consist of a ferromagnetic material having a high magnetic property.

6. A reciprocating device according to claim 1

wherein said surface is a planar top surface of said disc member, and said top surface is spaced in a close proximity to said bottom opening of said cylinder chamber.

7. A reciprocating device according to claim 1 wherein said surface is a circular peripheral surface of said disc member, and said circular peripheral surface is spaced in a close proximity to said bottom opening of said cylinder chamber.

8. A reciprocating device comprising:

a horizontal engine block having at least two vertical cylinder chambers therein; said cylinder chambers having a bottom opening and a top opening respectively; a first piston slidably disposed within one of said cylinder chambers; a second piston slidably disposed in the other cylinder chamber; said first piston and second piston having identical magnetic polarization; first connecting rod means movably coupled to said first piston and to a first U-shaped section of a crank shaft through said top opening of said first cylinder; said crank shaft being rotatably mounted on the top surface of said engine block; second connecting rod means movably coupled to said second piston and to a second U-shaped section of said crank shaft through said top opening of the other cylinder chamber; said crank shaft being configured such that when said first U-shaped section is at a top dead centre position said second U-shaped section is at a bottom dead centre position; biasing means disposed within said cylinder chambers to normally maintain said first piston and said second piston to position immediate to said bottom openings respectively; a disc member rotatably mounted in a spaced relation to the under surface of said engine block; said disc member being rotatable with respect to a central shaft vertically located midway between said vertical cylinder chambers; and said disc member having a planar top surface located in a close proximity to said under surface of said engine block; a plurality of fixed magnetic elements mounted in said disc member over a locus of slightly less than 180 degrees and directly opposite to said bottom openings of said vertical cylinder chambers, said fixed magnetic elements having a magnetic polarization identical to said first piston and second piston whereby said disc member is selectively rotatable to align said fixed magnetic elements with said first piston and second piston alternately to drive said first piston and second piston in complementary reciprocating motion so as to rotate said crank shaft.

9. A reciprocating device according to claim 8 including two permanent magnets mounted in a mounting base mounted in a close spaced relation to the under surface of said disc member and positioned directly opposite to said cylinder chambers, said permanent magnets having an opposite magnetic polarization to the magnetic polarization of the pistons.

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