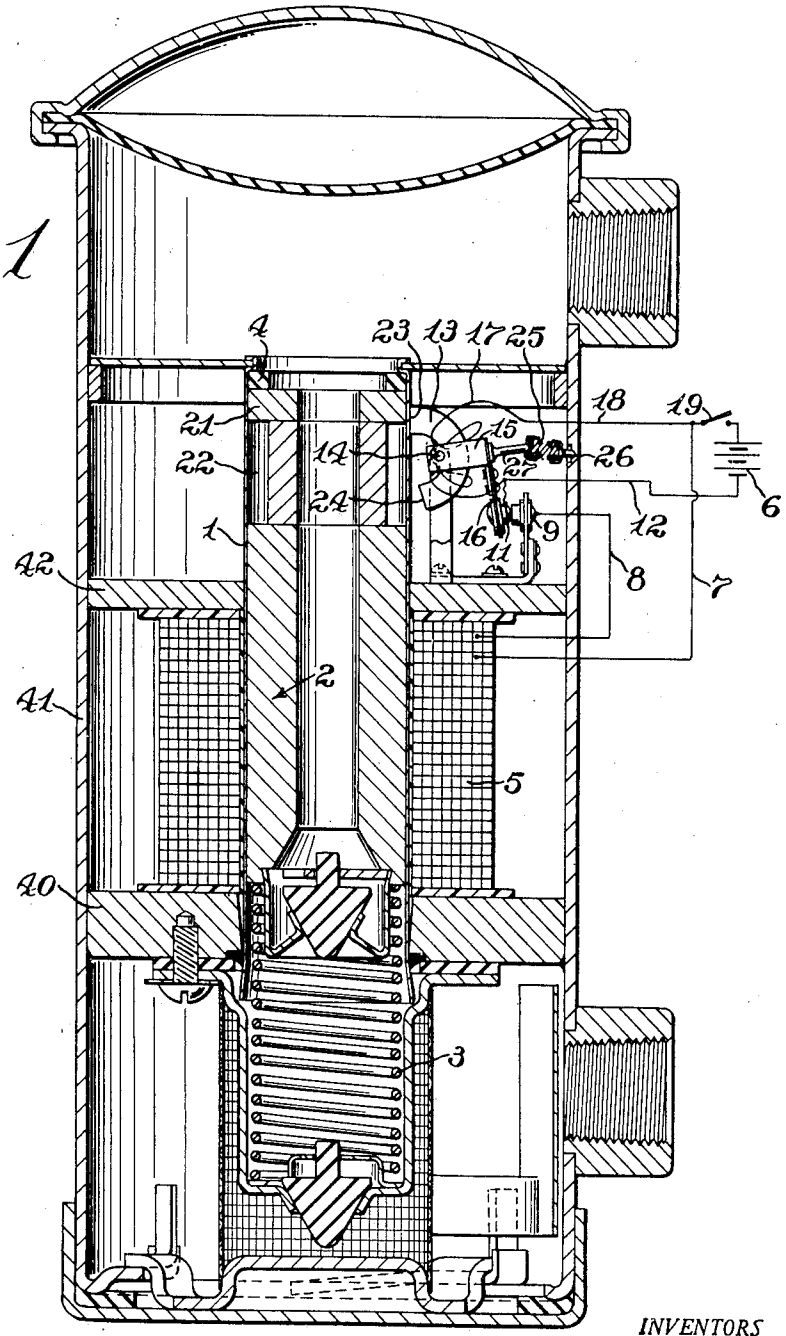
Sept. 6, 1949. L. C. PARKER ET AL 2,481,147

RECIPROCATING ELECTROMAGNETIC MOTOR

Filed Sept. 18, 1947 2 Sheets-Sheet 1

Fig. 1



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RECIPROCATING ELECTROMAGNETIC MOTOR

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Fig. 2

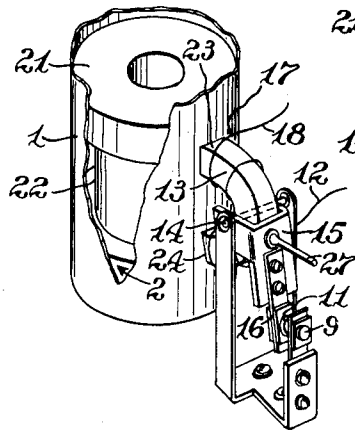


Fig. 4

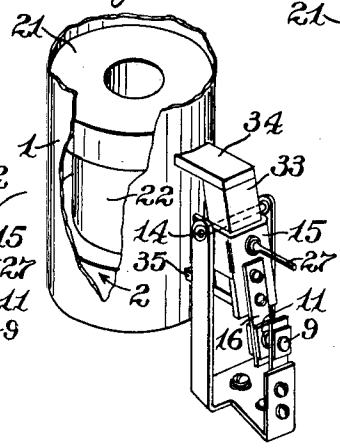


Fig. 5

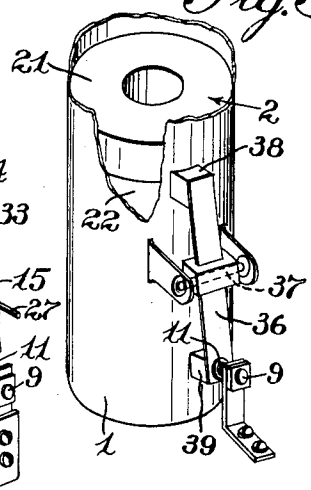


Fig. 3

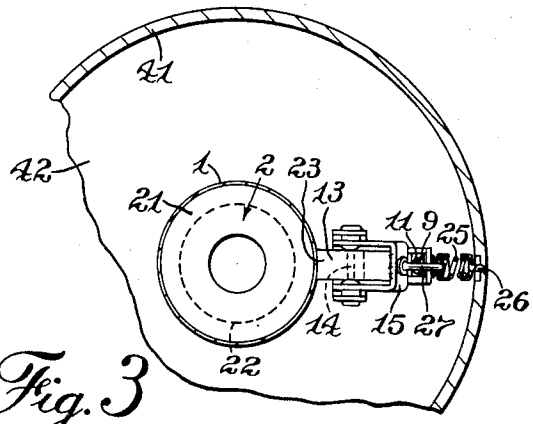


Fig. 6

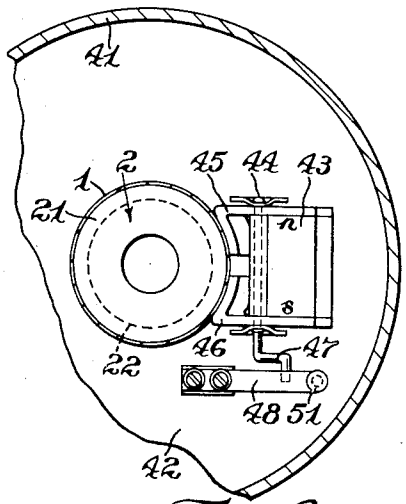
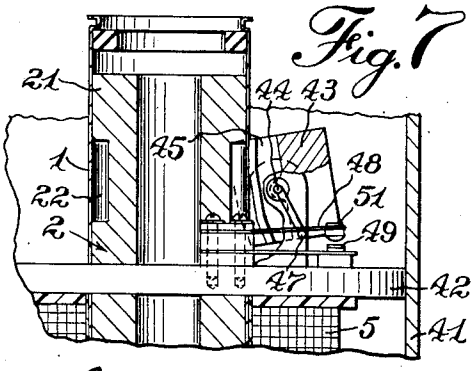


Fig. 7



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UNITED STATES PATENT OFFICE

2,481,147

RECIPROCATING ELECTROMAGNETIC MOTOR

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Application September 18, 1947, Serial No. 774,724

4 Claims. (Cl. 172—126)

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The present invention relates to a reciprocating electromagnetic motor, and more particularly to a motor for actuation of fuel pumps and the like. The motor is here illustrated as incorporated in the pump structure illustrated and described in the application of Dickey et al., Serial Number 736,862, filed March 24, 1947, now Patent No. 2,472,067, assigned to the assignee of the present application, the pump structure per se forming no part of the present invention.

It is an object of the present invention to provide a reciprocating electromagnetic motor having control contacts, and efficient and reliable means for actuating the contacts by a reciprocating member of the motor.

It is another object to provide such a device in which the contacts are opened and closed by a magnetized member which is pivotally mounted on an axis perpendicular to the direction of movement of the reciprocating member of the pump, and the latter is provided with a spaced portion of magnetic material for cooperating therewith to actuate the contacts.

It is another object to provide such a device which is arranged to cause a positive closure of the contacts with adequate pressure, and to provide a quick clean break of the contacts when they open.

Further objects and advantages will be apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a vertical substantially mid-sectional view of a pump structure incorporating a preferred embodiment of the invention;

Fig. 2 is a detail in perspective, partly broken away, showing the contact operating mechanism of Fig. 1;

Fig. 3 is a detail plan view of the contact actuating mechanism of Fig. 1;

Fig. 4 is a view similar to Fig. 2 showing a modified form of the magnetic contact controlling member;

Fig. 5 is a similar view showing a further modification of the contact controlling mechanism;

Fig. 6 is a detail view similar to Fig. 3 showing an embodiment of the invention in which the magnetic contact controlling member is polarized parallel to its pivotal axis; and

Fig. 7 is a detail view in side elevation, partly broken away and in section, of the structure shown in Fig. 6.

In Fig. 1 of the drawing, there is illustrated a cylinder 1 of non-magnetic material in which is slidably mounted a plunger 2 of magnetic material such as soft iron. A spring 3 is arranged to urge the plunger 2 toward the upper end of the cylinder, its movement in this direction being preferably limited by an elastic stop member 4.

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Means for retracting the plunger 2 against the action of spring 3 is provided in the form of a solenoid 5, and means for periodically energizing the solenoid in order to cause reciprocation of the plunger are provided comprising a battery 6, one terminal of which is connected by a lead 7 to one end of the solenoid winding, while the other end of the solenoid winding is connected through a lead 8, fixed contact 9, movable contact 11 and lead 12 to the opposite terminal of the battery.

Means actuated by the movement of the plunger are provided for controlling the contacts 9, 11 so as to close the contacts at the upper end of the piston stroke, and open the contacts at the lower end of said stroke. As here shown, this means comprises an arcuate member 13 of magnetic material which is pivotally mounted adjacent the cylinder 1 on an axis transverse to the axis of the cylinder as indicated at 14. A bracket 15 forms the support for the magnetic member 13 and carries a downwardly extending blade 16 on the free end of which the movable contact 11 is mounted so as to be moved into and out of engagement with the fixed contact 9 as the magnetic member 13 rocks about its pivot 14. Means for maintaining the member 13 magnetized constantly during the operation of the motor is provided in the form of a coil 17, one end of which is connected to the battery lead 12, and the other end is connected through a lead 18 to the opposite battery lead 7. A manual switch 19 is inserted in the battery lead 7 to control the energization of coil 17 and solenoid 5.

The plunger 2 is provided with a portion 21 which is separated from the main body of the plunger by a space or annular gap 22. It will be understood that this gap may be in the form of a turned-down section of the plunger, or may be an insert of non-magnetic material, the object being to provide a space of high magnetic reluctance between the portion 21 of the plunger and the main body thereof.

The magnetic member 13 is so formed and mounted that, when it rocks in a counterclockwise direction as viewed in Fig. 1, its upper end 23 comes substantially into contact with the exterior surface of the cylinder 1, while the contact 11 is thereby engaged with the fixed contact 9. On the other hand, when the magnetic member 13 is rocked in a clockwise direction, its lower end

24 will similarly approach the surface of the cylinder 1, while the contacts 11, 9 will be opened.

Means for causing the magnetic member to operate by a snap action and to hold the contacts closed during the downstroke of the plunger is provided in the form of a toggle spring 25 which is compressed between a fixed bearing 26 and a projection 27 on the pivoted frame 15.

In the operation of this embodiment of the invention, starting with the parts in the positions illustrated in Fig. 1, closure of the manual switch 19 causes energization of the solenoid coil 5 and magnetic coil 17. Energization of solenoid 5 causes the plunger 2 to be retracted downward, compressing the spring 3 until the portion 21 of the plunger is moved out of the zone of influence of the upper end 23 of magnet 13 and into the zone of influence of the lower end 24 thereof. The attraction of the lower end of the magnet for said portion 21 thereupon causes the magnet to rock in a clockwise direction, opening contacts 11, 9 and thereby deenergizing the solenoid 5. This action takes place positively and abruptly due to the action of the toggle spring 25.

The spring 3 is thereupon effective to raise the plunger 2 toward its upper position, where the portion 21 thereof again comes into the zone of influence of the upper end 23 of the magnet. This causes the magnet to rock counterclockwise, closing contacts 11, 9 thereby again energizing the solenoid 5 so that the reciprocation of the plunger is repeated as long as the switch 19 remains closed.

In the embodiment of the invention illustrated in Fig. 4, the magnetic member is in the form of a permanent magnet 33 provided with pole pieces 34 and 35 extending toward the surface of the cylinder 1, and shaped to conform thereto. The operation of this embodiment of the invention is the same as that first described except that the manual switch 19 is here called upon to control only the solenoid 5.

In Fig. 5 of the drawing, the contact actuating means is illustrated as comprising an elastic blade or plate 36 pivotally mounted at 37 and carrying on its ends permanent magnets 38, 39 which extend into proximity with the cylinder 1 and are arranged to be moved alternately into engagement with the cylinder by the proximity of the spaced portion 21 of the plunger 2. The movable contact 11 is carried by the lower end of the blade 36 and is moved into and out of engagement with the fixed contact 9 as the blade rocks on its pivot 37.

In Figs. 6 and 7 of the drawing, there is illustrated an embodiment of the invention in which provisions are incorporated for preventing the magnetization of the plunger 2 by the solenoid from having any effect on the operation of the contacts. Referring back to Fig. 1, it will be noted that the magnetic circuit of the solenoid 5 is completed through the plunger 2, the lower pole piece 40, the casing 41 and the upper pole piece 42, all of which are of magnetic material as set forth more completely in the disclosure of Dickey et al. above referred to. In view of this closed magnetic circuit, the portion of the plunger 2 above the pole piece 42 is substantially demagnetized even when the solenoid 5 is energized so that there is very little, if any, effect on the operation of the contacts, such effect as may occur merely causing a slight change in the length of the stroke of the piston. In order to prevent any interaction of this character, the structure shown in Figs. 6 and 7 is provided in

which a permanent magnet 43 is pivotally mounted as indicated at 44 on an axis transverse to the axis of the cylinder 1, the magnet 43 being polarized as indicated in Fig. 6, parallel to its pivotal axis.

Pole pieces 45, 46 are attached in any suitable manner to the poles of the magnet 43 and extend into proximity to the cylinder 1, being arranged to substantially conform to the exterior surface thereof. The pivot 44 of the magnet 43 is connected to rotate with the magnet and its pole pieces 45, 46, and is extended and bent to form a crank arm 47. This crank is arranged to engage an elastic blade 48 which is anchored at one end and carries on its free end a movable contact 51 which normally engages a fixed contact 49. It will be understood that contacts 49, 51 correspond to contacts 9, 11 in Fig. 1 of the drawing, and control the energization of the solenoid 5 in the same manner. For this purpose, the crank 47 is so arranged that rocking of the magnet 43 in a counterclockwise direction in Fig. 7 causes the crank 47 to open the contacts, while rocking of the magnet in the opposite direction allows the contacts to close.

In this embodiment of the invention, when the plunger 2 approaches its upper position, as shown in Fig. 7, the portion 21 thereof moves up and opens the magnetic gap between the pole pieces 45, 46 of magnet 43 while the main portion of plunger 2 enters the gap from below and partially closes it. This causes the magnet 43 to rock in a clockwise direction as shown in Fig. 7, to further close said gap, whereby the crank 47 permits contacts 49, 51 to close, thus energizing solenoid 5. The plunger 2 is thereby retracted downwardly, moving the main portion of the plunger away from the pole pieces 45, 46 and bringing the spaced portion 21 into the gap therebetween. The mutual attraction between the magnetic material of the portion 21 of the plunger and the pole pieces 45, 46 thereupon causes the magnet 43 to rotate in a counterclockwise direction, thus causing the crank 47 to raise contact 51 out of engagement with contact 49, deenergizing the solenoid 5 and allowing the spring 3 to return the plunger 2 to its upper position. The length of the stroke of the plunger is thus approximately equal to the width of the pole pieces 45, 46 minus the width of the space 22.

It will be appreciated that any stray magnetic flux caused by the energization of the solenoid 5 will have no effect on the action of the magnet 43 in controlling contacts 49, 51 since any attraction for one of the pole pieces 45, 46 caused by such flux would be balanced by a corresponding repulsion for the other pole piece. Any possible interaction with the solenoid 5 is thereby effectively prevented.

Although certain embodiments of the invention have been shown and described in detail, it will be understood that other embodiments are possible and that changes may be made in the design and arrangement of the parts without departing from the spirit of the invention.

We claim:

1. In an electromagnetic motor, a non-magnetic cylinder, a plunger of magnetic material slidably mounted therein, a spring urging the plunger toward one end of the cylinder, a solenoid surrounding the cylinder and arranged when energized to retract the plunger and overcome the spring, and means for controlling the energization of the solenoid including a magnet mounted adjacent

the cylinder with freedom for pivotal movement on an axis transverse to the axis of the cylinder, said plunger having a portion so spaced axially from the main body thereof that during the reciprocation of the plunger the spaced portion comes alternately into and out of the zone of influence of the poles of the magnet so as to cause the magnet to rock about its pivotal axis; and a pair of contacts controlled by the rocking motion of the magnet; in which the magnetic axis of the magnet is substantialy parallel to its pivotal axis, and including further, pole pieces for the magnet having portions substantially conforming to the exterior surface of the cylinder.

2. In an electromagnetic motor, a non-magnetic cylinder, a plunger of magnetic material slidably mounted therein, a spring urging the plunger toward one end of the cylinder, a solenoid surrounding the cylinder and arranged when energized to retract the plunger and overcome the spring, and means for controlling the energization of the solenoid including a magnet mounted adjacent the cylinder with freedom for pivotal movement on an axis transverse to the axis of the cylinder, said plunger having a portion so spaced axially from the main body thereof that during the reciprocation of the plunger the spaced portion comes alternately into and out of the zone of influence of the poles of the magnet so as to cause the magnet to rock about its pivotal axis; and a pair of contacts controlled by the rocking motion of the magnet; in which the magnetic axis of the magnet is substantially parallel to its pivotal axis, and including further, pole pieces for the magnet having portions substantially conforming to the exterior surface of the cylinder in which the spaced portion of the plunger is separated from the main body portion by a magnetic gap which is substantially equal in length to the length of the pole pieces axially of the cylinder less the length of the stroke of the plunger.

3. In an electromagnetic motor, a cylinder of non-magnetic material, a plunger of magnetic material slidably mounted therein, a spring urging the plunger toward one end of the cylinder, electromagnetic means for retracting the plunger against the force of the spring including a solenoid surrounding the cylinder and plunger, and means

for periodically energizing the solenoid to cause reciprocation of the plunger including a permanent magnet pivotally mounted adjacent said end of the cylinder for rotation on an axis transverse to the cylinder, and contacts controlled by the rocking of said magnet about its axis, said plunger being formed with an annular magnetic gap which is moved into and out of the flux path of said magnet by the longitudinal movement of the plunger; in which the magnet is polarized substantially in alignment with its pivotal axis, and including pole pieces for the magnet substantially conforming to the adjacent surface of the cyinder.

4. In an electromagnetic motor, a non-magnetic cylinder, a plunger of magnetic material slidably mounted therein, a spring urging the plunger toward one end of the cylinder, a solenoid surrounding the cylinder and arranged when energized to retract the plunger and overcome the spring, and means for controlling the energization of the solenoid including a magnet mounted adjacent the cylinder with freedom for pivotal movement on an axis transverse to the axis of the cylinder so as to move its poles alternately toward and away from the cylinder, said plunger having a portion so spaced axially from the main body thereof that during the reciprocation of the plunger the spaced portion comes alternately into the zone of influence of one of the poles of the magnet and out of the zone of influence of the other pole, and vice versa, so as to cause the magnet to rock about its pivotal axis; and a pair of contacts controlled by the rocking motion of the magnet.

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