

Sept. 5, 1933.

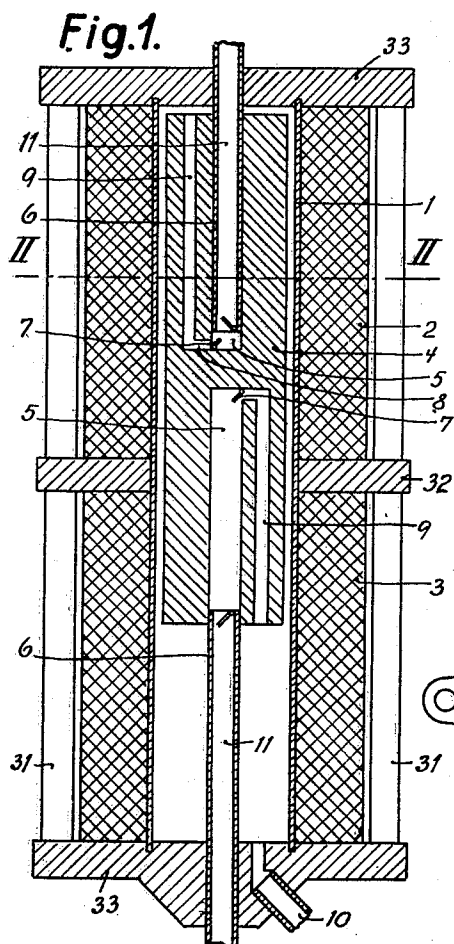
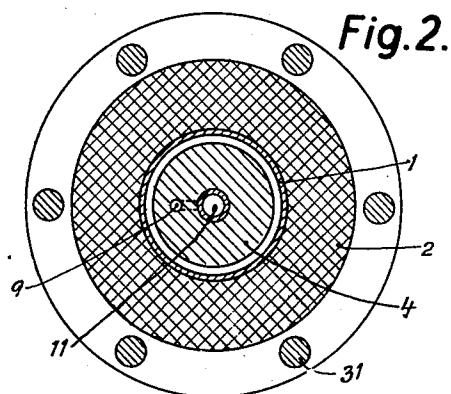
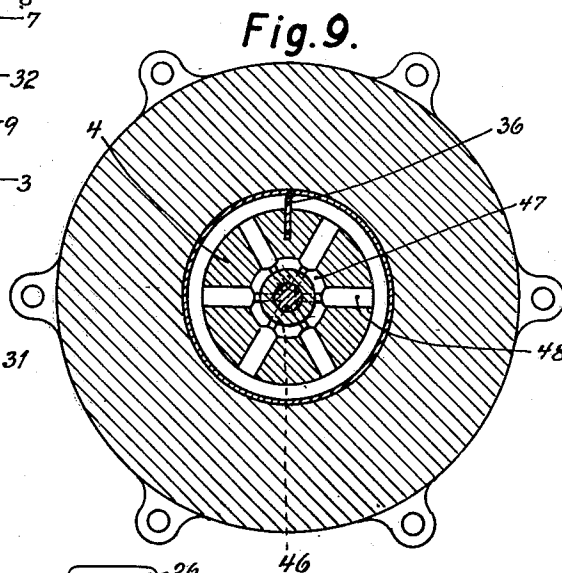
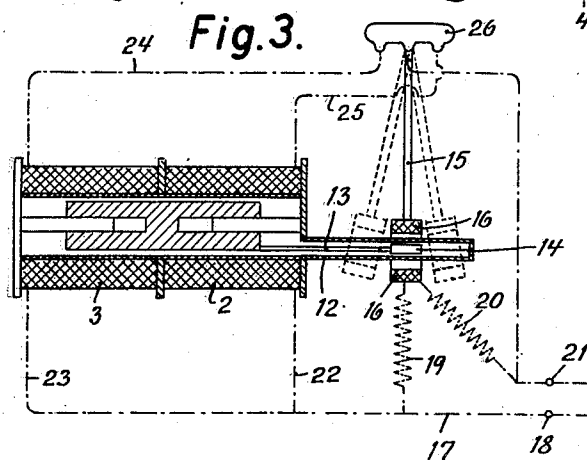
I. A. RIMSTAD ET AL

1,925,934

ELECTROMAGNETIC AIR OR LIQUID PUMP

Filed May 4, 1932

4 Sheets-Sheet 1



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Fig. 4.

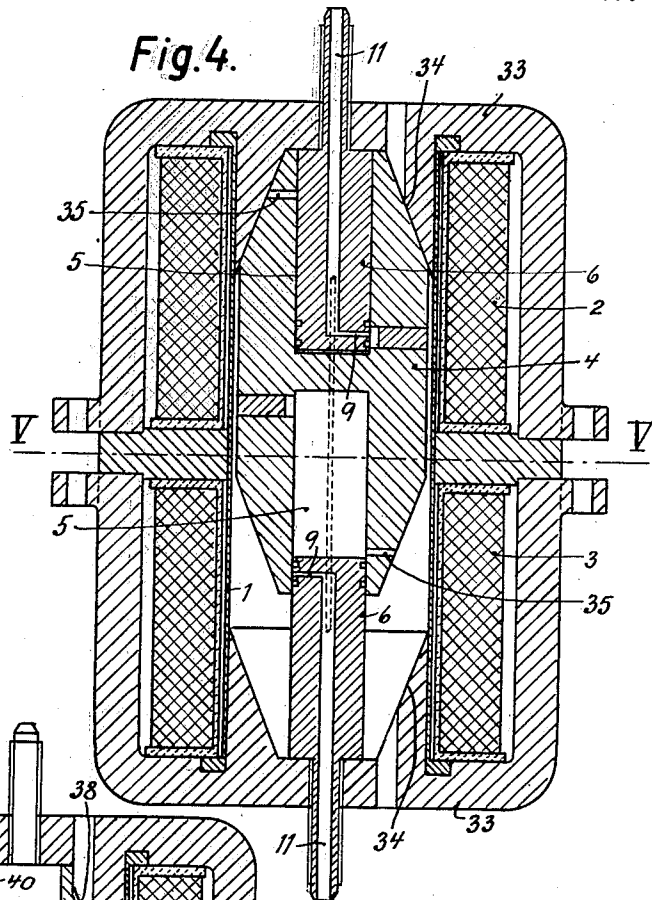
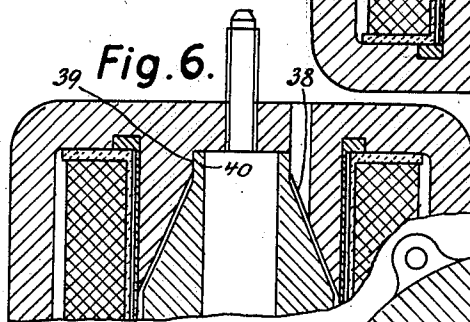
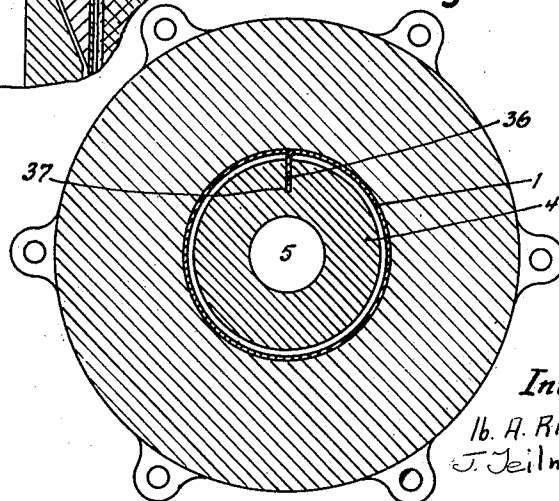


Fig. 5.



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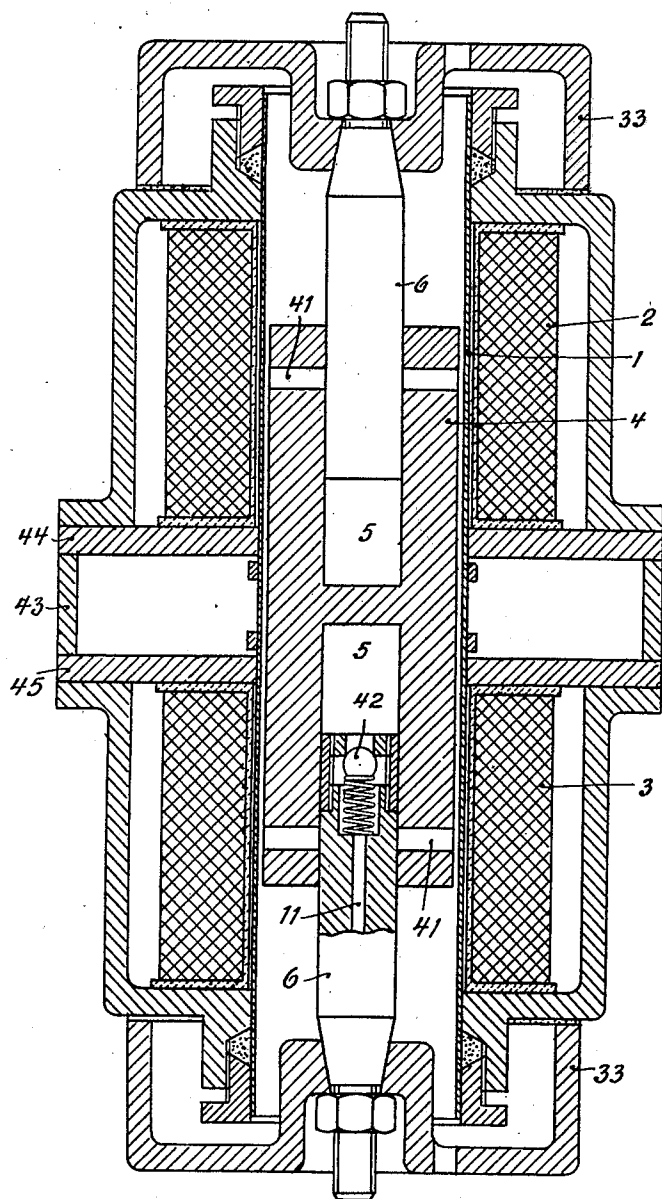
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Fig. 7.



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Fig. 8.

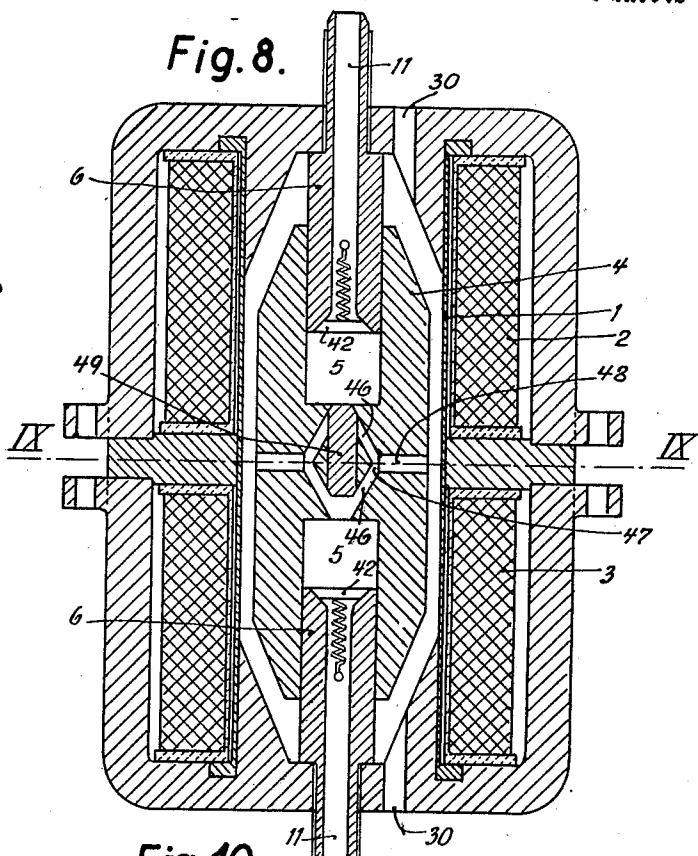
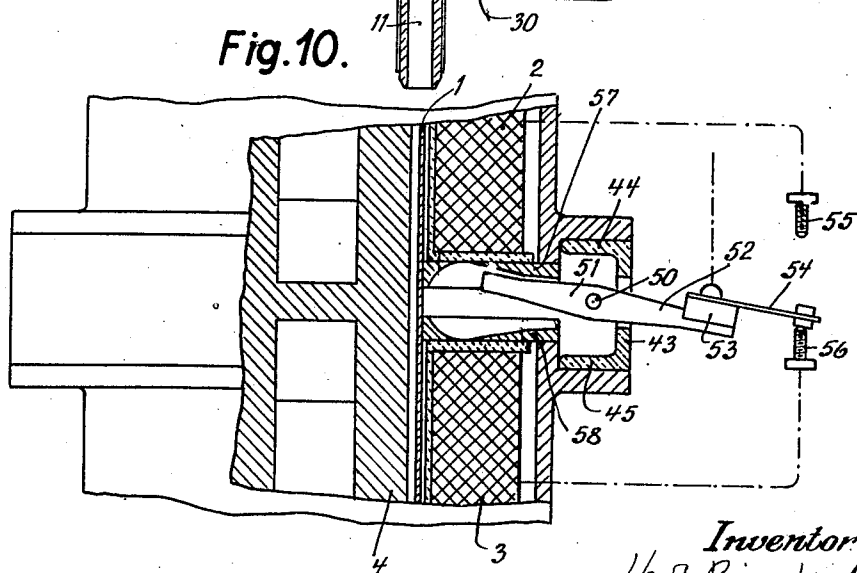


Fig. 10.



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UNITED STATES PATENT OFFICE

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ELECTROMAGNETIC AIR OR LIQUID PUMP

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Application May 4, 1932, Serial No. 609,244,
and in Germany July 11, 1931

9 Claims. (Cl. 103—53)

Air or liquid pumps are known which are intended to be used mainly for high pressures, for instance for compressors in connection with refrigerators and which mainly consist of two solenoids enclosing a cylinder, in which a core is moved backward and forward in the magnetic fields and thereby performs a pumping action, and the present invention relates to a pump of this nature offering several important technical advantages in comparison with the known pumps.

The principal drawbacks of the known pumps of the above mentioned nature are the impossibility of attaining a sufficiently high compression pressure and the circumstance that the reciprocating travel of the core produces much noise, and these drawbacks are removed by the constructions of a high-pressure pump described below, in which a core with central bores travels in a cylinder enclosed by solenoids, the said bores co-operating with pistons firmly secured to the end bottoms of the cylinder.

The invention in its simplest construction is shown in:

Figure 1 which is a diagrammatical vertical longitudinal section of the entire pump,

Figure 2 is a section along the line II—II in Figure 1,

Figure 3 shows one construction of the wiring serving to control the core,

Figure 4 is a longitudinal section of a modified construction of the pump cylinder with core and pistons,

Figure 5 is a section along the line V—V in Figure 4,

Figure 6 is a vertical section of one end of the pump cylinder with a modified construction of the core.

Figure 7 is a vertical longitudinal section of a modified construction of the pump cylinder,

Figure 8 is a fourth construction of the cylinder, especially useful for liquid pumps,

Figure 9 is a horizontal section along the line IX—IX in Figure 8, and

Figure 10 is a modified construction of the switch.

Referring to the drawings, 1 is a pump cylinder encircled by two solenoids 2 and 3. In the cylinder a core 4 is adapted to travel which is fitted at each end with a cylindrical bore 5 co-operating with a stationary piston 6. The bore 5 is fitted at the bottom with a channel 8 and valve 7, which channel leads to a channel 9 parallel to the bore 5. Finally the pump cylinder 1 is fitted with a supply channel 10. Each

of the two stationary pistons 6 is fitted with bores 11 adapted to convey the compressed air where it is to be utilized. The core 4 does not fit tightly in the pump cylinder 1, while on the other hand the two pistons 6 fit tightly in the corresponding bores 5 in the core.

It will thus be understood that by alternating the opening and the closing of the circuit through the solenoids 2, 3, the core 4 will travel backwards and forwards in the pump cylinder 1.

The motion of the core 4 in the pump cylinder is effected by the arrangement shown in Figure 3. One end of the cylinder is fitted with a tubular extension 12 of diamagnetic material, and the core 4 is fitted with a rod or the like 13 similarly of diamagnetic material which supports an iron block 14, which thus by the reciprocating motion of the core 4 in the pump cylinder will be moved backward and forward in the hollow tube 12. Immediately outside of the rod 13 there is provided a pendulum 15 with a solenoid 16 encircling the tube 12.

The figure shows the wiring diagram for the device, a wire 17 from one terminal 18 being connected to a wire 19, leading to the solenoid 16, while another wire 20 passes from the solenoid to the other terminal 21, so that consequently the solenoid will always be energized and follow the travel of the block 14.

The two solenoids 2 and 3 are connected to the wire 17 by way of wires 22 and 23, while the said solenoids by way of wires 24 and 25 are connected to a throw-over switch 26 disposed on the pendulum 15. The switch 26 will alternately connect the wires 24 and 25 to a wire 27 leading to the terminal 21.

The device acts in the following manner:

Supposing a contact to be closed between the throw-over switch 26 and wire 25, then the solenoid 3 will become energized and will move the core to the right, Figure 3, whereby the block 14 will be pushed out to the extreme end of the tube 12. Thereby the solenoid 16 will swing over, so that the switch 26 closes contact with the wire 24, whereby the coil 2 becomes energized. In this manner the core 4 will automatically be moved backward and forward in the pump, and two pistons 6 will thereby alternately pump air or liquid out through the channels 11, their action being quite similar to the action of ordinary single-acting suction and pressure pumps.

As will be seen from the drawings, Figures 1 and 2, the solenoids 2 and 3 are enclosed by a grid of iron rods 31, which close the magnetic

circuit to a central flange 32 between the two solenoids by way of the two outer flanges 33, whereby the advantage is secured that the magnetic field will always be of sufficient intensity to produce the required pressure.

Figures 4 to 6 show a somewhat modified construction of the pump.

The core 4 reciprocating in the cylinder 1 is barrel-shaped, the truncated-cone ends of the same co-operating with and fitting closely into the corresponding bottom flanges 34. The pistons 6 are fitted with an angular bore 9 communicating with the axial channels 11. Finally an air-supply channel 35 is provided near the ends of the cylinder.

When now the solenoids are alternately energized, and consequently the core 4 reciprocates between the two end flanges 33, a pumping motion and compression of the air in the two cylinders 5 will be effected, as the air, when the core is in the position shown in Figure 4, uncovers the right-hand channel 35, whereby the air suddenly enters into the corresponding cylinder. By the subsequent motion of the core into the position opposite the one shown on the drawings, the air in the lower cylinder 5 will be compressed but, simultaneously, the downward motion of the core will produce a steadily increasing vacuum in the upper cylinder 5, which vacuum gradually will retard the motion of the core, until the upper piston 6 has been withdrawn so far from the upper cylinder 5 that the left-hand channel 35 has been uncovered.

Simultaneously the air in the lower cylinder 5 will be greatly compressed, and when the piston has reached its inner position in the cylinder, the air will pass through the channels 9 and 11 and into the pipe system.

The cylinder 1 in which the core 4 is travelling may be fitted, as shown in Figure 5, with a key or the like 36 co-operating with a corresponding longitudinal groove 37 in the core.

In order to produce sufficient ventilation in the solenoid windings the latter may be subdivided into concentric sections with intermediate spaces in which a cooling medium may circulate.

Figure 6 shows a modified construction of the bottom flanges, the conical cavity 38 of the latter being fitted with a cylindrical recess 39 corresponding to a neck 40 at each end of the core 4.

In the above constructions the use of the valves is avoided, but at times it may be of importance to insert valves in the circuits. This will be of especial importance when the pump is to be used for pumping of liquids, for instance volatile liquids, such as benzine or the like, but valves may also be useful for pumps intended to produce a high air pressure.

One construction of the pump fitted with valves is shown in Figure 7, in vertical longitudinal section.

In each end of the core 4 there are a couple of bores 41 serving to admit air into the cylinders 5, when the pistons 6 are in one of their outer positions.

At the inner ends of the pistons 6, a known type of valve 42 is inserted (either a cone valve, a disc valve or a ball valve).

The apparatus acts in the following manner:

When the solenoids alternately become energized the core 4 will move backward and forward in the described manner, whereby the stationary pistons 6 will alternately compress the air in the cylinders 5, the air entering into the corresponding cylinder by way of the bore 41,

when the core is in its outer position. When the core 4 approaches its outer position the air will be compressed until its pressure is in excess of that of the pressure of the valve spring together with the pressure present in the channel 11, whereby the valve 42 will be lifted and the air thus flows into this channel.

In order to reduce the noise produced when the core 4 moves backward and forward the pump is constructed in such a manner that the core 4 will be able to move a short distance beyond the closed magnetic field, and further vacuum on the suction side of the pump is made as low as possible, whereby the noise produced by the operation of the machine will also be reduced.

In order to attain the highest possible efficiency a ring 43, 44, 45 may be inserted, which is made from non-magnetic material, whereby for instance the advantage will be attained that the two magnetic fields will be sharply separated, and that compressed iron may then be used for the pistons 6 which must then be fitted with a gunmetal lining, which serves to take up the wear and to separate the iron in the core from the iron in the pistons.

The further arrangement is made that during its travel the core 4 cannot strike the bottoms 33, as noise-preventing air cushions will be formed, at the end of the stroke, in the cylinders 5 under the pistons 6.

Figures 8 and 9 show a modified construction of this pump. Here the longitudinal bore 11 of the pistons 6 is closed by a suitable valve device 42. Each of the channels 11 is connected to the outer air if the apparatus is to be used as a compressor, or else to a liquid tank if the apparatus is to be used as a liquid pump. By means of a discharge pipe 30, the cylinder proper is connected to the compressed-air pipe or a liquid-supply pipe device.

The two cylinders 5 bored in the core 4 are inter-connected by inclined channels 46 leading to an annular channel 47, which in its turn communicates with the cylinder by way of channels 48.

In the intermediate part of the core left between the two cylinders 5 and encircling the channels 46 and 48, a valve body 49 is adapted to travel in such a manner that the same can alternately close the seat-like apertures of the channels 46 at the bottom of the cylinders 5.

When the two solenoids 2 and 3 are alternately energized the core 4 will travel backward and forward in the cylinder encircled by the solenoids. Hereby a pumping action will be performed in the two cylinders 5, the said cylinders alternately drawing in air or liquid by way of the valves 42 and discharging the same through the channels 46, 47 and 48 into the cylinder, from which the air or liquid will be passed through the discharge pipe 30, while the valve body 49 alternately closes the valve seats of the channels 46.

By means of a key 36 disposed on the wall of the cylinder and projecting into a groove 39 in the core 4, the latter is prevented from rotating.

In order to change the current in the two solenoids the change-switch shown in Figure 10 may be used. Between the two solenoid armatures is a ring 43, 44, 45 which in the present modification is lined by two magnetic rings 57 and 58. In the ring 43, 44, 45 between the two rings 57 and 58 is arranged a double-

armed lever 51, 52 movable on a tap 50, so that the one arm 51 protrudes in the space between the two linings 57 and 58, whilst the other end of the lever 52 is provided with an insulated member 53 to which is attached a blade spring 54 which alternately can effect connection with the two terminals 55 and 56 which again are in connection with the two solenoid armatures.

It will be understood that the alternate actuating of the two solenoids will cause the magnetic field between the two solenoids to change correspondingly which again will cause the lever 51, 52 to swing from the one to the other position thus alternately connecting and breaking the circuit to the two solenoids.

Having now described our invention, what we claim as new and desire to secure by Letters Patent is:

1. An electromagnetic pump comprising solenoids, a guide cylinder in said solenoids, a core reciprocated in said cylinder by alternate energization of said solenoids, and having bores constituting pump cylinders, relatively stationary pistons carried by the ends of the cylinder and fitting in said bores, and control means for the respective solenoids including a circuit controlling electric pendulum.

2. An electromagnetic pump comprising solenoids, a guide cylinder in said solenoids, a core reciprocated in said cylinder by alternate energization of said solenoids, and having bores constituting pump cylinders, relatively stationary pistons carried by the ends of the cylinder and fitting in said bores, said core being provided with channels connecting the bores with the interior of the cylinder.

3. An electromagnetic pump comprising solenoids, a guide cylinder in said solenoids, a core reciprocated in said cylinder by alternate energization of said solenoids, and having bores constituting pump cylinders, relatively stationary pistons carried by the ends of the cylinder and fitting in said bores, the ends of the core and the cylinder being correspondingly tapered.

4. An electromagnetic pump comprising solenoids, a guide cylinder in said solenoids, a core reciprocated in said cylinder by alternate energization of said solenoids, and having bores constituting pump cylinders, relatively stationary pistons carried by the ends of the cylinder and fitting in said bores, said pistons having channels therein, and means for establishing communication between said channels and the in-

terior of the bores when the pistons are in their innermost positions.

5. An electromagnetic pump comprising solenoids, a guide cylinder in said solenoids, a core reciprocated in said cylinder by alternate energization of said solenoids, and having bores constituting pump cylinders, relatively stationary pistons carried by the ends of the cylinder and fitting in said bores, the ends of the core and cylinder being correspondingly tapered and the extreme ends of the tapered core having tubular extensions, and the ends of the cylinder being shaped to accommodate said extensions.

6. An electromagnetic pump comprising solenoids, a guide cylinder in said solenoids, a core reciprocated in said cylinder by alternate energization of said solenoids, and having bores constituting pump cylinders, relatively stationary pistons carried by the ends of the cylinder and fitting in said bores, and a key carried by said cylinder and engaging the grooves in the core.

7. An electromagnetic pump comprising solenoids, a guide cylinder in said solenoids, a core reciprocated in said cylinder by alternate energization of said solenoids, and having bores constituting pump cylinders, relatively stationary pistons carried by the ends of the cylinder and fitting in said bores, and a jacket enclosing said solenoids and forming part of said cylinder.

8. An electromagnetic pump comprising solenoids, a guide cylinder in said solenoids, a core reciprocated in said cylinder by alternate energization of said solenoids, and having bores constituting pump cylinders, relatively stationary pistons carried by the ends of the cylinder and fitting in said bores, said pistons being formed with passages therethrough, and check valves in said passages, said core being provided adjacent its ends with ports adapted to be uncovered by the pistons during outward travel of the latter.

9. An electromagnetic pump comprising solenoids, a guide cylinder in said solenoids, a core reciprocated in said cylinder by alternate energization of said solenoids, and having bores constituting pump cylinders, relatively stationary pistons carried by the ends of the cylinder and fitting in said bores, and non-magnetic intermediate members disposed between the solenoids.

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