

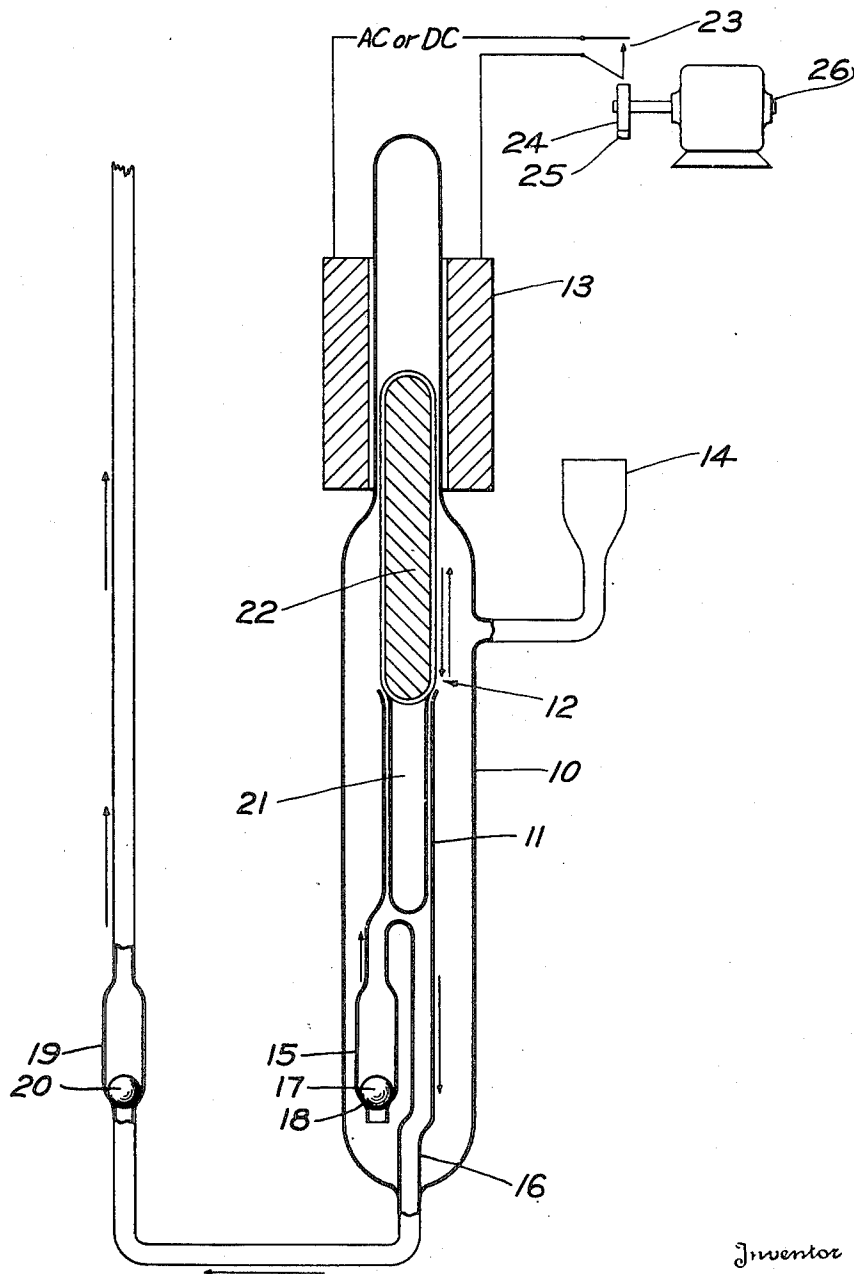
Sept. 6, 1949.

S. L. MADORSKY

2,481,320

MAGNETIC PUMP

Filed June 5, 1945



Inventor
Samuel L. Madorsky

By *Robert A. Ravens*
Attorney

UNITED STATES PATENT OFFICE

2,481,320

MAGNETIC PUMP

Samuel L. Madorsky, Washington, D. C., assignor
to the United States of America as represented
by the United States Atomic Energy Commis-
sion

Application June 5, 1945, Serial No. 597,651

6 Claims. (Cl. 103—53)

1

This invention relates to pumps and is more particularly concerned with apparatus for the pumping of liquids within zones that are maintained under high vacuum.

In the design of pumps for use in or with high vacuum apparatus one problem that is inevitably encountered is that of providing a leak-proof connection between the pump proper, which is located in the high vacuum zone, and the power source for operating the pump which is located without the evacuated zone.

It has been proposed in an attempt to solve the foregoing problem to provide electrically operated pumps of the type in which the driven element or armature is separated from the driving element or field by a sealed membrane. By this expedient it is possible to drive the pump armature through the magnetic field mutual to the field and armature thus avoiding the necessity for packing glands or other mechanical expedients for preventing the leakage of the gases of the atmosphere surrounding the pumps into the low pressure zone.

While it is true that the magnetic operation of a pump wholly obviates the necessity for rotating parts extending from the low pressure pumping zone into the surrounding atmosphere, magnetic pumps of conventional design are not generally used in low pressure zones due to the fact that satisfactory operation of the pump valves is extremely difficult of attainment in a situation where the intake and the exhaust of the pump are both connected to an evacuated system through which it is desired to circulate a liquid. As a result of this difficulty apparatus that is satisfactory from the point of view of operation is complex and costly to build while the more simple and economical forms of apparatus have heretofore been found unsatisfactory. Furthermore, in conventional magnetic pumps it is customary to employ a hollow plunger through which the liquid to be pumped is passed during the intake stroke. This has the disadvantage of reducing the lifting power for a given flux density.

In magnetic pumps it is also customary to positively drive the armature in both directions which requires a long current period resulting in high current consumption and excessive heating of the field coils.

It is therefore an object of this invention to overcome the foregoing difficulties and to provide a magnetically operated pump of simple design that is highly economical and efficient in operation and that is particularly adapted for

2

satisfactory operation in zones that are maintained under high vacuum.

It is a further object of this invention to provide an improved valve mechanism for a magnetically operated pump for the movement of liquids in an evacuated zone wherein the intake and exhaust valves are so arranged that they are operated by the liquid that is pumped without the necessity for mechanical connections of any kind.

It is another object of this invention to provide a magnetic pump having a reciprocating plunger that is positively driven in but one direction and that effects its return stroke by gravity with the result that the current period is short and the current consumption is low.

Other objects and advantages of this invention will be apparent upon consideration of the following detailed description of a preferred embodiment thereof in conjunction with the annexed drawing wherein the single figure is a view in elevation of a pump constructed in accordance with the teachings of this invention.

Referring in greater detail to the drawings, the pump there shown is comprised of a glass reservoir 10, a glass cylinder 11, a plunger 12 and a field coil 13. The liquid to be pumped is supplied through a conduit 14 leading to the reservoir 10 and passes into the cylinder 11 through a glass intake conduit 15 that establishes connection between the reservoir and the cylinder. Upon action of the plunger 12, the liquid is displaced from the cylinder through a glass exhaust conduit 16.

The illustrated form of pump is intended for use in an evacuated system, and it is contemplated that the conduit 14 be connected to a source of liquid in an evacuated zone and that the exhaust conduit 16 be connected to an evacuated zone to which liquid is to be supplied. This being the case, it is apparent that all parts of the pump will operate under very low absolute pressures. For this reason, the reservoir 10 is wholly sealed except for the supply conduit 14 which is itself sealed to a vacuum chamber.

The exhaust conduit 16 extends from the bottom of the cylinder 11 through the bottom of the reservoir 10 and is sealed to the reservoir at the point of egress. This sealing in the case of glass construction can be effected by melting the glass at the bottom of the reservoir 10 causing it to fuse with the glass of the exhaust conduit 16. Aside from sealing the bottom of the reservoir this construction has the advantage that the portion of the conduit 16 within the reservoir 10

is rigidly held and serves to support the cylinder 11 as well as the glass intake conduit 15 which depends from the cylinder in a position parallel to the conduit 16.

The conduit 15 is provided with an enlarged zone for the accommodation of a ball valve 17 that seats by gravity at 18 near the end of the conduit 15. The conduit 16 after passing through the bottom of the reservoir 10 is bent upwardly and extends to a point above the entire pump assembly. This conduit also contains an enlarged portion at 19 for the accommodation of a gravity seated ball valve 20.

The plunger 12 is comprised of a piston 21 and an iron core 22. The piston is normally located in the working space of the cylinder 11, being held there by the weight of the core, while the core normally occupies the position illustrated in the drawing. The upper portion of the reservoir 10 is of reduced cross section and is adapted to function as a guide bearing for the iron core portion of the plunger 12. The plunger 12 is raised magnetically by operation of the field coil 13 which closely surrounds the upper portion of the reservoir 10. This coil may be connected to either an A. C. or D. C. source through a switch such as that shown at 23. Switch 23 is of the type that is normally open but subject to periodic closing by a switch operating wheel 24 having a cam portion 25 of increased radius. The switch operating wheel 24 may be rotated either manually or by an electric motor such as that shown at 26. In any case, the switch 23 is closed when the arm thereof is raised by engagement with the cam portion 25. At other times the switch 23 is open. When the switch operating wheel is rotated, it will be seen that once in every 360° of angular displacement the circuit to the field coil 13 will be closed. At these times a magnetic field will be set up and this field acting on the core 22 will raise the plunger 12 including, of course, the piston 21. As soon as the circuit to the field core 13 is broken, the plunger 12 will fall by gravity to the position illustrated in the drawing.

When liquid is supplied through the conduit 14, it flows into reservoir 10 and eventually builds up to a level above the bottom of the cylinder 11. Preferably the pump is adjusted to operate at a frequency such that the head of liquid in the reservoir 10 will be maintained substantially above the bottom of the cylinder 11. If the head of liquid is above the bottom of the cylinder 11 when the field coil 13 is energized this head will act upon ball valve 17 and open the same so that liquid will be forced up into conduit 15 and into cylinder 11 until the level within the cylinder is the same as the level without the cylinder. At this time the circuit to the field coil is broken and the plunger 12 falls by gravity. Pressure of the liquid in the cylinder 11 induced by the fall of the plunger 12 immediately closes ball valve 17 and results in displacement of liquid from the cylinder 11 through the exhaust conduit 16. This cycle is repeated until the conduit 16 is filled and liquid is being delivered therefrom to the desired point.

Inasmuch as the pump of the present invention is intended for operation in evacuated zones, it is apparent that there will be little if any gas pressure acting upon the surface of the liquid in the reservoir 10. For this reason, the displacement from the cylinder per stroke varies with the height of the liquid in the reservoir. If liquid is supplied to the reservoir at such a rate that the liquid level therein is maintained near the

top of the cylinder 11, each stroke of the plunger 12 will result in displacement of all of the liquid in the cylinder. It is understood, of course, that the weight of the plunger will be adjusted to a value sufficient to raise the head of liquid to the desired point in the conduit 16. Valves 20 and 17 lie in substantially the same horizontal plane so that there is no head in the exhaust conduit 16 acting to close the valve 17 and hence to oppose the opening thereof in response to the head of liquid in the reservoir 10. It is understood, however, that valve 20 may be positioned either nearer to or further from the connection between the exhaust conduit 16 and the cylinder 11 so long as the effective head in conduits 15 and 16 acting to close valve 17 can be overcome by the head of liquid in the reservoir 10 when the liquid level in said reservoir is above the bottom of the cylinder 11.

It is to be understood that the switch 23 may be periodically operated by any means and that the motor driven switch wheel described above is merely illustrative. While the apparatus illustrated is largely constructed of glass, it is to be understood that other materials may be used with equal satisfaction.

Numerous variations in and modifications of the preferred form of the apparatus will be readily apparent and may be made without departing from the spirit and scope of this invention as defined in the following claims.

I claim:

1. A pump comprising a reservoir, a cylinder vertically disposed therein, said cylinder having an interior working space, a vertically reciprocable plunger, the lower portion of said plunger normally occupying the working space of said cylinder, and being guided by said cylinder in its reciprocating movement, the upper portion of said reservoir being constructed and arranged to guide the upper portion of said plunger in its reciprocating movement, means for periodically raising said plunger, said plunger being weighted to fall by gravity to its normal position, means for supplying liquid to said reservoir, means responsive to the head of liquid in said reservoir for establishing communication between the reservoir and cylinder upon upward movement of the piston, an exhaust conduit leading from said cylinder to the exterior of said reservoir, and a normally closed check valve in said conduit adapted to be opened by the liquid displaced by said piston in its gravity induced downward movement.

2. A pump comprising a sealed glass reservoir, a glass cylinder vertically disposed therein, said cylinder having an interior working space, a vertically reciprocable plunger, the lower portion of said plunger normally occupying the working space of said cylinder, and being guided by said cylinder in its reciprocating movement, the upper portion of said reservoir being constructed and arranged to guide said plunger in its reciprocating movement, means for periodically raising said plunger, said plunger being weighted to fall by gravity to its normal position, means for supplying liquid to said reservoir, means responsive to the head of liquid in said reservoir for establishing communication between the reservoir and cylinder upon upward movement of a plunger, a glass exhaust conduit bonded to said cylinder and extending through the wall of said reservoir to the exterior thereof, said conduit being bonded to said reservoir and serving to support the cylinder therefrom, and a normally closed check valve in

5

said conduit adapted to be opened by the liquid displaced incident to the fall of said piston.

3. A pump comprising a sealed reservoir, a vertical cylinder located therein, said cylinder having an interior working space, a vertically reciprocable plunger, the lower portion of said plunger normally occupying the working space of said cylinder and being guided by said cylinder in its reciprocating movement, the upper portion of said reservoir being constructed and arranged to guide the upper portion of said plunger in its reciprocating movement, means for periodically raising said plunger, said plunger being weighted to fall by gravity to its normal position, means for supplying liquid to said reservoir, an intake conduit depending from said cylinder, an exhaust conduit also depending from said cylinder and extending through the wall of said reservoir to the exterior thereof, a normally closed check valve in said intake conduit adapted to be opened by the head of liquid in the reservoir upon upward movement of said plunger, and a normally closed check valve in said exhaust conduit adapted to be opened by the liquid displaced incident to the downward stroke of the piston.

4. A pump comprising a sealed reservoir, a vertical cylinder located therein, said cylinder having an interior working space, a vertically reciprocable plunger including a piston and a core, the piston normally occupying the working space of said cylinder and being guided by said cylinder in its reciprocating movement, the upper portion of said reservoir being constructed and arranged to guide said core in its reciprocating movement, a circuit including a field coil surrounding the upper portion of said reservoir, means for intermittently making and breaking said circuit to raise said plunger and to permit it to fall, means for supplying a liquid to said reservoir, an intake conduit depending from said cylinder, an exhaust conduit also depending from said cylinder and extending to the exterior of said reservoir, a normally closed check valve in said intake conduit adapted to be opened by the head of liquid in the reservoir upon upward movement of said piston, and a normally closed check valve in said exhaust conduit adapted to be opened by the displacement of liquid incident to the downward stroke of said piston.

5. A pump comprising a reservoir, a cylinder vertically disposed therein, said cylinder having an interior working space a vertically reciprocable plunger including in its upper portion a core of material of high permeability, the lower portion of said plunger normally occupying the working space of said cylinder and being guided by said cylinder in its reciprocating movement, the upper portion of said reservoir being constructed and

6

arranged to guide said core of said plunger in its reciprocating movement, a normally open circuit including a field coil surrounding the upper portion of said reservoir, means for periodically making said circuit to raise said plunger, the plunger being weighted to fall by gravity to normal position when the circuit is open, means for supplying liquid to said reservoir, means responsive to the head of liquid in said reservoir for establishing communication between the reservoir and plunger upon upward movement of said piston, an exhaust conduit leading from said cylinder to the exterior of said reservoir, and a normally closed check valve in said conduit adapted to be opened by the liquid displaced by said piston in its gravity induced downward movement.

6. A pump adapted for operation in a low pressure zone comprising a sealed reservoir, a vertical cylinder within said reservoir, said cylinder having an interior working space, a vertically reciprocable plunger including a piston and a core, the piston normally occupying the working space of said cylinder and being guided by said cylinder in its reciprocating movement, the upper portion of said reservoir being constructed and arranged to guide said core in its reciprocating movement, a circuit including a field coil surrounding the upper portion of said reservoir, means for intermittently making and breaking said circuit to raise said plunger and to permit it to fall, means for supplying a liquid to said reservoir, an intake conduit depending from said cylinder, an exhaust conduit depending from said cylinder and extending through the reservoir wall and upwardly to a point above the bottom of said cylinder, a first check valve in said exhaust conduit, and a second check valve in said intake conduit exposed to the head of liquid in said reservoir tending to open it and the head of liquid between said valves and the pressure of said plunger tending to close it, said first check valve being so located that the head of a body of liquid between said valves is less than the head of a body of liquid extending in said reservoir above the bottom of said cylinder whereby the second valve will open when the plunger is moved upwardly.

SAMUEL L. MADORSKY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,881,724	Lahrer	Oct. 11, 1932
2,381,650	Dick	Aug. 7, 1945
2,382,426	Kecher	Aug. 14, 1945