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MAGNETIC DRIVE

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Fig. 1.

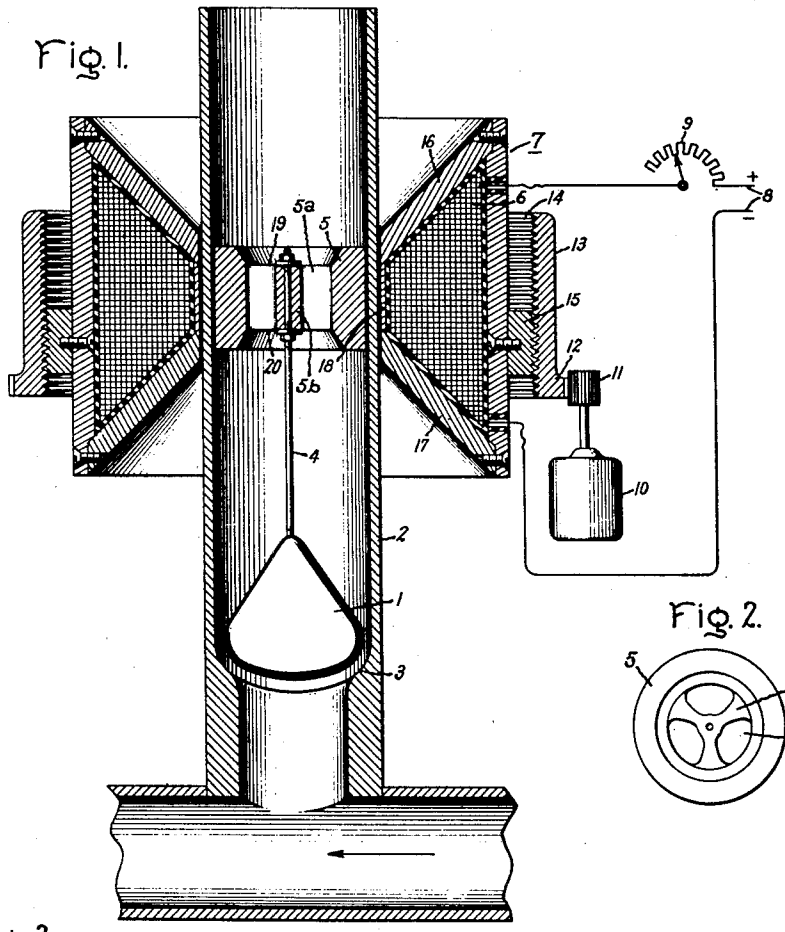
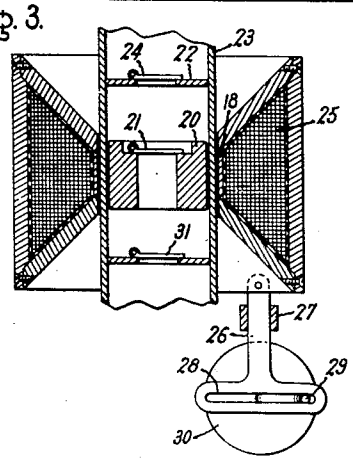


Fig. 2.

Fig. 3.



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MAGNETIC DRIVE

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Our invention relates to magnetic drives, more particularly to a magnetic drive for a member in a sealed chamber, such as a pump or valve in a fluid supply pipe, and has for its object simple, reliable and efficient electromagnetic drive means for effecting rectilinear movement of a member in a sealed chamber.

In carrying out our invention in one form, we utilize a coil mounted on a rectilinearly movable field structure surrounding the sealed chamber, such as a pipe. Inside of the pipe we provide a plunger armature which is connected to the valve or other member to be operated or which forms a pump plunger. We also provide means for moving the coil and field structure lengthwise of the pipe whereby the plunger armature is moved with the field structure. An accurate adjustment of the device to be moved in its final position is obtained by varying the excitation of the coil.

For a more complete understanding of our invention, reference should be had to the accompanying drawing, Fig. 1 of which is a sectional view of an electromagnetic drive for a valve embodying our invention; Fig. 2 is a plan view of the armature of Fig. 1; while Fig. 3 is a view similar to Fig. 1 showing the application of our invention to a pump.

Referring to Fig. 1 of the drawing, we have shown our invention in one form as applied to the operation of a movable valve member 1 in a pipe 2 made of nonmagnetic material such as Monel metal, the valve member being movable with reference to a valve seat 3 to vary the flow of a fluid through the pipe. The movable valve member 1 is connected by means of a rod 4 to a tubular plunger armature 5 made of magnetic material and having a close sliding fit in the pipe, a central bore 5*a* in the armature providing for the free flow of liquid therethrough. A spider 5*b* is provided on the armature in the bore 5*a* to the center of which the rod 4 is connected.

Surrounding the pipe 2 is a magnet coil 6 mounted on an annular magnet core or field structure 7 which is slidable lengthwise of the pipe, both the coil and the core structure surrounding the pipe. The coil 6 is energized from suitable direct current supply mains 8 through an impedance means shown as a variable rheostat 9.

A suitable electric motor 10 is provided for moving the coil and core structure lengthwise of the pipe thereby to move with it the armature 5 and the valve member 1. As shown, the motor drives a pinion 11 meshing with a ring gear 12

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on a sleeve 13 surrounding the magnet core structure 7. The sleeve is provided with internal threads 14 meshing with which is an externally threaded sleeve 15 secured to the magnet core 7. The sleeve 13 is suitably mounted in bearing means (not shown) for rotation but is secured against movement in either direction parallel with its axis of rotation, while the core structure 7 is held against rotation by suitable means (not shown). By means of the motor 10, the magnet core 7 and coil can be moved lengthwise of the pipe, the coil being suitably energized thereby to form a magnetic driving connection between the magnet core and the armature so that the armature is moved with the magnet core and maintained in a predetermined axial relation therewith.

For the purpose of reducing the weight of the armature 5, the magnet core 7 is constructed to reduce the axial length of the coil adjacent the pipe 2 by means of cone-shaped magnet core members 16 and 17 having their convex surfaces adjacent each other, i. e., on their respective lower and upper sides. The two end cone members 16 and 17 are secured to an outer cylindrical core member. As shown, the coil 6 is wound on a relatively short cylindrical member 18 made of brass surrounding the pipe 2 between the adjacent ends of the members 16 and 17, the turns of the coil also being wound on the convex surfaces of the members 16 and 17. A suitable layer of electrical insulation is provided for the members 16, 17 and 18. Thus the effective length of the electromagnet adjacent the pipe 2 is relatively short, and a correspondingly short plunger armature 5 is provided, as shown, whereby the weight of the armature is reduced.

This reduction of weight is important in driving applications involving the rapid oscillation of the magnet core and the armature such that the weight and inertia of both the armature and the magnet must be kept at a low value to assure that the force resisting movement of the armature, i. e., the inertia of the armature, together with the force required to operate the member connected to the armature, do not exceed the magnetic pull applied to the armature by the coil and field structure.

The magnetic field structure, including the core members 16 and 17 and the coil, is slidably mounted on the pipe 2. It is mounted in a position at right angles to the pipe, as by suitable nonmagnetic bearing shims, such that the armature 5 is centered magnetically in the pipe so that the armature is not held against the inner surface

of the pipe by any substantial magnetic force. This arrangement minimizes the friction between the armature and the inner wall of the pipe. Preferably both the armature and the field core 7 are fitted closely with relation to the pipe to provide for the most effective magnetic interlinkage between them, and also minimize radial magnetic pull of the armature against the inside of the pipe.

As illustrated, the armature is maintained, during operation of our device, substantially in the center of the strongest portion of the magnetic field so that the lateral axes of the electromagnet and armature are in substantial alignment. As arranged, the effective length of the armature 5 with respect to the effective length of the magnetic core 7 adjacent the pipe 2 provides a magnetic relationship between the armature and electromagnet in which the reluctance therebetween is a minimum. Thus, when suitably energized by the current source 8, the electromagnet will cause the armature to follow the movement thereof in substantially constant juxtaposed positional relationship so as to maintain the lateral axes of said last-mentioned elements in substantial alignment as shown in Fig. 1.

The rheostat 9 for adjusting the amount of current in the coil provides for the gradual positioning of the member being moved. This is of importance when the device is used in the operation of a valve, as shown in the drawing. Thus the rheostat 9 can be adjusted to weaken the current in the coil to a value such that a predetermined small displacement or lag of the armature occurs. The magnet core is then adjusted downward by the motor 10 for a rough positioning of the valve member 1, for example, not quite to the closed position. This positioning movement of the valve member 1 is opposed by the force applied to the valve member by the fluid flowing upward in the pipe, as seen in Fig. 1. After this rough positioning, the rheostat is adjusted to increase slowly the current in the coil whereby the armature is drawn downward to its final attracted position and the valve member 1 seated gradually on the valve seat 3. We have found that by this adjustment of the rheostat 9, a precision adjustment of the driven member 1 can be obtained. For example, the valve member 1 can be seated without appreciable impact.

It will be understood that the member 1 to be actuated may be any suitable operating member, for example, the operating member of a fluid pump as shown in Fig. 3 wherein the tubular armature 20 is provided with a check valve 21 on its upper end and a wall 22 is provided in the pipe 23 a predetermined distance above the armature, this wall 22 being likewise provided with a check valve 24.

To effect rapid oscillatory movement of the coil and field structure 25, I provide a yoke 26 slidably movable in a guide 27 in a direction parallel with the pipe and connected at its upper end, as viewed in Fig. 3, to the field structure. At its lower end the yoke 26 is provided with a laterally extending portion having a slot 28 in which moves a crank pin 29 driven by an electric motor 30.

In the operation of the device of Fig. 3, when the motor 30 operates to move the field structure rapidly up and down and moving the armature 20 up and down with it, a liquid is pumped in an upward direction, as seen in Fig. 3, in the pipe. When the armature moves upward, the valve 21 is closed and the valve 24 is forced open for the escape of the liquid. Upon downward movement

of the armature, the valve 24 closes and the valve 21 opens to allow the liquid to go upward into the space above the armature. If desired, a third valve 31 closing when the armature moves downward may be provided in the pipe 23 a predetermined distance below the armature.

We have found that in the magnetically driven pump of Fig. 3, the upward stroke of the field structure can be so adjusted as to bring the armature into very close relation with the head wall 22 of the pumping chamber so that substantially all of the liquid is forced out each upward stroke. In fact, the upper end of the armature may be allowed to touch the wall 22 without appreciable jar or impact. This close pumping relation is made possible by the resilient magnetic driving connection between the armature and field structure. In comparison, it will be understood that with mechanically driven plunger type pumps a very substantial clearance must be provided between the end of the plunger and the end of the chamber.

While we have shown two particular embodiments of our invention, it will be understood, of course, that we do not wish to be limited thereto since many modifications may be made, and we therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of our invention.

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

1. A magnetic drive comprising in combination with a tubular member made of non-magnetic material, a plunger armature slidably movable in said tubular member, a magnet core surrounding said tubular member and movable along said tubular member, a coil on said magnet core, impedance means, connections including said impedance means for energizing said coil to cause same to move into lateral axial alignment with respect to said magnet core, means for moving said magnet core to cause said armature to follow the movement of said magnet core in substantially constant juxtaposed relation thereto, and means for varying the amount of said impedance means included in circuit with said coil so as to provide a precision adjustment of said armature.

2. A magnetic drive comprising in combination with a tubular member made of non-magnetic material, valve means in said tubular member for controlling the passage of a fluid through said tubular member including a valve seat and a movable valve member, a plunger armature slidably movable in said tubular member, an operating connection between said valve member and said armature, a magnet core surrounding said tubular member and movable along said tubular member, a coil on said magnet core, impedance means, connections including said impedance means for energizing said coil whereby said armature is caused to move in said tubular member to a predetermined position with respect to said magnet core, means for moving said magnet core thereby to move said armature and move said valve member into engaged and disengaged relation with said valve seat, and means for varying the amount of said impedance means included in circuit with said coil so as to provide a precision adjustment of said movable valve member relative to said valve seat.

3. A magnetic drive comprising, in combination with an elongated chamber of nonmagnetic material, an electromagnet comprising an annular magnet core and a coil surrounding said chamber,

said core being provided with two cone-shaped end members having their convex sides adjacent each other and said coil being mounted on said core member between said cone-shaped members, a plunger armature slidably disposed in said chamber in attractive relation with said core, and connections for energizing said coil to attract said armature to a position of substantial lateral axial alignment with said core thereby to provide a path of minimum reluctance therebetween.

4. A magnetic drive comprising in combination with a tubular member made of nonmagnetic material, a plunger armature slidably movable in said tubular member, a magnet core surrounding said tubular member, a coil on said magnet core, impedance means, connections including said impedance means for energizing said coil to cause said armature to move to a position relative to said magnet core providing a path of minimum reluctance therebetween, means for moving said magnet core thereby to move said armature, and means for varying the amount of said impedance means included in circuit with said coil so as to provide a precision adjustment of said armature.

5. A magnetic drive comprising, in combination with a wall of non-magetic material forming a chamber, a driven member in said chamber including a plunger armature fitting in said chamber for slidable movement therein, a magnet core member surrounding the wall of said chamber, a coil positioned to excite said core member, connections for energizing said coil thereby to attract said armature to a predetermined axial positional relation with respect to said core member, means for moving said core member with relation to said wall whereby said driven member follows said core member in substantially fixed positional relation therewith, and means for varying the current in said coil to effect a precision adjustment of said driven member.

6. A magnetic drive comprising, in combination with a tubular wall made of non-magnetic material and forming a cylindrical chamber, a driven member in said chamber including a plunger armature fitting in said chamber for slidable movement therein, an annular magnet core surrounding the wall of said chamber and provided with two cone-shaped end core members having their convex sides adacent each other, a coil mounted upon said core member between said cone-shaped members, connections for energizing said coil to attract said armature into a predetermined axial positional relation with respect to said core member, and means for moving said core member axially relative to said chamber thereby to cause said driven member in said chamber to follow said core member in substantially fixed axial positional relation with respect thereto.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
716,110	Rose et al.	Dec. 16, 1902
855,801	Moore	June 4, 1907
1,232,406	Bliss	July 3, 1917
1,297,236	Peiler	Mar. 11, 1919
1,304,843	Zacharias	May 27, 1919
1,452,327	Thompson	Apr. 17, 1923
1,690,348	Wallace	Nov. 6, 1928
1,903,902	McLaren	Apr. 18, 1933
2,270,243	Parsons	Apr. 7, 1942

FOREIGN PATENTS

Number	Country	Date
33,672	Sweden	of 1912