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MAGNETIC ACTUATOR
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FIG. 1

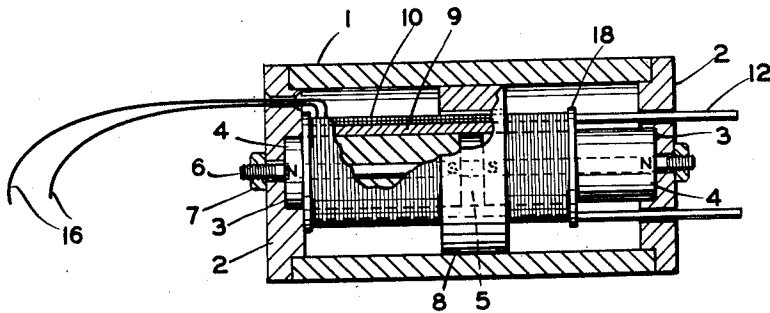
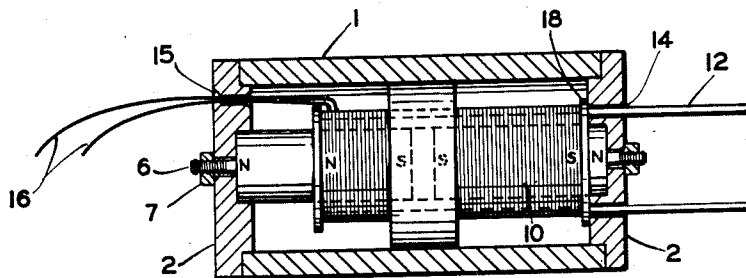


FIG. 2



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MAGNETIC ACTUATOR

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5 Claims. (Cl. 317—171)

This invention pertains to magnetic devices. It is particularly concerned with a new and improved type of electromagnetic actuator having a number of desirable advantages.

The invention contemplates a unique arrangement of a coil winding and magnetic cores whereby changes in polarity of the coil cause linear travel of the latter over the cores.

A feature of the invention lies in the nature of the cores and in their relation to the coil. The cores are permanent magnets, linearly disposed in fixed spaced relation to one another, and are of opposed polarity. The coil is adapted to axially slide over the cores in one direction or the other, accordingly, as current is made to flow through the coil in one direction or the other.

A further feature of the invention is a push-pull effect provided by the arrangement of the elements of the device, whereby the coil is both pushed and pulled over the cores by the flux condition of the elements thereof when the coil is energized.

An advantage of this push-pull effect is to provide a forceful and swift movement of the coil.

A further advantage of the invention is the wide latitude of travel afforded to the coil in moving over the cores. The wide latitude of travel gives to the device many and diversified uses.

A still further advantage is the capacity of the coil to restore to starting position at the opposite end of the cores without the aid of springs. This is accomplished by simply reversing the polarity of the coil relative to the cores.

An object of the invention is, therefore, to provide new and useful improvements in magnetic actuators.

A further object of the invention is to provide a magnetic actuator having a coil and magnetic core arrangement with a push-pull effect provided to the coil when the latter is energized.

A still further object of the invention is to provide a magnetic actuator including a coil winding adapted to linearly move in one direction or the other over magnetic cores, the direction of coil travel depending on the direction of current flow therethrough.

The invention further lies in the construction and novel arrangement of the various elements thereof and in their cooperative association with one another.

The foregoing and other objects and advantages of the invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings, wherein an embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawings are for purposes of illustration and description, and are not to be construed as defining the limits of the invention.

In the drawings, wherein a magnetic actuator embodying the invention is illustrated:

Fig. 1 is a longitudinal section through the device; and Fig. 2 is a view showing the condition of the device

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when the current flow through the coil is from left to right, the drawing indicating moved position of the coil.

In describing the invention in detail, reference is directed to the drawings, wherein there is shown a housing comprising a cylindrical tube 1 plugged in opposite ends by caps 2. Axially fitted in a recess 3 of the inner wall of each cap is a cylindrical slug 4. An end of each slug is press-fitted into the recess so as to be retained therein. The slugs are in linear arrangement, and the free ends thereof are closely spaced from one another by a gap 5. A brass rod 6 extending axially through the housing, and fastening means 7 threaded on the rod against the outer walls of the caps holds the housing and caps together. The slugs are formed of magnetic material having a high degree of magnetic retentivity, such as hard steel, but desirably an alloy of aluminum, nickel and iron, known as Alnico. The slugs are highly magnetized to form permanent magnets. The slugs are disposed with opposing magnetic forces, as indicated, the S pole of one being opposed to the S pole of the other. Fitted into the tube in contact with the inner wall thereof is a ring 8 of a width so as to surround the gap 5. Tubing 1, caps 2 and the ring 8 are formed of magnetic material of low reluctance and of low retentivity, such as soft iron, or material commonly known as Armco. The tubing, caps, and ring provide a flux path of low reluctance for the magnets, whereby the strength of the magnets is concentrated at the pole ends thereof. Slidable in a linear direction over the slugs is a unit including a bobbin or sleeve 9 of light aluminum material carrying an electrical coil winding 10. The bore of ring 8 is of sufficient diameter to permit travel of the bobbin and coil through it, but is of close tolerance relative to the coil so as to provide a minimum gap between the two. The sleeve is of a length sufficient to span the pole gap 5 when an end of the sleeve limits against an end cap wall of tube 1. The distance of the coil may ride along the slugs is represented by the space remaining between the coil and an end wall. The sleeve is limited in its sliding movements in one direction or the other by the end walls of the housing, though, if desired, intermediate stop means, not shown, may be utilized to limit movement short of the end walls.

In Fig. 1 there is zero current flow through the coil. In this condition, because of the opposed polar flux condition of the magnets, no coercive force is exerted on the coil. The coil may be caused to move to the right by providing a current flow through the coil in one direction, and it may be caused to return to the left by providing a current flow through the coil in the opposite direction.

In Fig. 2 the coil has been energized by a current flow in such direction that the N pole of the coil is at the left and the S pole, at the right. Energizing the coil does not demagnetize the slugs, because of their high magnetic retentivity. The effect of the current flow through the coil in Fig. 2 is to cause the coil to be linearly moved to the opposite end of the housing over the slugs. This is effected by a push-pull magnetic condition created by the flux condition of the coil and that of the magnets. It is to be noted in Fig. 2 that the flux conditions of the coil and slug at the left end of the device repel one another, whereby the coil is pushed to the right. It is also to be noted that the flux conditions of the coil and slug at the right end of the device aid one another to exert a pulling force on the coil to the right. The push and pull magnetic forces supplement one another to provide a swift travelling movement of the lightweight coil bobbin unit over the slugs to the right.

Now, if in Fig. 2 the current flow were to be reversed, the flux conditions and magnetic forces created would be the reverse and the coil-bobbin unit would be pushed

and pulled leftward where it would assume a position as in Fig. 1.

The device is subject to wide application. For example, it may be utilized to operate an external machine switch or other device. To this end, suitable take-off means may be provided. This may take the form of one or more elongated fingers 12 fixed to an end wall 18 of the bobbin. The fingers would pass through openings 14 in an end wall of the device. In this arrangement, the fingers would be carried in one direction or the other with the travelling of the coil unit, and they would serve to operate a switch or other external device. An end cap of the housing is provided with a suitable aperture 15 through which the coil leads 16 pass to a suitable source of D. C. power, not shown.

It is to be noted that the coil may be moved from one end of the housing to the other simply by reversing the current flow through the coil from one direction to the other. In this respect, a decided advantage is obtained, in that springs are not needed for the return of the device. Another advantage is the wide latitude of travel afforded to the coil by this arrangement, as well as the high frequency of response of the lightweight coil and bobbin.

Although but one embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the design and arrangement of the parts without departing from the spirit and scope of the invention, as the same will now be understood by those skilled in the art.

What I claim is:

1. A composite magnetic actuator comprising a cylindrical housing tube closed by end walls, a pair of identical permanent linear cylindrical magnets of high retentivity disposed axially within the housing, each magnet having one end secured to an end wall of the housing and each magnet having its free end of similar polarity and spaced from the other by a short gap, a ring extending from the center of the inner wall of the housing and closely surrounding the free ends of the magnets, the ring, housing and end walls of the housing formed of material having low magnetic retentivity and providing a flux path of low reluctance to the magnets, and an electrical winding sleeving the entire length of one magnet and a portion of the length of the other magnet, the winding adapted on receiving a current flow in one direction to be pushed and pulled linearly over the magnets in a particular direction from one end wall to the other by repelling magnetic forces arising between the magnet and coil at one end of the coil and by supporting magnetic forces arising between the magnet and coil at the other end of the coil.

2. In a composite magnetic actuator as in claim 1, wherein the winding is coiled about a cylindrical bobbin of lightweight non-magnetic material and the combined winding and bobbin are slidable over the cylindrical magnets as a unit.

3. In a composite magnetic actuator as in claim 1, wherein the coil is equipped with take-off means extending from said cylindrical housing and arranged to be carried with the movements of the coil and serving as means for operating associated devices.

4. In a magnetic actuator of the character described, a pair of linearly arranged straight permanent magnets of high retentivity wherein a slight gap separates an inner pole end of one magnet from a similar pole end of the other magnet, the location of said slight gap being free of other relatively strong permanent magnetic forces, a non-magnetic coil winding slidable over the magnets and having a length equal to that of one of the magnets plus an appreciable portion of the other, wherein the directional sliding of the coil is determined by the direction of current flow through the coil and by a resultant push of repelling magnetic forces created between an end of the coil and an outer end of one of the magnets and by a resultant pull of attracting forces created between the opposite end of the coil and the outer end of the other magnet and take-off means connected to said coil and arranged to be actuated directly in response to movement of said coil.

5. In a composite magnetic actuator of the character described, a pair of straight linearly arranged permanent magnets of high retentivity, each magnet being supported by an end wall at its outer end and by a rod extending linearly through said magnets and between the end walls, each magnet having its inner end in close spaced relation to that of the other, the spaced ends being of similar polarity, the location of said ends being free of other relatively strong magnetic forces, a non-magnetic coil winding slidable about the magnets from the end wall of one to the end wall of the other magnet, the coil winding sleeving one magnet for its entire length and sleeving an appreciable portion of the other magnet, the coil winding being caused to be pushed and pulled over the magnets from one end wall to the other by magnetic forces created in the coil cooperating with magnetic forces existing in the permanent magnets, and the direction of coil movement depending upon the direction of current flow passed through the coil so that when a current flow creates in the coil a polarity at one end that is similar to the polarity at the related outer end of a magnet, the coil will be pushed by the repelling forces created at such end and will be pulled by the attracting forces created at the opposite end over the magnets until limited by the end wall at the outer end of the other magnet.

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