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SOLENOID ARRANGEMENTS

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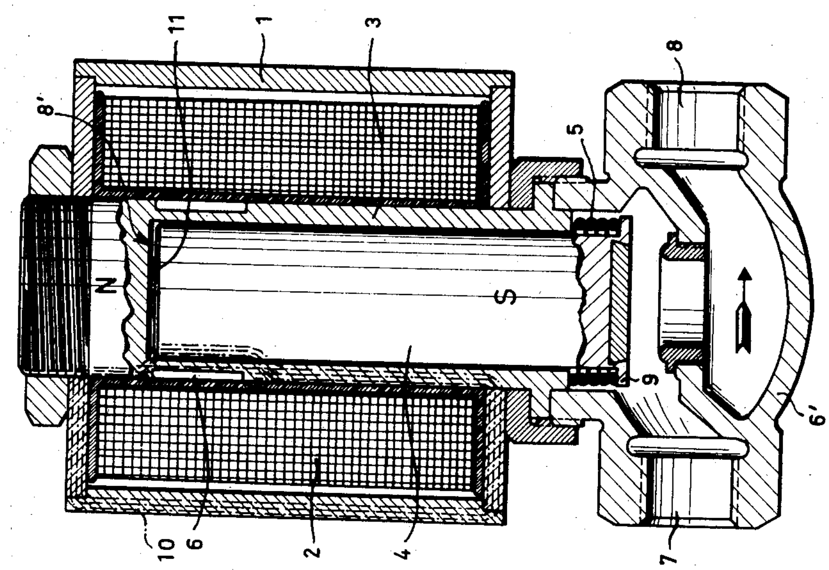

FIG. 2

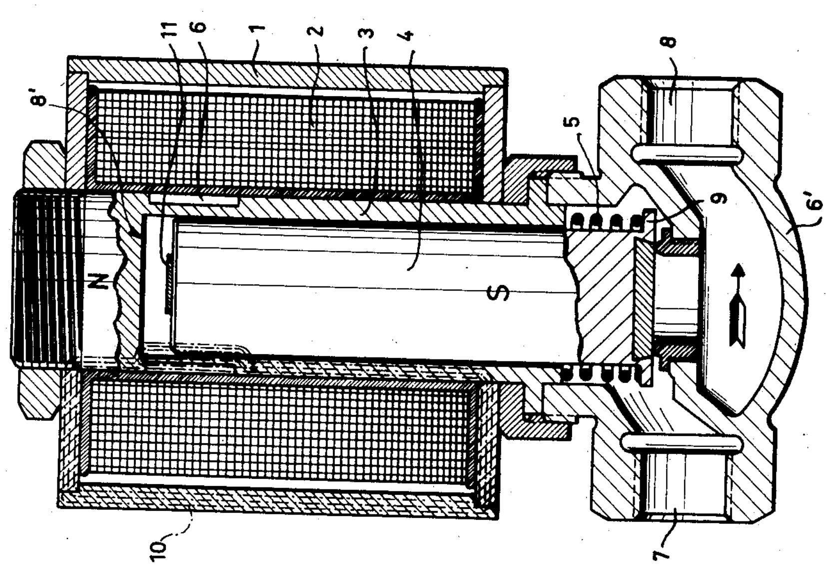

FIG. 1

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SOLENOID ARRANGEMENTS

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1 Claim. (Cl. 317—191)

The present invention relates to solenoid arrangements.

Many solenoid arrangements are known, which arrangements, have associated with them various difficulties. For example, two of the most prevalent difficulties experienced with solenoid arrangements are:

(1) the sticking of the core when the electromagnet is energized; and

(2) the random nature of the operation of many of these solenoid arrangements.

It is therefore an object of this invention to provide a solenoid arrangement which avoids the previously mentioned disadvantage of sticking of the core when the electromagnet is energized.

It is another object of the present invention to provide a solenoid arrangement which operates consistently and without difficulty.

It is yet another object of this invention to provide a solenoid arrangement which operates efficiently and yet which is simple to manufacture.

An additional object of this invention is to provide a solenoid arrangement wherein the movable core may be easily energized by a minimum magnetic field strength.

With the above objects in view the present invention mainly consists of a solenoid arrangement comprising an elongated tubular magnet coil adapted to be excited by an external current source, a hollow guidance tube arranged in the tubular magnet coil coaxially therewith and adjacent to the inner wall thereof, the hollow guidance tube being formed with an annular recess in the outer wall thereof so that in the region of the annular recess the wall thickness of the hollow guidance tube is substantially reduced, the annular recess being spaced from one end of the hollow guidance tube, a magnetizable cylindrical core member arranged slidably in the tubular guidance tube with one end of the core member located in the region of the annular recess in the guidance tube, and the core member extending in direction toward the one end of the guidance tube, and spring means permanently tending to slide the magnetizable cylindrical core member outwardly through the one end of the hollow guidance tube.

The novel features which are considered as characteristic for the invention are set forth in particiar in the appended claim. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a sectional view of a solenoid arrangement in an unenergized condition; and

Fig. 2 is a sectional view of the same solenoid arrangement in an energized condition.

Referring now to the drawing, a tubular magnetizable magnet housing **1** is shown inside which an electromagnet coil **2** is arranged. The magnet coil 2 is adapted to be connected to an external current source (not shown). Within the magnet coil there is arranged a hollow guidance tube 3, this tube being permanently fixed to the magnet coil housing 1. Arranged within the tubular guidance tube 3, is a slidable core 4. A spring 5 permanently urges the magnetizable core 4 into a rest position thereof.

Fig. 1 illustrates the unbiassed condition of the spring 5 when the magnet coil is not energized.

Fig. 2 on the other hand shows the energized condition, wherein with the attraction of the core 4, the spring 5 becomes biassed.

The guidance tube is provided with an annular recess 6 in the region of the end portion of the magnetizable core 4 and bounded in axial direction by two annular end faces. This recess is preferably dimensioned so that the depth thereof is equal to from one quarter to one half of the wall thickness of the guidance tube 3. The length of the recess is determined by the length of the desired stroke of the core so that in the positions of Figs. 1 and 2, the end face of the core is located within transverse planes passing through the annular end faces of recess 6.

Figs. 1 and 2 illustrate the operation of the solenoid arrangement in conjunction with a valve 6′. As is clearly shown, the inlet 7 is isolated from the outlet 8 when the magnet coil 2 is not energized. Fig. 2, on the other hand, illustrates the inlet 7 in communication with the outlet 8, whereby a liquid or a gas may readily flow there between.

It is of course understood that the solenoid arrangement need not be used with the valve arrangement shown. It may equally well be used for other purposes. Examples of some other possible applications of this solenoid arrangement are:

(1) Arrangements involving the operation of a switch, such as a relay switch.

(2) Bell arrangements involving the ringing of a bell, in which case the core acts as a hammer or

(3) Any other arrangement requiring percussion means.

In order to avoid a transverse magnetic field component a non-magnetizable plate 11 is used, which plate will space the core 4 from the stop 8′ in the energized condition of the coil 2. It is of course obvious that the stop 8′ may be changed in form and need not be placed as shown, but may be arranged and suitably placed at the opposite end of the guidance tube so that when the core 4 is moved upon energization of the electromagnet 2, the flange 9 of the core 4 will butt against the stop. Although a spring has been shown in this arrangement for returning the core to its rest position when the magnet coil is not energilzed, such spring is not absolutely necessary since in some cases it may be possible to return the core to its rest position by means of its own weight.

The solenoid arrangement operates as follows:

Upon energizing the magnet coil **2**, magnetic lines of force **10** will begin to flow about the path shown in Fig. 1. The illustrated lines of force in Fig. 1 is intended to indicate the path of the lines of force initially and immediately after the magnet coil **2** is energized. In the region of the annular recess **6** the magnetic lines of force stray outwardly of the guidance tube **3**. The straying of the magnetic lines of force in this region is due to the annular recess **6** formed in the guidance tube **3** which results in the saturation of the reduced wall portion by the magnetic lines of force passing therethrough, and for this reason all the magnetic lines of force cannot entirely pass through the reduced wall portion. As a result, part of the flux path will be formed in the air gap defined by the recess 6 and part of the path will include the magnetizable core 4 and the gap between the end face of the core and the inner face of stop **8′**. The magnetizable core as a consequence becomes magnetized and is attracted toward the stop 8′ which is likewise magnitized. Due to the plate 11, which is made of a non-magnetizable member having a high reluctance to the passage of the magnetic lines of force, the magnetizable core 4 when attracted will be spaced from the stop 8′. This spacing between the core 4 and the stop 8′ prevents a transverse component of magnetic field thereby preventing any sticking of the core.

Fig. 2 illustrates the core in a fully attracted position, the core 4 being spaced by the non-magnetizable plate 11 from the stop 8′. In order to appreciate the operation of the solenoid arrangement the magnetic lines of force have again been illustrated, it becoming apparent that in the fully attracted position of the core the magnetic lines of force will take the path of least reluctance, and therefore pass almost entirely through the core member.

Due to the efficient operation of this arrangement greater core movements can be used with a smaller magnetic field than in known arrangements, thus permitting a reduction in the number of windings necessary for the magnet coil and also the magnitude of the current source which is used to excite the coil. The north and south poles have been marked to indicate the polarity of the magnetic field, which of course depends on the direction of current flow. It is to be understood that the magnetic lines of force 10 bound the entire coil structure. The magnetic lines of force in Figs. 1 and 2 are shown passing through one section of the arrangement only in order to simplify the figures.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of solenoid arrangements differing from the types described above.

While the invention has been illustrated and described as embodied in a magnetic valve, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claim.

What is claimed as new and desired to be secured by Letters Patent is:

A solenoid arrangement, comprising, in combination, an elongated tubular magnet coil adapted to be energized by an external current source; a magnetizable housing including an outer tubular part surrounding said coil, and two inner annular flanges at the ends of said coil, a magnetizable hollow guidance tube fixedly mounted in said tubular magnet coil coaxial therewith and adjacent to the inner wall thereof and abutting on said inner flanges so that a closed path for a magnetic flux is formed by said magnetizable housing and a part of said guidance tube, said elongated guidance tube having an integral closed end portion whereby a closed recess is formed in said guidance tube, said end portion having a transverse inner face constituting the bottom of said recess, said guidance tube being formed with an annular recess in the outer wall of said guidance tube so that in the region of said annular recess the wall thickness of said hollow guidance tube is substantially reduced, said annular recess extending in a direction parallel to the axis of said tube for a distance substantially less than the length of said tube, said annular recess being bounded by two annular end faces, one of said end faces being located substantially in a transverse plane passing through said transverse inner face; and a magnetizable cylindrical core arranged slidably in said recess of said guidance tube, said magnet core having a transverse end face located opposite said inner face, said magnet core being axially movable between two positions and having in both said positions said end face thereof located in transverse planes passing through said annular recess so that the magnetic flux in the region of reduced wall thickness of said tube passes through the gap between said end face and said inner face for moving said core toward said end portion when said magnet coil is energized.

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