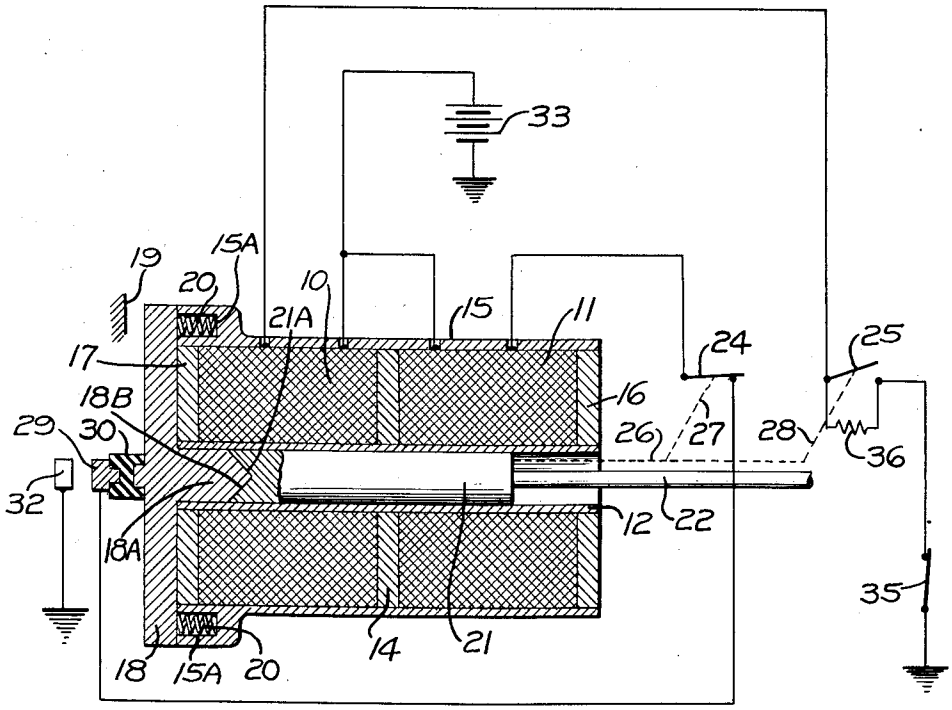
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SOLENOID STRUCTURE AND CONTROL

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SOLENOID STRUCTURE AND CONTROL

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The present invention relates to an improved solenoid structure and a new control circuit therefor.

An object of the present invention is to provide an improved solenoid structure of this type which requires no energizing current in one operating position of the same.

Another object of the present invention is to provide a solenoid structure of this type in which the control current is relatively small in comparison to the operating current.

Another object of the present invention is to provide an improved solenoid structure involving the used of two members movable with respect to the windings in which the leakage flux is relatively small.

Another object of the present invention is to provide a solenoid construction of this character which may be made inexpensively.

Another object of the present invention is to provide a novel control circuit for a solenoid operated device.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. This invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings in which:

The single figure is a transverse sectional view through a solenoid structure embodying features of the present invention, and also shows in schematic form the novel circuit, embodying features of the present invention, connected thereto.

The solenoid structure incorporates two coils or windings **10** and **11** coaxially disposed on a brass tube **12**, but spaced by a steel magnetizable ring **14**, the perimeter of which abuts the inner wall of the outer steel casing **15**, which contains such coils and which is closed at opposite ends by the rings **16** and **17**. The ring **16** is of steel and, while the ring **17** may be of steel, it is preferably of a non-magnetizable material such as, for example, aluminum, for purposes of minimizing leakage flux, considering the fact that it is mounted adjacent a specially constructed movable core member **18** which, in its unmagnetized condition, is pressed against the stop **19** by circumferentially arranged coil compressed springs **20** recessed in an enlarged portion **15A** of the casing **15**.

The core member **18** is generally in the form of a steel disc having a centrally disposed and axially extending cylindrical portion **18A** which is slidably mounted in tube **12** and which has a conical end portion **18B** adapted to be snugly received in a cooperating conical recessed portion **21A** of the cylindrical steel core member **21**, also slidably mounted in the tube **12**.

The core member or plunger **21** has a rod **22** coaxially extending therefrom for attachment to a device (not shown) that is to be operated thereby. The core member **21** is mechanically coupled to a pair of single pole, single throw switches **24**, **25**, and the mechanical coupling therefor is indicated by the dotted lines **26**, **27** and **28**.

The other movable core member **18** has mounted thereon an insulated electrical contact **29** which is insulated by the interposed piece of insulation **30**. The contact **29** is engageable with the grounded cooperating contact **32** forming elements of a switch **32**.

The windings or coils **10** and **11** each have one terminal connected to the ungrounded terminal of the source **33** which may be A.C. or D.C. The other terminal of winding **11** is returned to ground through the series connected switches **24** and **32**, and the other terminal of winding **10** is returned to ground through the switch **25** and the "On-Off" control switch **35**, such switch **25** being arranged to short circuit a current limiting resistance **36**. It is understood that while the provision of such resistance **36** and its short circuiting switch **25** is preferred, the same may be omitted, in which case the switch **35** is connected directly to one terminal of winding **11**.

With the switch **35** in its closed position, as shown, an energizing current for winding **10** flows from battery **33**, through winding **11**, resistance **36** and switch **35**, the resistance **36** serving to limit the flow of current through coil **10** under the conditions shown. The field thus set up by the coil **10** maintains the two movable core members **18** and **21** in attracted and contacting position to thereby maintain switch **24** closed, switch **25** open, and switch **32** open.

When the switch **35** is opened, the energizing current for coil **10** is interrupted and the core member **18** is thus allowed to move to the left against the stop **19**, under the influence of the biasing springs **20**, to thereby close switch **32**. When switch **32** is closed, an energizing current flows through the other coil **11** through the following path: from the source **33**, winding **11** and switches **24** and **32**, and, as a result, the core **21** is moved to the right. Near the end of such travel of the core member **21**, the switch **24** is opened and the switch **25** is closed. Opening of switch **24** interrupts the flow of energizing current to coil **11**, while closure of switch **25** results in short circuiting of resistance **36** to thereby condition the energizing circuit for the other coil **10** so that maximum energizing current may initially flow through coil **10** when switch **35** is subsequently closed.

It is noted that because of the two-coil construction, it is possible to achieve higher realizable forces than in the case with a single coil construction using a spring return. This is so since in the latter case all of the work which the solenoid is to do is accomplished in one direction.

Using the instant construction, the magnetic structure performs a push and pull stroke, and the amount of force developed in such push and pull strokes may be in different rations depending upon the purpose intended to be achieved, this being accomplished simply by proper design of coils **10** and **11**.

It is understood that the broad idea of using a two-coil solenoid construction is not new, but the instant arrangement avoids one of the disadvantages of the prior art structures. This disadvantage is obviated by the spring biased core member **18** which with the coil **10** deenergized, an air gap is provided between the core members **18** and **21** so that flux produced as a result of current flow in coil **11** does not tend to keep the core member **21** in its sealed position (i.e. its most left position in the figure). In other words, the springs **20** in this case assure the development of an air gap between the core members **18** and **21** so that leakage flux from coil **11** is of insufficient intensity to prevent the core **21** from moving to the right as intended upon energization of coil **11**.

It is realized, of course, that other modifications may be made within the sphere of the present invention. For example, the member **22**, instead of extending to the

right from the core member **21**, may extend to the left, and in such case the movable core member **18** is suitably apertured to provide clearance for the member **22**, and the switch **32** is displaced from its central position, as shown, to allow passage of the member **22**.

The size of the springs **20**, in general, is governed by their ability to move the core member **18** against the force exerted by the flux due to current in coil **11**.

Another important feature of the present invention is that upon power failure, i.e. upon disconnection of the source **33**, the core member **21** remains in its position shown.

While the particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

I claim:

1. A solenoid construction including two windings, a common core member influenced magnetically by each of said windings to move said core member in opposite directions, a separate core member magnetically influenced only by one of said windings, said common core member comprising an elongated member disposed within said two windings which are coaxially arranged, and said separate core member being in the form of a disc having a portion thereof extending coaxially into only said one winding, a magnetizable casing enclosing said windings, and said disc being attractable by only said one winding to said casing.

2. An arrangement as set forth in claim 1 including spring means normally biasing said disc away from said casing and from said common core member.

3. A solenoid including two windings, a common core member influenced magnetically by each of said windings to move said core member in opposite directions, a separate core member influenced only by one of said windings, a first switch operated by said common core member, a second switch operated by said separate core member, an energizing circuit for the other one of said windings comprising serially said other winding, and said first and second switches.

4. A solenoid arrangement as set forth in claim 3 including a third switch operated by said common core member, a current limiting resistance connected in shunt with said third switch, a control switch, and an energizing circuit for said one winding including serially said one winding, said third switch and said control switch.

5. An arrangement of the character described comprising, in combination, a pair of axially aligned windings, a magnetizable cylindrical casing encircling said windings, a magnetizable disc closing one end of said casing, a magnetizable disc movably mounted with respect to the other end of said casing, spring means normally maintaining said movable disc away from said casing, a third disc in said casing separating said pair of windings, a core member in said pair of windings, said core member having a length less than the combined lengths of said two windings so that said windings when energized successively move the core in opposite directions, said movable disc member being attracted to said casing only upon energization of one of the said pair of windings to close a flux path which extends through said casing, said movable disc, and said third disc, the first mentioned disc, casing and third disc providing a closed flux path for flux developed by the other one of said pair of windings, said spring means serving to disestablish a flux path for said one winding when said one winding is deenergized.

6. An arrangement as set forth in claim 5, including a switch operated by said movable disc, a second switch, an energizing circuit for said other winding, said energizing circuit including said other winding, said second switch and the first mentioned switch.

7. An arrangement of the character described comprising, in combination, a pair of axially aligned coils, a core member in said coils having a length less than the combined lengths of said two coils so that energization of one of the windings moves the core in one direction and energization of the other coil moves the core member in the opposite direction, a first magnetic structure enclosing one of said coils, a movable armature attracted to said other coil only when said other coil is energized, said armature when attracted closing a magnetic circuit for said other coil, means normally biasing said armature from said other coil to disestablish a magnetic circuit for said other coil, first switching means operated upon movement of said armature, second switching means operated upon movement of said core, and an energizing circuit for said one coil comprising serially said first and second switching means.

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