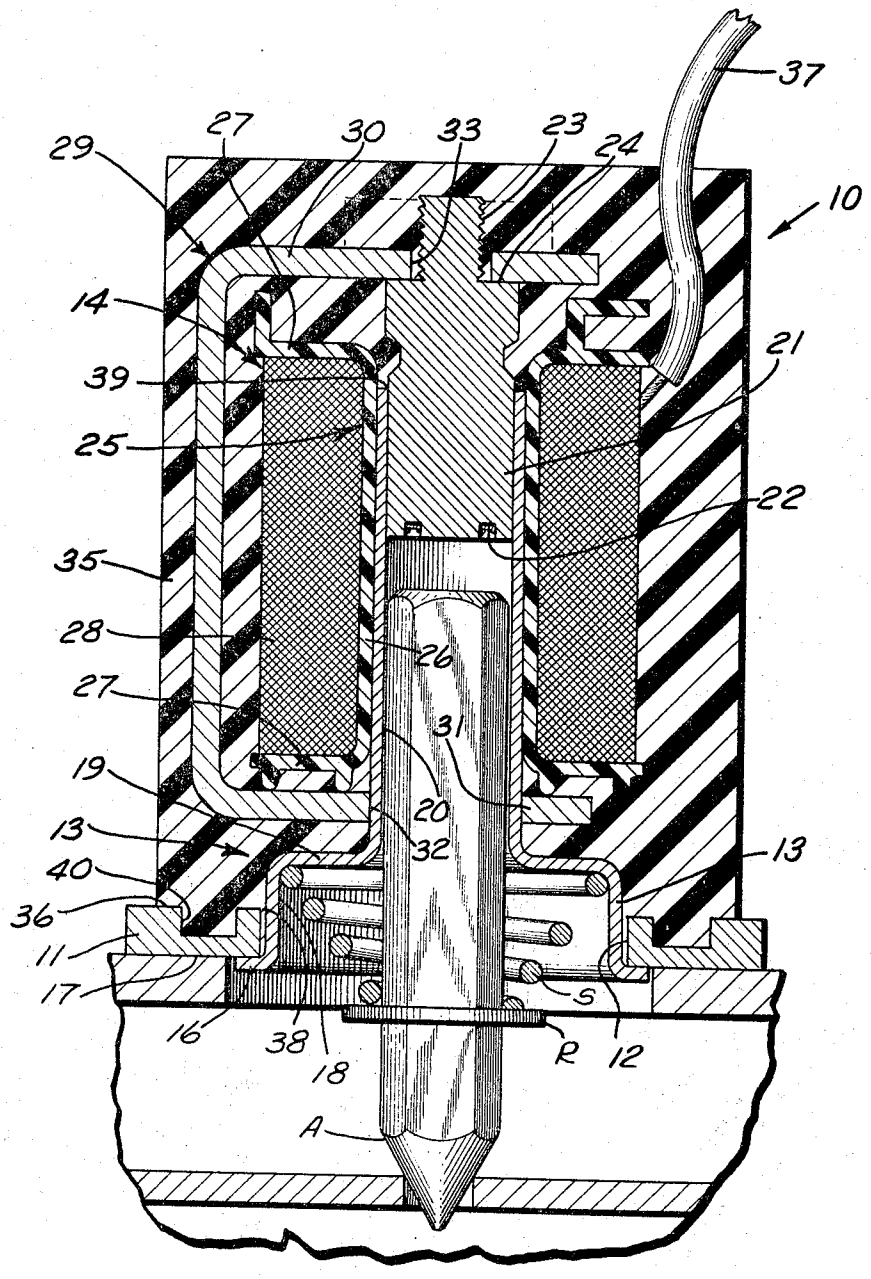
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CONSTRUCTION FOR SOLENOID DEVICES

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CONSTRUCTION FOR SOLENOID DEVICES

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The present invention relates to an improved solenoid construction and more particularly relates to a solenoid construction which is designed for underground installation and which must therefore be adapted to resist the deleterious effects of water and corrosive damage encountered there.

Solenoids which are adapted to be used for operating solenoid actuated valves such as are employed in underground sprinkling systems and other buried fluid distributing systems must be adequately protected from the deleterious effects of their subterranean environment. In particular, the electrical coil must be protected from water seepage and, to the extent possible, all loose part connections should preferably be kept to a minimum. Gasketed structures are not entirely satisfactory due to the possibility of leakage over a period of time at the part-gasket interface.

We have provided a solenoid construction wherein the electrical coil is completely encapsulated in a protective plastic material which, in turn, encapsulates the armature guide and is bonded to the solenoid base plate and the guide as well as the coil in order to insure a positive fluid-tight seal between all of these associated parts. The resultant structure is a one-piece unit having insulated electrical leads protruding therefrom but being otherwise completely protected from the deleterious effects of underground burial.

It is therefore a principal object of the present invention to provide an improved solenoid construction suitably designed for installation in an underground environment or in other environments where water and/or corrosive damage is a problem.

A further object of the present invention resides in the provision of a solenoid construction wherein the armature guide and the associated electrical coil are completely encapsulated within a protective plastic material and in which encapsulation material serves, in turn, to provide a positive fluid seal between the base plate of the solenoid, the armature guide, the electrical coil and its associated parts, and the end plug of the armature guide.

Yet another object of the invention is directed to a solenoid construction of the type generally described above wherein means are provided to insure that the bond formed between the encapsulation material and the associated metal parts will not break.

These and other objects, advantages, and features of the present invention will become apparent from time to time as the following specification proceeds, and with reference to the accompanying drawings, wherein:

The figure is a vertical sectional view taken through a solenoid constructed in accordance with the present invention which solenoid is designed for use in a fluid shut-off valve.

With reference to the drawing, the solenoid **10** comprises generally a flat base plate **11** which, for the present purposes, is preferably formed of stainless steel or like corrosion-resistant materials and the base plate has an aperture **12** formed therein. An armature guide **13** extends upwardly through the aperture **12** and has a solenoid coil **14** mounted thereover which, in turn, has a pair of insulated electrical leads **37** extending therefrom and electrically connected therewith. The base of the armature guide **13** has an outwardly directed circular flange **16** formed integrally therewith which engages the undersurface **17** of the base plate **11** immediately around the aperture **12**. An enlarged diameter section **18** of the armature guide **13** leads upwardly from the flange **16** through the aperture **12** and terminates in a horizontally extending inwardly directed annular shoulder **19** which, in turn, terminates in a radially reduced cylindrical guide portion **20**. The cylindrical guide portion **20** has a metal plug **21** snugly fitted in the upper end thereof to close that end of the guide and this plug, in turn, has a shading ring **22** fitted within the inner end face thereof for purposes well understood by those skilled in the solenoid art. A threaded shank **23** is formed integrally with the plug **21** and extends upwardly from the upper end face **24** thereof.

The coil **14** comprises generally a bobbin **25** having a cylindrical winding section **26** and integral end flanges **27**. The bobbin **25** is formed of an insulating plastic material and has a copper wire winding or the like **28** wound on the winding section **26** intermediate the end flanges **27**. A C-frame **29** having upper and lower horizontally extending legs **30** and **31**, embraces the coil **14** and is fitted over the armature guide so that the guide extends upwardly through an enlarged aperture **32** formed in the base leg **31** thereof and so that the threaded shank **23** of the plug **21** extends upwardly through a diametrically reduced aperture **33** formed in the upper leg **30**. The aperture **33** is sufficiently small so that the under surface of the leg **30** rests on the end face **24** of the plug **21**. In assembly, the coil **14** is fitted within the C-frame and the composite structure is then dropped over the armature guide **13**. From an assembly standpoint it is sometimes desirable to secure a nut to the shank **23** to positively secure the C-frame and its associated coil **14** on the guide **13** but such is a matter of preference in accordance with the particular manufacturing techniques used and is not under all circumstances necessary. Such a nut is shown in the figure in broken lines.

The protective encapsulation material **35** is molded completely around the solenoid parts thus far described and is bonded to the upper surface **36** of the base plate **11**, the outer surface of the armature guide **13** (or at least so much thereof as extends above the plate **11**), the C-frame **29**, the outer windings of the coil **28**, the bobbin **25**, and the exposed surfaces of the plug **21** including the threaded shank **23**. A pair of insulated electrical leads **37** extend from the coil **28** through the encapsulation material **35** and the properties of the encapsulation material **35** and the insulating material for the leads **37** are preferably selected so that a positive bond will be formed therebetween during the encapsulation-molding operation.

The resulting structure is a one-piece unit which is completely sealed against the elements and the electrical coil is completely protected from damage by water seepage both from within the associated valve structure (and from within the armature guide itself) and from without. For instance, the encapsulation material is bonded both to the face section of the armature guide **13** and the base plate **11** to prevent water seepage to the coil from within the valve at point **38** and encapsulation material bonded to the plug **21** and upper end of the armature guide prevents any seepage to the coil from within the guide about the point **39**. By providing an intimate bond between the insulating skin of the lead wires **37** and the encapsulation material, all possibility of water damage to the coil is eliminated.

The base plate **11** is preferably formed of stainless steel and the armature guide may be formed of any suitable material which will resist the corrosive effects of the water or other fluid medium to which its interior walls may be exposed and which material will provide a positive bond with the epoxy or other encapsulating material employed.

Recognizing that a solenoid construction of the type here described may be, on occasion, exposed to rather severe mechanical strains imposed upon them because of the environments in which they are employed and that any plastic-to-metal bond is susceptible to breakage under adverse conditions, the upper surface **36** of the plate **11** is provided with a series of vertically walled indentations **40** which are filled by projections of the epoxy encapsulating material during the encapsulation-molding operation so that a twisting action which might tend to relatively rotate the base plate and the encapsulation material will be impeded. By the same token, threading a nut on the shank **23** to maintain the C-frame and its associated coil in a fixed position relative to the armature guide will also further insure that any forces tending to break the bond at the interface of the encapsulation material and the armature guide-base plate, will not cause such bond breakage.

It will be understood that this embodiment of our invention has been used for illustrative purposes only and that various modifications and variations in the invention may be effected without departing from the spirit and scope of the novel concepts thereof.

For purposes of illustration, an armature A of a well known configuration is shown mounted for slidable movement in the guide **13** and as being biased into part-closing engagement with a valve seat by a conically configurated spring S which has one end seated on the shoulder **19** and its opposite end seated on a spring retainer R mounted on the outer end of armature A.

What we claim is:

1. In a solenoid construction:
an armature guide;
an electrical coil surrounding said guide and having lead wires connected thereto and extending therefrom;
a stop plug positioned in one end of said guide and having a portion extending therefrom; and
an electrically non-conductive impervious material completely surrounding the exterior of said guide and said coil and the coil ends of said lead wires and the extended portion of said stop plug and bonded to the exposed portions of each of said guide, coil, lead wires, and stop plug.

2. In a solenoid construction:
an armature guide formed of stainless steel;
an electrical coil surrounding said guide and having lead wires connected thereto and extending therefrom;
a stop plug positioned in one end of said guide and having a portion extending therefrom; and
an epoxy resin material completely surrounding the exterior of said guide and said coil and the coil ends of said lead wires and the extended portion of said stop plug and bonded to the exposed portions of said guide, coil, lead wires, and stop plug.

3. In a solenoid construction:
a base plate having an aperture formed therein;
an armature guide extending upwardly through said aperture and having an outwardly extending flange about one end thereof engaging the under surface of said plate;
an electrical coil surrounding said guide and having electrical leads connected thereto and extending therefrom;
a stop plug positioned in one end of said guide and having a portion extending therefrom; and
an electrically non-conductive impervious material completely surrounding the exterior of said guide and said coil and the coil ends of said lead wires and the extended portion of said stop plug and bonded to the exposed portions of each of said plate, guide, coil, lead wires, and stop plug.

4. In a solenoid construction:
a base plate having an aperture formed therein;
a cylindrical armature guide extending upwardly through said aperture and having an outwardly extending flange formed about one open end thereof engaging the under surface of said plate;
a cylindrical plug fitted within the opposite open end of said cylindrical armature guide to close that end of the guide;
an electrical coil surrounding said guide and having insulated electrical leads connected thereto and extending therefrom; and
an electrically non-conductive impervious material completely surrounding that portion of said guide extending above the plane of said plate, the inner ends of said leads, said coil, and said plug;
wherein said material is bonded directly to the upper surface of said plate and to said guide and to the exposed portions of said coil and said plug and to the coil-connected ends of said leads; and
wherein said material covers the end of said armature guide about its line of contact with said plug whereby to insure a positive fluid-tight seal between said plug and said guide.

5. In a solenoid construction:
a base plate formed of an anti-corrosive metal and having an aperture formed therein;
a cylindrically shaped armature guide formed of a corrosion-resistant material extending upwardly through said aperture and having an outwardly extending flange formed at one end thereof and engaging the under surface of said plate;
a plug fitted within the opposite open end of said cylindrical armature guide and closing that end of the guide and extending exteriorly of the guide;
an electrically non-conductive bobbin fitted over said guide and having an electrical coil wound thereon;
insulated electrical leads extending from an electrically connected with said coil;
a C-frame embracing said bobbin and coil and having one leg fitted over said armature guide and having another leg fitted on and positively secured to said plug; and
an electrically non-conductive impervious material completely surrounding and bonded to the exposed portions of said guide, bobbin, coil, plug, C-frame, and the upper surface of said base plate;
wherein said material provides a seal between said armature guide and said plug and between said armature guide and said plate, respectively, along the line of contact between the respective parts.

6. A solenoid assembly constructed in accordance with claim **5** wherein one of said plate and said insulating material has a projection extending therefrom along the interface between the material and the plate and wherein the other of the plate and insulating material has a complementary projection-receiving aperture formed therein whereby to prevent relative rotation between the insulating material and said plate.

7. In a solenoid construction:
a base plate having an aperture formed therein;
an armature guide extending upwardly through said aperture and having an outwardly extending flange about one end thereof engaging the under surface of said plate;
an electrical coil surrounding said guide and having insulated electrical leads connected thereto and extending therefrom; and
an insulating plastic material completely surrounding that portion of said guide extending above the plane of said plate, the inner ends of said leads, and said coil;
wherein said material is bonded directly to the upper surface of said plate and to said guide and to the exposed portions of said coil and to the coil-connected ends of said leads; and
wherein one of said plate and said insulating material has a projection extending therefrom along the inter-

face between the material and the plate and wherein the other of the plate and insulating material has a complementary projection-receiving aperture formed therein whereby to prevent relative rotation between the insulating material and said plate.

8. A solenoid including:

an armature guide;

an electrical coil surrounding said armature guide and having lead wires connected thereto and extending therefrom;

a stop plug positioned in one end of said guide and having a portion extending therefrom;

the improvements therein comprising, an electrically non-conductive impervious material completely surrounding the exterior of said guide and said coil and said coil ends of said lead wires and the extended portion of said stop plug and bonded thereto to fixedly secure the position of said guide and said coil and the coil ends of said lead wires and the extended portion of said stop plug to prevent relative movement therebetween.

9. The solenoid of claim 8 further including a base plate having an aperture formed therein for surrounding said guide opposite the end receiving said plug; and a

magnetic frame surrounding at least a portion of said electrical coil and embracing said guide and said stop plug, whereby said electrically non-conductive impervious material fixedly secures the position of said base plate and said frame to prevent relative movement between said guide, said coil, and the coil ends of said lead wires, the external portion of said stop plug, said base plate, and said frame.

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