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VARIABLE INDUCTOR

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The present invention relates to an electronic apparatus in which one component is moved relative to another component in order to change one of the electrical values of the apparatus, certain electrical values of which are affected by means of moisture being present adjacent to the movable and the fixed components.

More specifically, it may be stated that the present invention is concerned with electrical devices, such as, for example, slug-tuned coils and other types of variable inductors, in which a ferro-magnetic body, such as, for example, an iron core, a ferrite core, or any other type of core material, is moved within a central tube into or out of a wound coil. The presence of an extremely small amount of moisture within the tube containing the movable component in this type of construction is extremely detrimental for many purposes. Thus, for example, the presence of a small amount of moisture may, in case of R. F. transformers, vary the Q of the coil in an undesired manner. It is a broad, general object of the instant invention to provide electrical apparatus in which means are provided adjacent the movable components and the fixed components which will prevent the ingress of moisture into this region. Further objects of the present invention, as well as many of its advantages, will be apparent from the remainder of this specification.

This invention may be briefly summarized as being concerned with electronic apparatus of the type indicated in the preceding discussion, in which a viscous material which is incapable of absorbing moisture from the atmosphere and which retains its gelatinous form over the entire range of temperatures within which the apparatus is designed to be used, is placed within such apparatus so as to prevent moisture from appearing within the area where the movable component is moved with respect to the fixed component in varying an electrical value. The actual invention is, of course, more fully defined in detail by the appended claims forming a part of this specification. The actual details of the invention present here will be apparent from the remainder of this specification and these claims, together with the accompanying drawing, in which:

Fig. 1 is a side cross-sectional view showing a variable inductor formed in accordance with this invention; and

Fig. 2 is a cross-sectional view taken at line 2—2 of Fig. 1 of the drawing.

It is seen from a detailed examination of these two figures that a complete apparatus 10 constructed in accordance with this disclosure includes a center tube 11 of cardboard or ceramic or other dielectric material within which there are placed ferro-magnetic or metallic cylindrical slugs 12. These slugs 12 are designed to be moved within the tube 11 as the attached screws 15 are turned within appropriate threaded bushings 16. These screws 15 are provided with slotted heads 17 for the obvious purpose. The bushings 16 employed with the invention are preferably provided with an externally threaded surface 18 which is designed to be utilized in

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mounting the complete apparatus 10, and are secured at one end 20 thereof to a generally cup-shaped positioning member 21 which is adapted to fit over the adjacent extremity of the tube 11 so that the bushing 16 is at all times in the desired position with respect to this tube. The bushings 16 are also attached to end plates 22.

Disposed about the center tube 11 so as to be in proximity to the slugs 12 are small wound electrical coils 25 (supplied with leads not shown) which may be located within a ferromagnetic retaining cup 26, as shown. This cup 26 is employed primarily to aid in controlling the magnetic lines of flux with respect to the coils in a desired manner, and can, if desired, be dispensed with.

The cups 26, the coils 25, the end plates 22, and the cup-shaped members 21 attached to the threaded bushings 16 are preferably held together with respect to one another by a comparatively rigid, moisture-impervious, dielectric resin structure 27, such as, for example, any common potting composition. Suitable resins for this purpose include various phenolic casting compositions, epoxy resins, polyester styrene copolymers and like resins, and filled resin mixtures. The complete resin structure 27 employed with the invention thus effectively serves to prevent the ingress of moisture into the vicinity of the wound coils 25 and any connected wiring. Such connected wiring normally includes terminal plugs, capacitors, etc. normally employed with the invention and held within the resin structure 27. However, the specific apparatus described up to this point is not satisfactory for use under a wide variety of conditions inasmuch as a small amount of moisture will tend to seep or otherwise get into the center tube 11 through the threaded bushings 16. Such an extremely small amount of moisture effectively limits the application of the apparatus described up to this point inasmuch as it causes a change in the electric value of the coils 25 as it gets within the portion of the tube immediately adjacent such coils, and tends to seep within the tube into the adjacent area of the coils.

With the present invention, this difficulty is effectively prevented by a very simple expedient. This expedient consists of placing a viscous substance—which is unaffected by moisture; that is to say, it is incompatible with moisture and will not absorb the same when exposed to it—within the center tube so that this viscous material may be moved within this tube so as to at all times fill the portion of the tube 11 adjacent the coils 25 which is not occupied by the slugs 12. As shown in Fig. 1 of the drawing, this viscous material 28 is thus merely located within the center tube 11 and is moved within this tube as the screws 15 are turned so as to slide past the slugs 12 between these slugs and the center tube 11 within a small circumferential passage 29. This passage is necessary because of the incompressible nature of the material 28. Inasmuch as the viscous materials employed with the invention are incompressible, it is necessary that the center tube 11 be not quite completely filled with this material in order to avoid breakage when the slugs 12 are moved.

The precise composition of the viscous material 28 employed with the invention is capable of wide modification within the scope of this disclosure. Preferably, the material employed should be of such physical characteristics that it is substantially unchanged in viscosity and electrical characteristics over the entire range of temperatures within which the apparatus 10 is designed to be used. Particularly suitable substances for use with the invention are the so-called "silicone" compounds formulated from dimethyl or methyl phenyl silicone fluids by the incorporation of a few percent of exceedingly finely divided silica within these fluids. Many silicone fluids having a relatively high viscosity may be used directly

within the apparatus of this invention. A discussion of the chemistry of suitable silicones which may be employed is far beyond the scope of this specification. However, reference is made to the text "Silicones and Their Uses," by R. R. McGregor, McGraw-Hill Book Company, New York, New York, 1954.

The instant invention is not to be considered, however, as being limited to silicones as other compositions, such as, for example, castor-oil gelled with polyethylene, and a number of specific petroleum fractions, can be employed with the instant invention, although such other compositions are not to be considered as preferable with the invention inasmuch as they are incapable of retaining their properties without material change throughout the normally desired temperature range of from about -55° C. to about 125° C. The silicones indicated above possess stability within this range, both as to their chemical consistency and as to their physical and electrical properties.

The instant invention is not to be considered as specifically limited to various electrical apparatus, including a tuned coil as herein specified, but can be applied with equal facility to other apparatus in which an electrical value of the apparatus may be affected by moisture being present adjacent the movable and fixed components. Also, the instant invention is not to be considered as being specifically limited to those situations where a tube is employed, although, obviously, it is best adapted for use where a tube is involved. Thus, it is thought that the subject matter of this invention can be applied to various trimmer capacitors in which one electrode is rotated with respect to another electrode.

A number of modifications within the scope of the present disclosure will be apparent to those skilled in the art from an examination of this specification. All such modifications, insofar as they are within the skill of the art, are to be considered as part of the inventive concept as defined by the appended claims.

We claim as our invention:

1. In a variable inductor for use in a radio frequency

transformer or the like, the combination of: a length of tubing; a tuning slug positioned within said tubing; a cap carried at each end of said length of tubing for sealing said tubing; means projecting through at least one of said caps for moving said slug axially within said tubing; a viscous material substantially filling said sealed length of tubing; an electrical coil mounted on the exterior of said tubing; and a housing encapsulating said coil and sealed length of tubing, with said slug moving means projecting through said housing, said housing comprising a unitary molded structure of electrical insulating material.

2. In a variable inductor in which a tuning slug is moved with respect to a coil in order to change an electrical value of the apparatus, certain electrical values of which are affected by the presence of moisture adjacent the coil and slug, the improvement which comprises: a center tube within which said slug is moved, said tube being closed at each end thereof; a viscous gel disposed within and substantially filling said center tube so as to be moved within said tube as said slug is moved and so as to prevent moisture from being present within said tube; and an electrical insulating material enclosing said closed tube and coil, said insulating material comprising a unitary piece of molded resin filling the interstices about said tube and coil so as to prevent moisture from being present about said coil.

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