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2,875,419

TUNABLE RADIO FREQUENCY COILS

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FIG. 1



FIG. 2

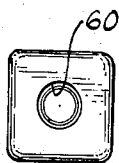


FIG. 3

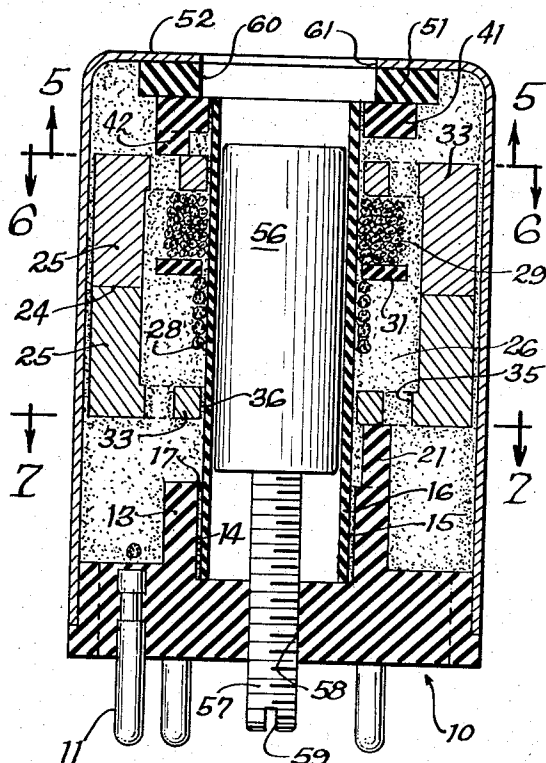


FIG. 4

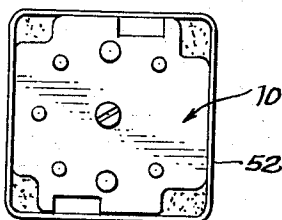


FIG. 5

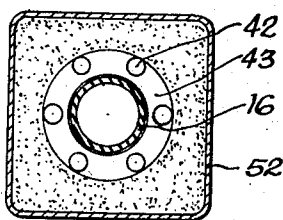


FIG. 7

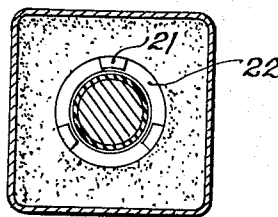
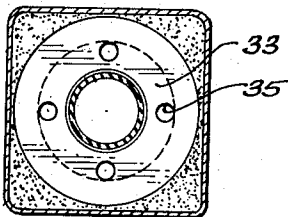


FIG. 6



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TUNABLE RADIO FREQUENCY COILS

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7 Claims. (Cl. 336—83)

This invention relates to an improved radio frequency transformer or analogous device in which the protection of the windings against the effects of humidity is of paramount importance, and particularly when the moisture is in the form of salt water.

In many applications of radio and related equipment for military uses the specifications often dictate that the equipment shall withstand exposure to salt water for a protracted period without deleterious effect on performance. As is known, the performance of inductance coils as used in such equipment can be measured as the Q of the coil.

While the hermetic sealing of a coil per se may be generally accomplished by impregnation with a suitable varnish or plastic composition the problem in the case of a variable inductance takes on an entirely different character. For example, when the inductance is varied by shifting of a ferromagnetic core within the coil the mechanical features rule out the generalized impregnation heretofore utilized for coils of fixed inductance.

Accordingly, the principal object of this invention is to provide an inductance coil having mechanical means for varying the amount of inductance and in which the windings are fully protected against the effects of soaking in salt water and, therefore, of humidity generally, such as the vapor of boiling water.

A further object is to provide an inductance coil as aforesaid having novel means for introducing and facilitating flow of the impregnant or potting compound into and around every interstice of the coil or coils proper and the voids within the surrounding container generally used to house the same and serving in many cases as an electrostatic shield.

Other objects will become apparent from the following description which, taken with the accompanying drawing, discloses a preferred mode of carrying the invention into practice.

In this drawing:

Fig. 1 is a side elevation, in full scale, of a typical radio frequency transformer for a radio receiver and embodying the invention;

Fig. 2 shows a top plan view thereof;

Fig. 3 is a vertical, medial cross section of the device of Fig. 1 but greatly enlarged;

Fig. 4 shows a bottom plan view;

Fig. 5 is a cross section taken in the direction of the arrows 5—5;

Fig. 6 is a cross section taken in the direction of the arrows 6—6; and,

Fig. 7 is a cross section taken on the line 7—7 of Fig. 3.

Turning now to the drawing which illustrates a radio frequency transformer, a base part 10 of conventional form, say molded plastic composition, is provided with terminal prongs 11 whereby the ends of the coil or coils may be connected to a socket whereinto the prongs 11 may be inserted.

Base 10 is provided with an annular, inwardly directed projection or boss 13 having an inner diameter 14 slightly in excess of the outer diameter 15 of a cylindrical sleeve 16 whereby the latter is rigidly retained by a snug fit subsequently implemented by the introduction of potting compound into the space 17. Conveniently such clearance space may be afforded by the ordinary draft allowed in molding the base 10. Where, herein, the words "potting compound" are employed it is intended to comprehend an electrically insulating material initially in flowable form and capable of being rendered solid and rigid by heat or unaided chemical action.

A plurality of pedestals 21, say three in number (Fig. 7) extends upwardly from the upper rim of the boss 13 to define a similar number of interspaces 22 for a purpose to be described. Resting on the pedestals 21 is a core e. g. of ferromagnetic material comprising, in this instance, a pair of cup-shaped elements 25 placed rim to rim to define a cylindrical space 26 within which the coils 28 and 29 are positioned. The purpose of the elements 25 is to confine the magnetic field about the windings to eliminate the losses which may be due to the proximity of the aluminum shield can. The coil or coils, as the case may be, may be of any construction, are wound on the sleeve 16, and are not to be regarded as limited to the form shown. Inasmuch as two are illustrated in adjacency an insulating washer 31 is preferably interposed.

The bottom wall 33 of each of the core parts 25—25 has a plurality of openings 35 to provide for the passage of the potting compound. By way of example, four such openings are shown (Fig. 6). In order to be received over the sleeve 16 each wall 33 also has an opening 36 affording a slight clearance.

Positioned over the upper core section 25 is an annular member or spacer 41 preferably of molded plastic composition and provided with downwardly extending bosses 42, exemplificatively six in number and defining, with the upper face of the core section, interspaces 43. The inner diameter of the spacer 41 is larger than the sleeve 16 to allow flow of the potting compound, as will appear.

To retain the core sections 25—25 and spacer 41 in rigid relation with each other a washer 51 of any suitable material, for example, silicone rubber, is employed, and receives clamping pressure from the container or housing 52 of the customary aluminum. In the example the housing is of square cross section to mate snugly with the periphery of the base 10 whereover it is crimped or otherwise secured in the well-known manner, the deformation of the lateral wall of the container during crimping being of such degree as to stretch the same to compress the washer 51 and to maintain the coaxial relation of the several parts pending potting.

Sleeve 16 is preferably plastic tubing having a very low moisture absorption characteristic and serves as an inner wall to limit distribution of the potting compound as well as a guide for the movable core or "slug" 56 having a shank 57 threadedly and snugly engaged in a hole 58 in base 10. By means of a slot 59 the core 56 may be suitably traversed to vary the inductance during alignment of the circuit. It will be noted that inasmuch as only a single tuned inductance is involved there is only one tuning slug 56. A lock nut or spring may be used to insure against accidental loss of the predetermined adjustment.

During the potting operation to be described the space within the sleeve 16 must be closed off. This may be accomplished by the use of a dummy core and plug of any suitable material in this case, "Teflon" to fit within the sleeve 16 and openings 60 and 61. A screw may be

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passed through the dummy and received in the opening 58, the core 56 and stud 57 having been removed. Before installation the dummy core and screw are coated with a lubricant material capable of being unaffected during the potting operation in order that the same may be subsequently easily removed.

The potting compound preferred for devices in accordance with the invention is an epoxy resin, for example, "Scotchcast L-V Resin, available from Minnesota Mining and Manufacturing Co., St. Paul, Minnesota, combined with a suitable filler, say powdered mica. One preferred form is powdered mica No. 6X, available from Mineralite Sales Corporation of New York, New York. The mica is heated at 200° to 210° F. for one-half hour to eliminate moisture and is thoroughly mixed with the powdered resin in the ratio of eleven parts by weight of mica to nine parts by weight of resin. The resulting mixture is then deaerated under a vacuum of 29" of mercury at 130° to 140° F. to insure complete elimination of moisture.

Before potting the coil assembly is baked at 200° to 210° F. for one hour to remove all moisture from the windings and the potting operation effected immediately thereafter to minimize the re-entry of moisture.

The assembly is submerged in the potting compound which is kept in a chamber allowing for evacuation of the surrounding atmosphere and having heating means to maintain the compound at 130° to 140° F. As shown in Fig. 4, base 10 has the general shape of a cruciform, whereby corner openings at the bottom of the housing 52 are provided which are in communication with its interior, and through which the potting compound enters when the housing is submerged in the compound and subjected to heat and vacuum. Inside the housing the various openings and spaces heretofore mentioned will be seen to facilitate flow of the compound to fill all spaces which are not occupied by a physical element or structure. A vacuum of 29" of mercury is applied for 45 minutes whereupon the vacuum is released and the assembly permitted to remain submerged for fifteen minutes. Vacuum of 29" is re-applied for at least one hour or until visually perceptible bubbling ceases. Vacuum is again released and the assembly permitted to remain in the compound for another thirty minutes whereafter it is removed and excess removed from the exterior.

The potting compound is cured at from 250° to 260° F. for two hours.

Examination of a thus-processed transformer by medial cross section reveals every void within the housing filled with the compound. No trace of air bubbles may be discerned and, in fact, the spaces between individual turns of the coils are found to be completely occupied by the compound. The cured and hardened compound will be seen to provide an effective bond between the various parts of the assembly to hold them in fixed spaced relation, thereby to prevent loosening of the parts when the assembly is subjected to vibration or changes in environmental conditions.

A transformer assembly manufactured in accordance with the foregoing has demonstrated no variation in Q after submersion for twenty-four hours in a saturated salt water solution. An equivalent result has been obtained after ten days immersion in tap water. Moreover, direct exposure to the vapor of boiling water for several hours is without deleterious effect.

Now that the potting procedure has been made clear the function of certain structural details heretofore alluded to will be described in their relation thereto. Thus, the provision of the bores 35 will allow penetration of the potting compound to fill the space 26 defined by the core sections 25—25 completely since it will be recalled that evacuation of air proceeds while the device is submerged in the liquid compound. Furthermore, access to the bores 35 and to the spaces intermediate

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the sleeve 16 and the parts positioned thereover is facilitated by the presence of the interspaces 22 and 43. It will be apparent that the compound will also fill all voids intermediate the housing 52 and the parts carried there-within whereby to result in extreme mechanical rigidity and a structure wherein all the parts are integrated by the hardened compound.

The invention will have been seen to be applicable equally to oscillator coils, choke coils and other electronic components subject to deterioration and impairment of function by moisture.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

I claim:

1. The improvement in single-tuned inductance coils and the like comprising a sleeve, a winding surrounding said sleeve, a core including a pair of cup-shaped members having mutually coextensive rims positioned with their respective rims in abutment to define a space within which said winding is located, said members having passages for introduction of an insulating and bonding compound into said space to fill the same and to impregnate and support said winding, a base member having an upstanding post for receiving said winding, and a housing encasing said post, winding and members, said housing being secured to said base, conductive connections through said base to the ends of said winding, said compound also filling the remaining spaces within the housing and surrounding and adhering to the core, winding, sleeve and post, said compound also adhering to the interior of said housing and base whereby the housing and all parts therein are held in fixed spaced relation, a slidable element of ferrous material within said sleeve, and means extending through said base to said slidable element for varying the position thereof to selectively control the inductance of said winding filled with compound.

2. The improvement in accordance with claim 1 wherein said means comprises a rod member threadably engaging said base and extending through said base to the exterior of said housing.

3. The improvement in movable slug inductance coils comprising a base, an annular projection outstanding from said base, a sleeve outstanding from said projection and rigidly supported in the opening thereof, a winding supported on said sleeve, fixed core including a pair of cup-shaped parts positioned rim-to-rim and enclosing the winding, each of said parts having an aperture in the bottom wall for passage of said sleeve and other apertures in said wall providing fluid communication with the interior of said core, said other apertures being radially positioned substantially in alignment with the end of said annular projection, said projection having means defining passages through its wall for fluid communication with said other apertures, the bottom wall of one of the core parts abutting said projection, an annular member positioned on said sleeve and abutting the bottom wall of the other core part, said annular member having means defining passages in fluid communication with said other apertures in said other bottom wall, a housing encasing said projection, core parts, sleeve and annular member, and a resilient washer interposed between said annular member and housing, said housing being secured to said base in a manner to exert compressive force on said washer to seal the interior of the housing, said housing having an opening substantially coextensive with the opening of the washer, the interior diameter of the washer and of said annular member both being larger than the exterior diameter of the sleeve to define a space for entry of potting compound to the interior of the housing,

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a movable core portion within said sleeve, and means for shifting the axial position of said core portion.

4. In combination, a housing, a base member in one end of said housing, a sleeve member within said housing supported on said base member, at least one coil surrounding said sleeve, means affixed to the exterior of said base and conductively connected to the ends of said coil, a core including a pair of ferromagnetic cup-shaped members having mutually coextensive rims positioned with their respective rims in abutment, said core surrounding said coil, a synthetic resin substance having insulating and mechanical bonding properties, said substance coating the terminals of said coil and filling all spaces therebetween, said substance surrounding and filling said core and filling all spaces between said sleeve and said housing, said substance adhering to all parts which it contacts, whereby said substance, housing, core, coil, sleeve and base form a unitary structure, a movable element for varying the inductance of said coil being slidably positioned within said sleeve, and means extending through said base to control the position of said movable element.

5. The improvement in single-tuned inductance coils comprising a housing having a base member, a hollow element supported from said base, a coil surrounding said hollow element intermediate its ends, said base member having conductive connections to said coil, a hollow core surrounding said coil, said core being formed of a pair of cup-shaped elements of ferromagnetic material fitted over said hollow element, means affixed to said tuning slug and extending through said base for varying the position of said slug to alter the inductance of said coil, an insulating and bonding compound filling all spaces between said element and housing, said compound adhering to the interior of said housing and surrounding and adhering to said core, coil, and hollow

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element, and said compound also adhering to said base, whereby said compound, housing, base, coil, core and hollow element form a unitary housing for said tuning slug.

6. A coil structure comprising a base, an annular member extending from said base, a cylindrical sleeve supported at one end within said annular member, a winding carried on said sleeve intermediate its ends, a hollow core of ferromagnetic material disposed along said sleeve and surrounding said winding, conductive connections from said winding to the exterior of said base, a housing disposed about said core winding and sleeve and carried at one end on said base, an element adjacent the end of said sleeve opposite said base and between said housing and the adjacent end of said core, said element and said base being of non-absorptive materials to close off the interior of said sleeve from remaining spaces within said housing, a body of synthetic resin filling all spaces within said housing except the interior of said sleeve, and said resin being characterized by mechanical bonding properties to hold said housing sleeve, element, winding, core and base in fixed spaced relation.

7. The combination defined in claim 6, including an element of ferrous material slidably disposed within said sleeve, and a rod fixed to said element and extending through said base for adjustment of the position of said element to vary the inductance of said winding.

References Cited in the file of this patent

UNITED STATES PATENTS

2,149,529	LaFave	Mar. 7, 1939
2,180,413	Harvey	Nov. 21, 1939
2,388,295	Shea	Nov. 6, 1945
2,455,875	Peterson	Dec. 7, 1948
2,630,560	Earl et al.	Mar. 3, 1953