Nov. 25, 1969 W. E. NEUMAN 3,480,896

ADJUSTABLE INDUCTOR

Filed Nov. 1, 1967

Fig. 1.

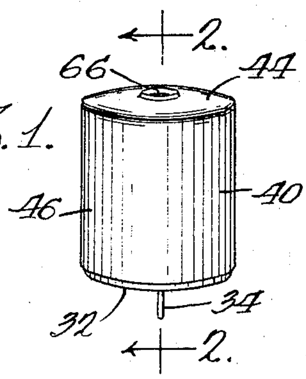


Fig. 2.

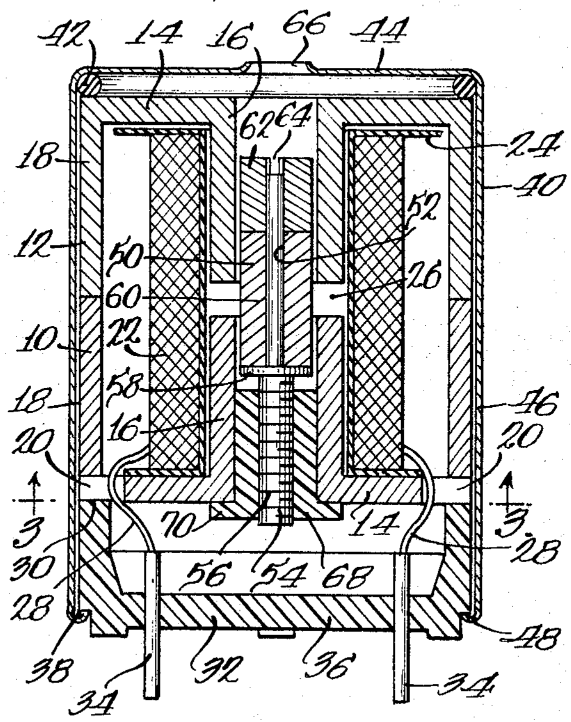
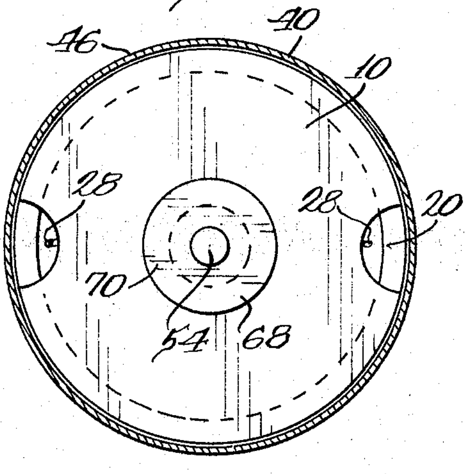


Fig. 3.



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United States Patent Office

3,480,896

Patented Nov. 25, 1969

3,480,896
ADJUSTABLE INDUCTOR

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Filed Nov. 1, 1967, Ser. No. 679,798
Int. Cl. H01f *15/02, 21/06, 27/02*
U.S. Cl. 336—83 3 Claims

ABSTRACT OF THE DISCLOSURE

In a variable inductor including a pair of facing cup cores and a tuning slug narrowly spaced from a central aperture in said cores, an improved mount for the slug providing a high friction screw thread for adjustment. Also, an improved assembly for such an inductor providing solid, shake-resistant support without core-deforming pressure.

Background of the invention

High Q coils of the type under consideration here are formed of two, facing, annular, cup cores wherein the outside rings or walls abut and the inside rings or walls stand somewhat apart. A winding is contained in the annular space between the inner and outer walls. A tuning slug fits closely within the sleeve defined by the inner rings and is adjustable to span the gap between the inner rings or to be variably displaced from such spanning position.

Inductors of this character must be assembled with great care. The gap between the inner rings is critical and the avoidance of stresses within the core structure is critical. Else, the permeability of the core will drift and vary over a period of time. At the same time, the inductors must be proof against a certain amount of shock incident to handling, use in mobile equipment, etc. Consequently, a problem resides in the simple assembly of an inductor of this character whereby the parts are secured firmly and accurately together without the imposition of distorting stresses.

Likewise, of course, it is highly important that the tuning slug, when once adjusted, remain in its adjusted position and not be subject to displacement therefrom by vibration or shock. As a part of this same consideration, it is desirable that the tuning slug be periodically adjustable from one position to another and retain its same resistance to accidental dislocation between such changes.

With regard to the latter consideration, it should be appreciated that for maximum reactance and maximum variation, the clearance of the slug is such as to preclude the existence of any intervening material between the slug and the inside sleeve.

Summary of the invention

The invention here is directed to a shockproof tunable inductor of the type described including a novel form of assembly and a novel provision for tuning slug adjustment, the latter of which is not only proof against shock but capable of unlimited readjustment without losing its strong frictional drag characteristics which maintain the tuning slug in position.

Brief description of the drawings

FIG. 1 is a perspective view of an inductor embodying my invention;

FIG. 2 is a vertical section through the inductor of FIG. 1 taken along line 2—2 of that figure looking in the direction of the arrows; and

FIG. 3 is a transverse section taken along the line 3—3 of FIG. 2 looking in the direction of the arrows.

Description of the preferred embodiment

The inductor considered includes two substantially identical annular cup cores **10** and **12** desirably formed of a ceramic ferrite sufficiently dense and solid as to have negligible or no water absorbing capability, although, for some purposes, sintered iron is suitable. The cores include an annular base **14** and inner and outer cylindrical walls **16** and **18** extending alike from the inner and outer peripheries of the base **14** respectively. The inner walls are shorter than the outer walls. The lower core **10** will have its base notched out as at **20** at one or more discrete points through the outer periphery inwardly beyond the outer wall **18**. A winding **22** on a spool or bobbin **24** is inserted into the annular cavity of the lower cup core **10** to surround and stand above the inner wall thereof. The upper cup core is inverted and inserted into the upper end of the spool with the inner wall contained within the axial aperture of the spool. The relationship of the cores to the spool is such that the outer walls of the cores contact each other and the inner walls stand somewhat spaced from each other defining an annular gap **26**. The leads **28** of the coil **22** are passed through the notches **20** for appropriate electrical connection.

The lower core rests on the rim **30** of a shallow, cup-like base formed of molded or machined plastic **32**. The diameter of the rim is equal to that of the core and the wall thickness of the rim is approximately equal to that of the outer wall of the core. The base has terminal pins **34** molded or assembled therein extending above and below the bottom **36** thereof to which the coil leads **28** are soldered within the cup. Externally, the base has a peripheral recess formed above its lower edge to define an annular ledge **38** parallel to the rim **30** of the base.

The inductor is bound together as a unit by a can **40** An O ring **42** of synthetic rubber having a diameter equal to the outside diameter of the cup cores **10** and **12** is placed on the top cup core and the inverted can **40** placed over the entire, stacked assembly of the two cup cores and the base, with the bottom **44** thereof bearing against the O ring and the cylindrical sides **46** extending down beyond the ledge **38** of the base. Thereafter the free edge **48** of the can is rolled inwardly as by spinning or the like to engage the ledge **38** and exert a compressive force against the outer edges of the cup cores and the base through the resilient medium of the O ring **42** to contain the whole structure firmly together. The O ring in this assembly contributes several desirable effects: it holds the two cup cores tightly together in straight compression along their outer edges for optimum magnetic coupling; it loads resiliently the engagement of the spun edge **48** against the ledge **38** for optimum tightness; it makes the assembly shake-proof; and it achieves all this without the application of pressure on the cup cores inwardly of the outer edges which might tend to distort the cores and interfere with the predictable values of the inductor.

In the illustrated inductor, a tuning slug **50** of ceramic or sintered iron is employed which fits very closely within the sleeve defined by the inside walls **16** of the cup cores for optimum coupling and a maximum range of values. This exceedingly close fit prohibits the use of material intervening between the inside wall of the cup core and the tuning slug, and imposes the requirement that adjusting engagement between core and slug be made axially away from the slug.

As shown here, the tuning slug **50** is a tubular member having a central aperture **52** therethrough. A fibre glass rod **54** is machined to have a threaded lower end **56**, a flange **58** upwardly of the threaded portion, and a small diameter stem **60** receivable closely within the bore **52** of the slug **50**. The stem extends upwardly above the slug. A brass cap **62** is press-fitted on the upwardly extending end of the stem above the slug, and desirably cemented thereto, in tight contact with the slug so that the slug is confined between it and the flange **58**. The cap is cross slotted at its top end as at **64** for adjustment by a screwdriver blade. The can **40** has an aperture **66** in the center of the base thereof through which screwdriver access to the cap is provided. The aperture **66** is smaller than the cap **62** so that the can constitutes a stop for the adjustment of the slug when the slug is wholly withdrawn from the gap.

A tubular, flanged nylon nut **68** is press-fitted and adhesively secured within the lower end of the aperture of the lower cup core **10** with the flange **70** thereof bearing against the base of the cup core. The threaded end **56** of the stem **54** is engaged in the nut. The nut need not be threaded. The fibre glass is sufficiently hard to impress its own threads into the softer nylon material. The engagement of the fibre glass threads with the nylon nut provides a high component of frictional resistance to accidental movement of the stem within the nut, and thus anchors the slug against accidental displacement while permitting an unlimited number of adjustments without lessening frictional holding.

This effect is attainable through the employment of the fibre glass stem. In a characteristic embodiment of this invention, the inside diameter of the sleeve will be about .122 inch and the outside diameter of the tuning slug will be about .115 inch. The aperture therefore through which the stem must extend is exceedingly small, about .038 inch, and with the frictional engagement sufficient to hold the slug in its adjusted position to meet the vibration resistant qualifications, a substantial torsional force of adjustment must be transmitted through the very small diameter stem. Fibre glass possesses the requisite torsional strength, is easily machinable, is nonmetallic, and is a unique and practical answer to the problem. A machined brass equivalent to the fibre glass stem has been employed successfully in the practice of this invention. The strength of the brass may be superior to the fibre glass. However such substitution results in a 10 to 20% increase in the loss of the inductor at some frequencies.

Although a single embodiment only has been described of this invention it should be appreciated that this embodiment is set forth only by way of illustration and not

by way of limitation and that this invention should be regarded as being limited only as set forth in the following claims.

I claim:

1. A tunable inductor comprising a pair of annular cup cores, each having an outer wall and a shorter inner wall extending alike from the outside edge and the inside edge respectively of an annular base, the free edges of said outer walls meeting, a winding contained in the annular space between said inner and outer walls, means securing said cores together in said relationship, a cylindrical tuning slug having an axial bore therethrough within said inner walls, and means for moving said slug variably across the gap between the inner walls of said cores including a shaft of a material strong in torsion extending through said slug bore and providing a shoulder, means anchoring said slug against said shoulder, said shaft extending beyond said shoulder in a threaded extension, and a nut in one of said inner walls beyond said gap engaging said threaded extension with high frictional resistance to rotation, said shaft having means at the free end thereof for effecting rotation thereof.

2. The combination as set forth in claim **1** wherein said nut is an unthreaded, relatively soft, deformable polymer, impressible by said extension to define matching threads.

3. The combination as set forth in claim **1** wherein said shaft is machined fibre glass.

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U.S. Cl. X.R.

336—136, 92