

May 7, 1968

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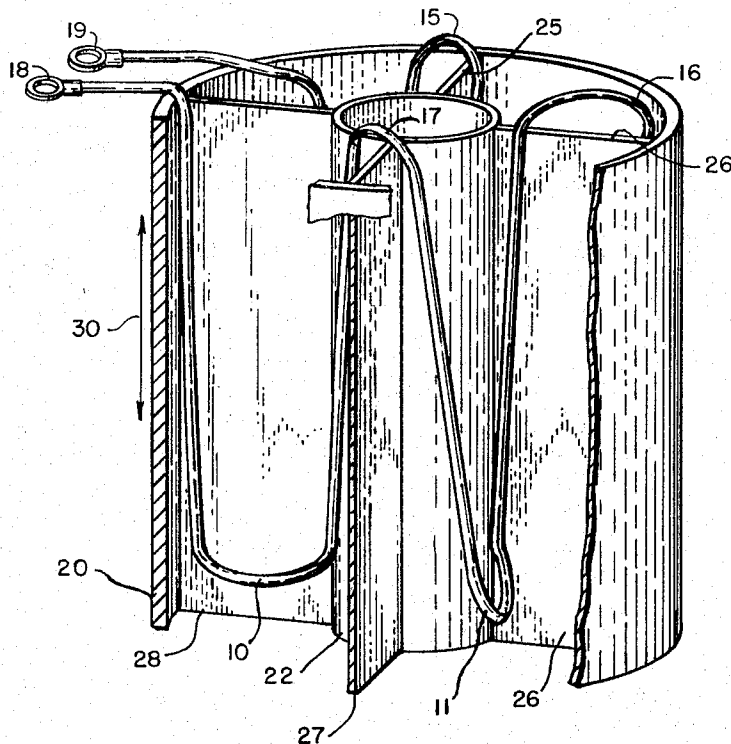
3,382,471

VARIABLE SHIELD CONTROL FOR TOROIDAL CORE INDUCTORS

Filed Jan. 6, 1967

2 Sheets-Sheet 1

FIG. 1



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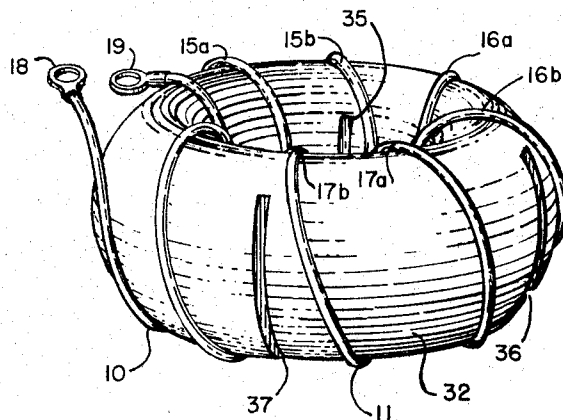
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Filed Jan. 6, 1967

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FIG. 2



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3,382,471 VARIABLE SHIELD CONTROL FOR TOROIDAL CORE INDUCTORS

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Filed Jan. 6, 1967, Ser. No. 607,859

6 Claims. (Cl. 336-87)

ABSTRACT OF THE DISCLOSURE

This invention relates to variable or controllable inductances and particularly to continuously adjustable inductances tuned by electrostatic shielding. More particularly this invention relates to an electrostatic-shield tuning means for a toroidally wound coil.

This invention is a device that provides a pair of concentric, cylindrical shields; one inside and one outside of a toroidal coil, respectively. The cylindrical shields are connected by radial vanes, also of shielding material, that are shaped and spaced to fit between the individual turns of the toroidal coil windings to provide a unit that can be moved in and out of the magnetic field of the coil without physical or electrical contact with the coil.

Varying the shielding between the windings of a coil provides a very effective method of changing the inductance of the coil without requiring electrical switching contacts or taps along the windings, or varying the core physically or magnetically. This method for varying the inductance of a coil has been applied in many ways to many simple forms of inductances but it has not been applied to the more complex toroidal form of coil, which is one of the most efficient forms of inductance and is finding increasing use in all forms of electrical circuitry.

It is therefore an object of this invention to provide an improved, continuously-adjustable inductor.

It is a further object of this invention to provide an improved, variable, shielding means for controlling an inductance.

It is a further object of this invention to provide an improved, variable, shielding means for controlling the inductance of a toroidal coil.

These and further objects of this invention will become apparent from the following description and the drawing of which FIGURE 1 shows in isometric view a typical species of this invention, partly in cross-section, to show the interrelation between the turns of the coil, the shielding vanes, and the cylindrical members.

FIGURE 2 shows a species with a solid core.

Referring now more particularly to FIGURE 1, an air-core, toroidal coil is shown, wound with only four turns for simplicity. The lower loops 10 and 11 of the windings of the toroidal coils are visible in the cutaway section of the shield and the upper loops 15-17 of the winding of the toroidal coil appear above the corresponding vanes 25-27 of the shielding device. The terminal 18 and 19 of the coil are adjacent to the remaining vane 28.

The shielding device includes the outer cylinder 20, the inner cylinder 22, and the interstitial vanes 25-28 that connect the two cylinders mechanically and, also, complete the electrical shielding.

The terminals 18 and 19 and the associated conductors provide the necessary electrical contact to the toroidal coil and may also provide mechanical support for the coil when the wire of the coil itself is strong enough to be self-supporting, as it must be in air-core structure. In this case, the toroidal coil, itself, may be withdrawn, axially, from the shielding structure by suitable mechan-

ical movement of the supporting terminals 18 and 19 although, normally, it is preferable that the shield, rather than the coil, be moved out of the toroidal configuration to avoid movement of any of the electrically conducting elements.

The amount of shielding may be increased, to some extent, or decreased as desired. In the attached drawing, the shield covers all but the tops of the upper loops 15-17 of the windings of the toroidal coil. If additional shielding is needed, the structure can be extended still further by notching the vanes to provide passage for the upper loops of the conductors, and notching the outer, cylindrical shield for the conductors connecting to the terminals so that the cylindrical shields and portions of the vanes can project beyond the physical limits of the toroidal coil. If less shielding is needed the shield may be positioned only a part of the way within the toroidal coil configuration.

An alternative way of providing less shielding and producing less variation in the control of inductance would be to provide vanes only for alternate turns, or for substantially fewer of the spaces between the turns of the coil. In this case the turns need not be uniformly spaced, since only the spaces between turns that are to accommodate the vanes need be widely enough spaced, mechanically, to contain one of the vanes of the shield. The other turns of the coil could be quite close together and doubled over one another in layers in a well-known manner. It should be noted, in any case, that it is an inherent limitation of this device that it is only applicable to toroidal configurations where the mechanical spacing between turns of the coil can be made large enough to accommodate the vanes of the electrostatic shield.

It may also be noted that this device would operate, with lesser efficiency, with only an outer, or an inner, cylindrical shield. In this case the shielding structure could be made to extend beyond both ends of the toroidal coil by passing the vanes through the portions of the turns of the toroidal coil where the loops are at their inner or outer extremities instead of their upper extremities as shown here.

By choosing the appropriate alignment of the vanes with the upper or the lower loops of the turns of the toroidal windings, the shielding structure could be inserted from either side with projections of the opposing vanes interleaving in the alternate spacing between adjacent turns of the winding. This interleaving could be carried still further by using one set of vanes attached to the inner cylinder and the other set of vanes attached to the other cylinder and aligning the vanes with the corresponding outer and inner extremities of the loops of the coil. Such a variation of the shield may be moved as a unit, or the inner and outer cylinders may be inserted, simultaneously, from opposite ends of the coil respectively.

The additional mechanical structure and mechanism for moving the opposing shielding vanes may, or may not, produce enough additional variation of the inductance to justify the additional mechanical problems. Additional range of control of inductance can also be achieved by providing additional, toroidal-wound coils and corresponding, shielding structures that may be separately controlled or ganged together to operate as a single unit.

As noted, the shielding structure is movable with respect to the toroidally-wound coil in an axial direction to be inserted between the windings of the coil or to be withdrawn completely from the field of the coil. This motion may be accomplished by many mechanisms that will be obvious to one skilled in the art and are omitted for simplicity. The necessary movement of the shielding structure is suggested by the arrow 30 indicating the di-

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rection of motion for the effective use of this device.

While only four turns of the toroidal coil are shown for simplicity and clarity, it is obvious that more turns will be needed for higher inductances and that many more vanes can be provided between such turns within the mechanical limitation of turn spacing and the thicknesses of the conductor and the vanes.

A toroidal core may be used to provide mechanical support for the coil, and would be necessary where the wire is not strong enough to be self-supporting. If more inductance is needed, such as a toroidal core can be one of the well-known ferrites. In either case the core must have slots wide enough and deep enough to accommodate the vanes between the turns of the windings.

FIGURE 2 shows a toroidal core of this type that is slotted to accommodate the vanes of the shield shown in FIGURE 1. The windings of FIGURE 2 also show more than one turn per vane.

In FIGURE 2 the elements that correspond to the elements of FIGURE 1 are similarly numbered.

The additional toroidal core 32 has four slots, of which parts 35, 36 and 37 are visible, to accommodate the corresponding vanes of the cooperating shield shown in FIGURE 3, of which 26, 27, and 28 are visible.

The toroidal coil windings includes the additional turns 15a, 15b, 16a, 16b, 17a, and 17b, for example, to show that additional windings between shielding vanes are quite practical.

The slotted core may be made of any of the well known core materials. It may be either inductive or non-inductive, depending on the characteristics required.

This variable inductance may be used as an antenna load to provide a variable control for an antenna that is particularly effective in the high frequency range where the wave lengths become too long for simple mechanical structures. One or more of these devices coupled to the antenna to provide an inductive load, in a well-known manner, will produce a comparatively light, compact, highly-efficient and controllable antenna structure.

What is claimed is:

1. A variable inductor comprising a toroidally-wound, inductive coil having open spaces between the individual turns of said coil, and a variable shielding structure comprising a cylindrical portion of shielding material coaxial to and spaced from said toroidally-wound coil and a plurality of vanes of shielding material extending radially

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from said cylindrical portion of shielding material along the axis of said toroidally wound coil and positioned interstitially between said individual turns of said coil, said shielding structure being movable with respect to said toroidally wound inductive coil to vary the inductance of said coil.

2. In a variable inductor as in claim 1, said toroidally-wound, inductive coil having a given inside diameter and said cylindrical portion of shielding material having a diameter less than said given inside diameter.

3. In a variable inductor as in claim 1, said toroidally-wound, inductive coil having a given outside diameter and said cylindrical portion of shielding material having a diameter greater than said given outside diameter.

4. In a variable inductor as in claim 1, said toroidally-wound, inductive coil having a given inside diameter and a given outside diameter; said cylindrical portion of said variable shielding structure comprising a first cylindrical portion of shielding material coaxial to and spaced from said toroidally-wound coil and having a diameter less than said given inside diameter; a second cylindrical portion of shielding material coaxial to and spaced from said toroidally-wound coil and having a diameter greater than said given outside diameter of said coil; and said plurality of vanes of shielding material extending radially between said first and second cylindrical portions of shielding material.

5. In a variable inductor as in claim 1, said toroidally-wound, inductive coil having a non-inductive core, to support said individual turns of said coil, with slots in said core between said individual turns of said coil to accommodate said vanes of shielding material.

6. In a variable inductor as in claim 1, said toroidally-wound, inductive coil having a ferrous core with slots between said individual turns of said coil to accommodate each of said vanes of shielding material.

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