

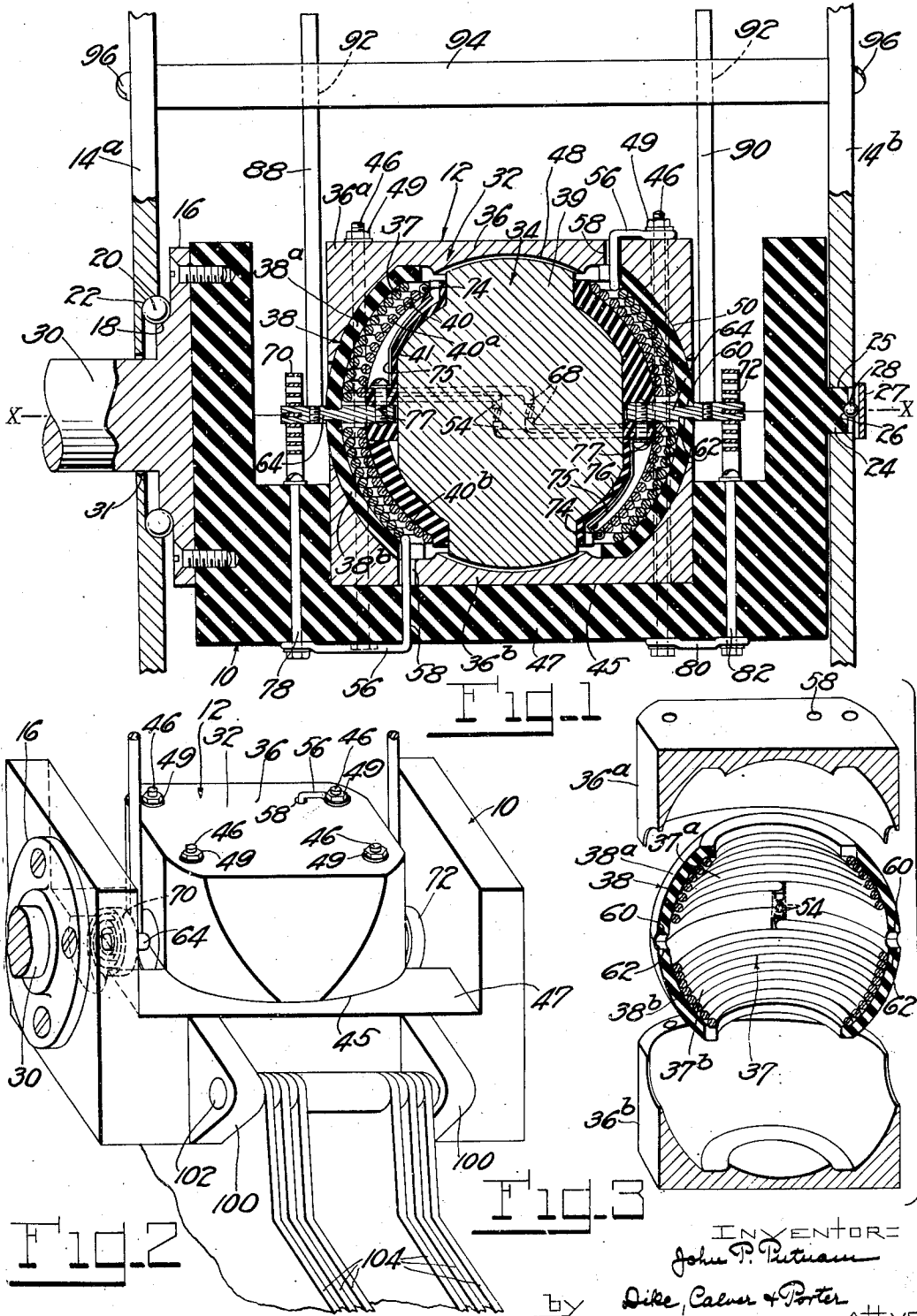
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VARIABLE INDUCTOR

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2,343,999

VARIABLE INDUCTOR

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6 Claims. (Cl. 171-242)

This invention relates to variable inductors which are particularly adapted, though not limited to tuning units for radio receivers of the "all wave" type.

In my prior Patent 2,201,453 issued May 21, 1940, there is disclosed a variable inductor whose inductively related coils are mounted on relatively rotatable elements of ferro-magnetic material which form a substantially closed magnetic field. The inductance range of this inductor is so large that the same, when used in conjunction with a suitable variable condenser, is well able to cover the entire short wave broadcast range, the intermediate range for police and aviation broadcasts, and the American broadcast range. The "Q" or "figure of merit" of this inductor is also sufficiently high to obtain fair image rejection, fair selectivity and a fair signal to noise ratio in a radio receiver.

It is the object of the present invention to increase the "Q" or "figure of merit" of this inductor so as to considerably improve the image rejection and the selectivity of a radio receiver, and to better the signal to noise ratio and thereby obtain a higher stage gain.

This object is accomplished by spacing the inductively related coils from their respective ferro-magnetic supporting elements and thereby reduce the capacity between them. By way of example, this may be done by providing spacers or liners of any suitable insulating material between the coils and their respective ferro-magnetic elements, whereby the thickness of the insulating spacers is so selected as to effect the optimum compromise between a high "Q" and a large inductive range.

The foregoing and other objects of the invention, together with means whereby the latter may be carried into effect will best be understood from the following description of an illustrative embodiment shown in the accompanying drawing: in which,

Fig. 1 is an enlarged cross-section through an inductor embodying the present invention.

Fig. 2 is a perspective view of the inductor.

Fig. 3 is a perspective view of certain separated parts of the inductor.

The inductor disclosed in the drawing is of the same general construction as the inductor disclosed in my above-referred Patent No. 2,201,453. Accordingly, there is provided a substantially U-shaped support 10 of any suitable insulating material which carries a variable inductor 12. The support 10 is rotatably mounted between metallic end plates 14a and 14b which

may be held in spaced relation by any suitable means, such as cross bars (not shown). More particularly, the support 10 carries at one end a disc 16 which provides one race 18 of a ball bearing 20 whose other race 22 is provided by the adjacent end plate 14a. The other end of the support 10 is provided with a shank 24 which is journaled in an opening 25 in the other end plate 14b. The shank 24 is provided with a central depression 26 in which is retained by a strip 27 a steel ball 28 that acts as a thrust bearing. The disc 16 is provided with a shank 30 which projects through an opening 31 in the end plate 14a and carries a knob (not shown) with which to rotate the support 10 about the axis $x-x$ (Fig. 1).

The inductor 12 consists of a rotor 32 and a stator 34. The rotor 32 comprises a ferro-magnetic shell 36 and a coil 37 which is carried by said shell through intermediation of a spacer or liner 38 of any suitable insulating material. The stator 34 comprises a ferro-magnetic core 39 and a coil 40 which is carried by said core through intermediation of a spacer or liner 41 of any suitable insulating material. More particularly, the rotor shell 36 consists of two separate halves or members 36a and 36b of which the member 36b is located in a correspondingly shaped recess 45 in the yoke 47 of the support 10. The shell members 36a and 36b are secured to each other as well as to the support 10 by means of a plurality of bolts 46 and nuts 49 in the manner shown in Fig. 1. The shell members 36a and 36b are provided with cavities (Figs. 1 and 3) which complement each other to form the spherical cavity 48 that has its center located on the axis of rotation of the support 10. The spherical cavity 48 is furthermore provided with a wide annular groove 50 in which the insulating liner 38 reposes in the manner shown in Fig. 1. The liner 38 is also preferably formed of two complementary halves 38a and 38b (Fig. 3). The rotor coil 37 is preferably made of two separate, space-wound coil parts 37a and 37b (Fig. 3) which are mounted in the liner halves 38a and 38b, respectively, in any suitable manner, such as by cementing. These coil parts are then connected in series by connecting their adjacent leads 54 in the manner indicated in Fig. 3. The opposite leads 56 of the rotor coil 37 are passed to the outside of the rotor shell 36 through suitable holes 58 in the latter.

Mounted for rotation about the axis $x-x$ (Fig. 1) in complementary bearing surfaces 60 and 62 of the liner halves 38a and 38b, respectively, are

axially aligned metallic stubs 64 which project from the stator 34. More particularly, these stubs 64 are mounted in one of two parts of which the stator liner 41 is composed and which are slipped over the ferro-magnetic core 39 and preferably cemented together at their abutting surfaces. The stator coil 40 is preferably made of two separate, space-wound coil parts 40a and 40b which are suitably secured, as by cementing, to the liner 41. These coil parts are then connected in series by connecting their adjacent leads 68 in the manner indicated in Fig. 1.

Mounted on the opposite ends of the metallic, and hence conductive, journal stubs 64 of the stator 34 are non-inductively wound, flexible spiral connectors 70 and 72 of the type disclosed in my prior Patent No. 2,097,642, issued November 2, 1937. As best shown in Fig. 1, the opposite ends 74 of the stator coil 40 are connected with the spiral connectors 70 and 72 by way of conductors 76 in narrow grooves 78 in the stator liner 41, metallic screws 77 which hold the stubs 64 in said liner, and the stubs 64 themselves. Likewise, the opposite leads 56 of the rotor coil 37 are connected with the spiral connectors 70 and 72. More particularly, one of these leads 56 is connected with the spiral connector 70 through intermediation of a conductor 78, while the other lead is connected with the spiral connector 72 by way of one of the metallic bolts 46 and suitable conductors 80 and 82. Hence, the rotor coil 37 and the stator coil 40 are connected in parallel across the spiral connectors 70 and 72. It is to be understood, however, that these coils 37 and 40 may be connected in series with each other if desired.

To prevent rotation of the stator 34, metallic rods 88 and 90 are secured to the stubs 64 and passed through holes 92 in a cross bar 94 of any suitable insulating material which is secured to the opposite end plates 14a and 14b in any suitable manner, as by screws 96. Thus, the stator 34 will remain stationary and the support 10 as well as the rotor 32 thereon may be rotated relative to the stator. The metallic rods 88 and 90 may be conveniently used as terminals for connecting the inductor in an electrical circuit.

The stator core 39 and the shell members 36a and 36b are preferably molded under pressure from finely divided iron particles and a suitable binder. The ferro-magnetic stator core 39 and the ferro-magnetic rotor shell 36 form together a magnetic path which is closed except for the narrow and substantially spherical gap between them. Hence, a maximum flux linkage between the relatively rotatable coils 37 and 40 is attained when the latter are in the position of maximum coupling. The result thereof for this position of the coils is a high maximum inductance for the inductor. However, when the coils 37 and 40 are in the position of maximum opposition and minimum inductance, the ferro-magnetic stator core and the ferro-magnetic rotor shell are substantially without effect upon the inductance. By reason of the foregoing, the inductance ratio of the present inductor is unusually large. Test inductors as herein described have been built to obtain an inductance ratio of 16 to 1.

In spacing the inductively related coils 37 and 40 from their respective ferro-magnetic supports 36 and 39 by interposing the spacers or liners 38 and 41 between them, the capacity between these coils and their ferro-magnetic

supports is greatly reduced, whereby the thickness of the insulating spacers is so selected as to effect the optimum compromise between a high "Q" and a large inductive range.

A tuning condenser may be combined into one unit with the present inductor in the manner disclosed in my prior Patent No. 2,066,944, issued January 5, 1937, in which case the support 10 is provided with spaced lugs 100 for supporting cross bars 102 on which the rotor plates 104 of the condenser are stacked in the manner shown in Fig. 2.

I claim:

1. A variable inductor comprising, in combination, two relatively rotatable ferro-magnetic members spaced from each other by a gap in any angular relative position of said members; conductively connected and inductively related coils in said gap; and means mounting said coils on said members, respectively, in spaced relation therefrom so that said coils are closer to each other than to their respective members, thereby considerably increasing the figure of merit of the inductor.

2. A variable inductor comprising, in combination, two relatively rotatable ferro-magnetic members of which one is substantially enclosed within the other and spaced therefrom by a gap in any angular relative position of said members; conductively connected and inductively related coils in said gap; and means mounting said coils on said members, respectively, in spaced relation therefrom so that said coils are closer to each other than to their respective members, thereby considerably increasing the figure of merit of the inductor.

3. A variable inductor comprising, in combination, two relatively rotatable ferro-magnetic members of which one is substantially enclosed within the other and spaced therefrom by a gap in any angular relative position of said members; insulating liners in said gap mounted on the adjacent surfaces, respectively, of said members; and conductively connected and inductively related coils in said gap mounted on said liners, respectively, said liners being of such thickness as to space said coils farther from their respective members than from each other, thereby considerably increasing the figure of merit of the inductor.

4. A variable inductor comprising, in combination, two relatively rotatable ferro-magnetic members of which one is substantially enclosed within the other and spaced therefrom by a gap; insulating liners in said gap mounted on the adjacent surfaces, respectively, of said members and spaced from each other by a spherical gap of uniform width in any relative angular position of said members; and conductively connected and inductively related, spherical coils in said spherical gap mounted on said liners, respectively, said liners being of such thickness as to space said coils farther from their respective members than from each other, thereby considerably increasing the figure of merit of the inductor.

5. A variable inductor comprising, in combination, a ferro-magnetic shell member; a ferro-magnetic core member in said shell member; insulating liners on the adjacent surfaces, respectively, of said members; coils mounted on said liners, respectively, in inductive relation with each other; and means for conductively connecting said coils including opposite metallic stubs projecting from said core member to the

outside of said shell member and being journalled in the liner of the latter, the shell member being provided with apertures through which said stubs pass with clearance, and said liners being of such thickness as to space said coils farther from their respective members than from each other, thereby considerably increasing the figure of merit of the inductor.

6. A variable inductor comprising, in combination, a ferro-magnetic shell member; a ferro-magnetic core member in said shell member; insulating liners on the adjacent surfaces, respectively, of said members; coils mounted on said liners, respectively, in inductive relation with

each other; and means for conductively connecting said coils including opposite metallic stubs mounted in the liner of said core member and projecting to the outside of the said shell member, said stubs being journalled in the liner of said shell member and the latter member being provided with apertures through which said stubs pass with clearance, and said liners being of such thickness as to space said coils farther from their respective members than from each other, thereby considerably increasing the figure of merit of the inductor.

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