Dec. 8, 1959 A. DONAVY 2,916,714

ADJUSTABLE INDUCTANCE COILS

Filed Oct. 23, 1956 2 Sheets-Sheet 1

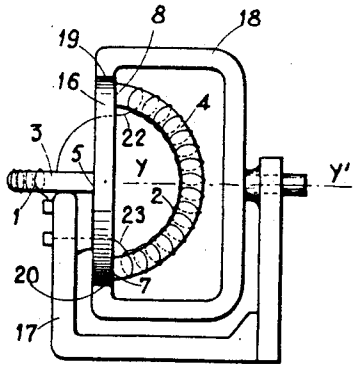


FIG. 1

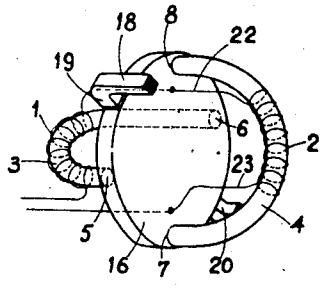


FIG. 2

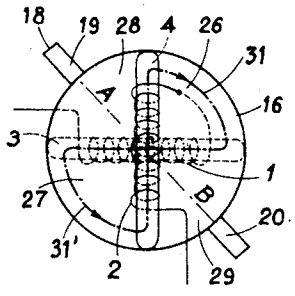


FIG. 3

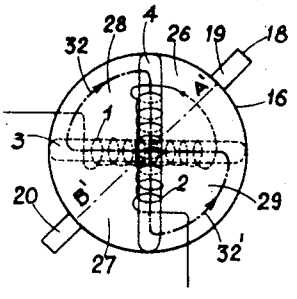


FIG. 4

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Filed Oct. 23, 1956 2 Sheets-Sheet 2

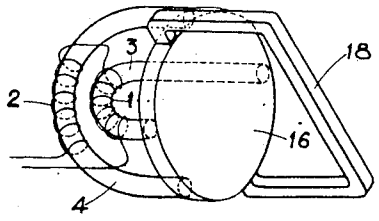


FIG.5

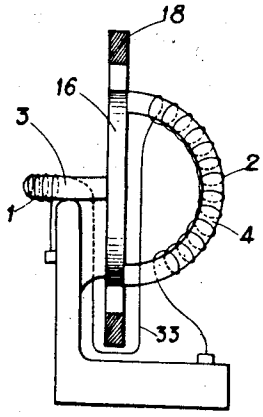


FIG.6

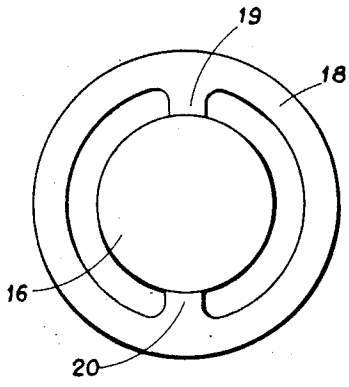


FIG.7

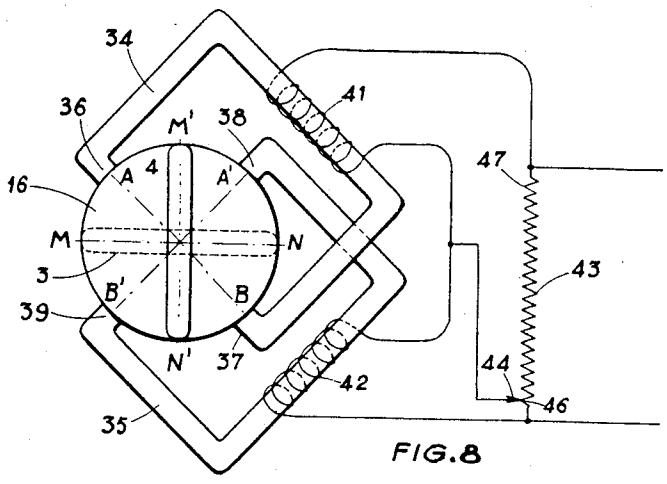


FIG.8

United States Patent Office 2,916,714 Patented Dec. 8, 1959

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ADJUSTABLE INDUCTANCE COILS

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Claims priority, application France November 8, 1955

12 Claims. (Cl. 336—110)

The present invention relates to inductance coils, and more particularly to coils of the type comprising two series-connected windings, wherein the inductance may be varied by modifying the direction of the magnetic flux produced by one of the windings with respect to the direction of the magnetic flux produced by the other winding.

The invention more particularly relates to coils of the type in which the two windings are supported by two U-shaped ferro-magnetic cores arranged in such a manner that the flux produced by each winding passes into the core of the other winding.

In such inductance devices, the two cores are usually rotatable one with respect to the other, in order to provide a varying gap therebetween so as to vary the inductance of the coil.

The construction of such inductance devices is somewhat complex and delicate, sliding contacts being needed for connection of the rotating winding with the outside circuits.

Therefore, it is an object of the invention to provide an inductance device of easy and dependable construction, comprising two series-connected fixed windings and, therefore, free of the above disadvantages.

The inductance device according to the invention comprises a pair of ferro-magnetic cores having their pole pieces secured on a flat piece of ferro-magnetic material, and magnetizing means adapted to produce magnetic saturation of said flat piece along a varying direction thereof.

The variation of the inductance is effected by modifying said direction.

The invention will be better understood from the following description when read in conjunction with the accompanying drawings, in which:

Fig. 1 shows, schematically, a side view of a coil according to the invention;

Fig. 2 is a perspective view of the essential components of the coil represented in Fig. 1 with parts broken off;

Figs. 3 and 4 illustrate the operation of the coil of Figs. 1 and 2;

Fig. 5 is a perspective view illustrating a modified embodiment of the invention;

Fig. 6 is a diagrammatic, partially sectional side view, of another embodiment of the invention;

Fig. 7 is a front view of certain parts of the coil illustrated in Fig. 6; and

Fig. 8 is a diagram illustrating still another embodiment of the invention.

Referring particularly now to Figs. 1 and 2, a coil is shown comprising two series-connected windings **1** and **2**, wound, respectively, on two stationary cores **3** and **4** of ferro-magnetic material. In the non-limitative embodiment described, these two cores **3** and **4** are in the shape of a U with two equal branches, the end faces of which, **5** and **6**, and **7** and **8** respectively, are flat and secured to a disc **16** of ferro-magnetic material, at the respective ends of two diameters of the disc **16** perpendicular to each other, the assembly comprising the cores and the disc being supported by a frame **17**, of non-magnetic material. A permanent magnet **18** is provided, the pole pieces **19** and **20** of which are applied on the periphery of the disc **16**, at two directly opposed points thereof, said magnet being mounted in such a manner as to rotate about the axis YY' of the disc **16**. In order not to interfere with the rotation of the magnet **18**, feeding wires **22** and **23** for the winding **2** are threaded through small holes provided in the disc **16**.

The magnet **18** is adapted to effect saturation of the disc **16**, along a diameter joining the poles **19** and **20** of the magnet **18**. Thus, when the magnet **18** is oriented as shown in Fig. 3, the disc **16** becomes saturated along diameter AB; the flux of the coil then extends over a closed path including sections **26** and **27** of the disc **16**, said sections **26** and **27** having a much higher magnetic permeability than that of the saturated sections **28** and **29**; under these conditions, the magnetic circuit of the coil follows the closed path illustrated by the line **31—31'** and, consequently, the resulting flux of the coil is the sum of the fluxes produced by windings **1** and **2**. When the magnet **18** is oriented as shown in Fig. 4, the disc **16** becomes saturated along diameter A' B'; the flux of the coil, which then passes through the sections **28**, **29** and follows the closed path shown by line **32—32'**, is thus the difference between the fluxes generated by both windings **1** and **2**.

It is thus apparent that the resultant flux in the magnetic circuit of the coil may considerably vary. The range covered by the inductance is thus very wide in the case illustrated; in Fig. 3, wherein the resultant flux is maximum, the value of the inductance is maximum, whereas it is minimum in the case of Fig. 4, where the resultant flux is minimum, and it has an intermediate value if the magnet **18** is in an intermediate position between those shown in Figs. 3 and 4.

In the alternative embodiment of Fig. 5, both cores **3** and **4** are positioned on the same side of the disc **16**, the magnet **18** being placed on the other side. In this embodiment, the continuous rotation of the magnet **18** is possible, without requiring any connecting wire to pass through the disc **16**.

The same result is also obtained in the embodiment illustrated in Figs. 6 and 7. In this case, the cores **3** and **4** are located on opposite sides of the disc **16**, and the magnet **18** has a shape enabling it to be disposed in the plane of the disc **16**. The wire **33** connecting the windings **1** and **2** then passes beyond the periphery of the magnet **18** and does not interfere with the rotation thereof.

In the modified embodiment represented in Fig. 8, instead of a rotating magnet, two stationary electro-magnets **34** and **35** are provided which have their poles applied on the periphery of the disc **16**; the poles **36** and **37** of the first magnet **34** engage the ends of the diameter AB, and the poles **38** and **39** of the second magnet **35** engage the ends of the diameter A' B', perpendicular to AB. Diameters AB and A' B' are, preferably, oriented according to the bissectrices of the angles formed by the diameters MN and M' N' which pass through the junctions of the cores **3** and **4** with the disc **16**. The windings **41** and **42** of the electro-magnets **34** and **35** are fed by direct current supplied through an adjusting device, such as a potentiometer **43**, which enables the intensity of the current to be adjusted in each of said windings. When the sliding contact **44** of the potentiometer **43** is on the end point **46**, the electro-magnet **34** is in a position of maximum energization; the disc **16** is thus saturated along the diameter AB, realizing the conditions described in connection with Fig. 3. When the sliding contact **44** is on the other end point **47**, the electro-magnet **35** is in a position of maximum energization, electro-magnet **35** be-

ing non energized; disc **16** will then be saturated along the direction of diameter A'B', realizing the conditions illustrated in Fig. 4. With the sliding contact **44** at a position intermediate between end points **46** and **47**, a condition intermediate between those shown in Figs. 3 and 4 will be reached, and consequently, the coil will present an inductance intermediate between the maximum value corresponding to the position shown in Fig. 3 and the minimum value corresponding to the position shown in Fig. 4.

It is to be understood that the invention is in no way limited by the embodiments illustrated, and that many modifications may be devised without departing from the scope of the invention.

For instance, the permanent magnet **18** of the embodiment shown in Figs. 1 through 7 may be replaced by an electro-magnet; on the other hand, a ferrite material may be utilized for the cores **3** and **4** and the disc **16**. Air gaps may also be provided in the magnetic circuit of the coil; for instance, a sheet of non-magnetic material may be interposed between the disc **16** and the end faces of the cores.

What I claim is:

1. A variable inductance comprising a pair of ferro-magnetic cores each having two pole pieces; an inductance coil wound on each of said cores; a flat piece of ferro-magnetic material on which said pole pieces are secured in quadrature, said pole pieces being perpendicular to the surface of said flat piece and said cores substantially spanning said flat piece, and magnetizing means for producing magnetic saturation of said flat piece along a variable direction thereof.

2. A variable inductance comprising a pair of ferro-magnetic cores each having two pole pieces; an inductance coil wound on each of said cores; a disc of ferro-magnetic material, on which said pole pieces are secured in quadrature, said pole pieces being perpendicular to said disc and said cores substantially spanning said disc and magnetizing means for producing magnetic saturation of said disc along a diameter thereof, the angular position of which is variable.

3. A variable inductance device according to claim 2, in which said ferro-magnetic cores are U-shaped.

4. A variable inductance device according to claim 2, in which said ferro-magnetic cores are respectively located on the two faces of said disc.

5. A variable inductance device according to claim 2, in which said ferro-magnetic cores are both located on the same face of said disc, in two planes perpendicular to said disc and at right angles one with respect to the other.

6. A variable inductance device comprising a pair of ferro-magnetic cores each having two pole pieces; an inductance coil wound on each of said cores; a disc of ferro-magnetic material on which said pole pieces are secured in quadrature, said cores substantially spanning said disc, and a permanent magnet having its pole pieces in contact with the periphery of said disc at the ends of one diameter thereof, said permanent magnet being rotatable about the axis of said disc.

7. A variable inductance device according to claim 6, in which two coils are respectively wound around said cores and connected to feeding wires passing through apertures provided in said disc.

8. A variable inductance device according to claim 6, in which said permanent magnet is perpendicular to the plane of said disc.

9. A variable indutance device according to claim 6, in which said permanent magnet is located in the plane of said disc, around the periphery thereof.

10. A variable inductor comprising a pair of ferro-magnetic cores each having two pole pieces; an inductance coil wound on each of said cores; a flat disc of ferro-magnetic material on which said pole pieces are secured in quadrature, respectively at the ends of two perpendicular diameters thereof, said pole pieces being perpendicular to the surface of said flat piece and said cores substantially spanning said flat piece; and magnetizing means, comprising a pair of stationary electro-magnets having their pole pieces in contact with the periphery of said flat disc, respectively, at the ends of two perpendicular diameters thereof, for producing magnetic saturation of said flat disc along a variable diameter thereof.

11. A variable inductor according to claim 10, in which said two perpendicular diameters joining the pole pieces of the electro-magnets are oriented according to the bissectrices of said two perpendicular diameters joining the pole pieces of the cores.

12. A variable inductor according to claim 10, in which said electro-magnets comprise adjustable energizing means.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,916,714

December 8, 1959

Alain Donavy

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, lines 42, 44, and 47, and column 4, lines 1, 10, 14, and 17, strike out "device", each occurrence.

Signed and sealed this 24th day of May 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE

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