Nov. 25, 1947. C. WENTWORTH 2,431,438

VARIABLE PERMEABILITY INDUCTANCE DEVICE

Filed Oct. 31, 1942

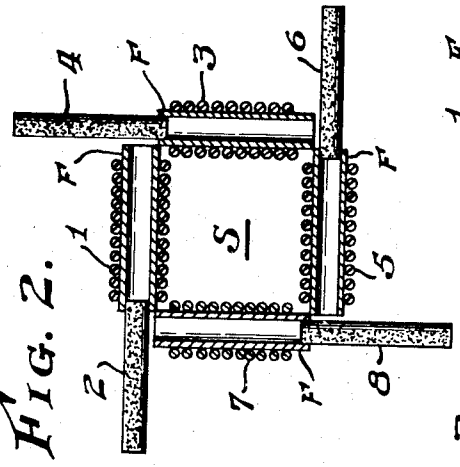


FIG. 2.

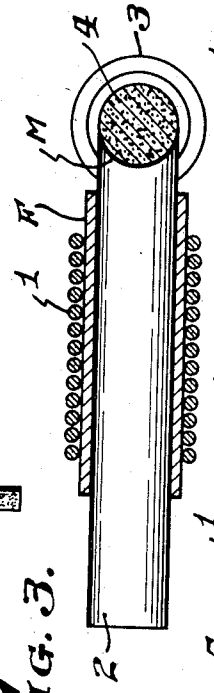


FIG. 3.

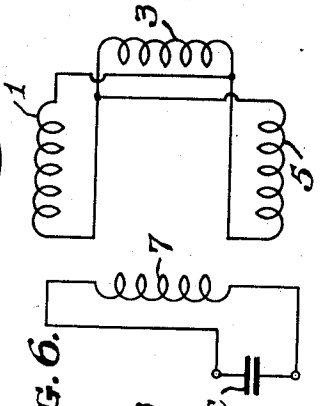


FIG. 6.

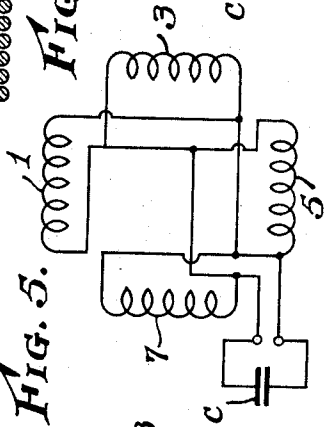


FIG. 5.

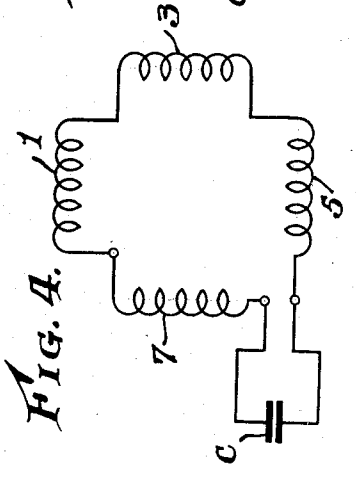


FIG. 4.

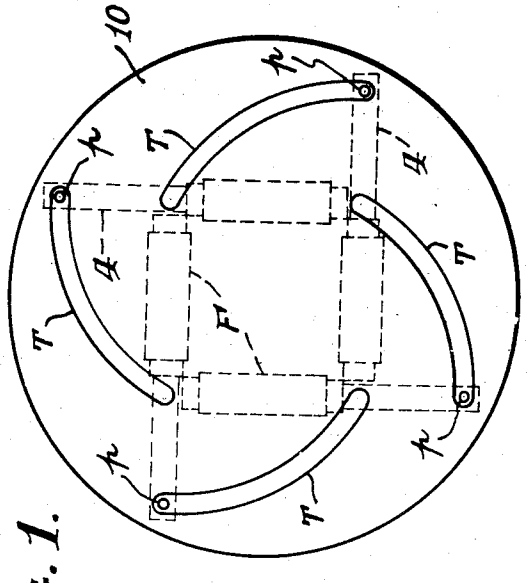


FIG. 1.

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UNITED STATES PATENT OFFICE

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VARIABLE PERMEABILITY INDUCTANCE DEVICE

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Application October 31, 1942, Serial No. 464,003

5 Claims. (Cl. 171—777)

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This invention relates to variable permeability tuning devices for use in radio and analogous systems for the communication of intelligence.

The principal object of the present invention is to provide an inexpensive and compact permeability tuning device and one nevertheless characterized by an extended tuning or inductance variation range.

As brought out in copending application Serial No. 395,938 to Robert L. Harvey, now U. S. Patent No. 2,304,761 theoretically a toroid is the most desirable form of coil since a coil of this shape generates no external field and possesses the highest inductance for a given length. While a true toroidal coil and core cannot be used in a variable permeability tuner (since relative movement of the core and coil would produce no change in inductance) Harvey approximates this ideal form by constructing his coil in the form of a "helical toroid" and provides a magnetic core of helical form which is adapted to be entered into and withdrawn from the core; the core extending slightly more than 360° about its axis of generation whereby the airgap between the ends thereof comprise a path of relatively low reluctance for the magnetic flux of the coil and decreases the distributed capacity thereof. It may be said, generally, that the unique shape of Harvey's magnetic core renders it difficult to mould by mass production methods.

Accordingly, a specific object of the present invention is to provide an improved variable permeability tuner which shall possess substantially all of the advantages of Harvey's helical toroid yet one which utilizes a simplified form of magnetic core and which lends itself readily to inexpensive production methods.

The foregoing and other objects are achieved in accordance with the invention by the provision of a plurality of straight coils and cores arranged to constitute the sides of a square or other polygon and by the provision of means for causing simultaneous relative movement between the cores and coils which are individual thereto. Preferably, the coils and cores are of cylindrical construction and a length substantially no greater than twice their diameter. One end of each core is preferably shaped in the form of a concave meniscus so that when the cores are in their retracted position, each may abut the curved side surface of another core and thus provide a closed path for the magnetic flux.

Certain details of construction together with other objects and advantages will be apparent and the invention itself will be best understood in

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reference to the following specification and to the accompanying drawing wherein:

Figure 1 is a front plan view of a variable permeability inductance device constructed in accordance with the invention and showing a suitable adjusting mechanism therefor,

Figure 2 is a sectional view of the coils and cores of Fig. 1 showing the cores withdrawn from the coils,

Figure 3 is an enlarged fragmentary view of one of the coil and core sections of Fig. 2 and showing two of the cores in abutting relation and

Figures 4, 5 and 6 are circuit diagrams showing various electrical connections for the apparatus of the invention.

In the accompanying drawing wherein like reference characters designate the same or corresponding parts in all figures, four magnetic core inductors comprising coil forms, F, coils 1, 3, 5 and 7 and cores 2, 4, 6 and 8, respectively, are shown arranged, in accordance with the invention, in the form of a polygon, which in the instant case, comprises a square S. This square S is closed, or substantially so, on its inner boundary only, by junction points which lie on the outer surfaces of the cylindrical coil forms F. Thus, the bore of each of these cylinders is unobstructed, thereby permitting the entry therein and the partial withdrawal therefrom of the magnetic cores which are individual thereto. As shown more clearly in Fig. 3, each core is somewhat longer than its form and has its leading end in the shape of a concave meniscus M so that it fits snugly against the cylindrical outer surface of the core which is adjacent thereto when the said cores reach the limit of their inward movement. In one practical embodiment of the invention the coils were 0.5'' long and 0.25'' diameter; the cores were 0.875'' long and approximately 0.25'' diameter. This arrangement covered a tuning range of 3.7 to 1. The tuning range was increased at least 5% when the core ends were of the shape described.

A simple mechanical device for moving all of the cores simultaneously in inductance changing relation with respect to their coils is shown in Fig. 1. Here the driving force is applied simultaneously to the cores 2, 4, 6 and 8 through a pin p adjacent to the trailing ends of each core by means of a face cam 10 having four eccentrically arranged arcuate slots T in which the pins p are seated. The axis of rotation of the cam 10 coincides with the center of the square S, and the slots T are so arranged thereon that when the cam is rotated, the arcuate edges of these slots

bear against the core pins *p* to drive the cores into or out of their coils as determined by the direction in which the said cam is rotated.

The continuously variable permeability inductance device of the present invention lends itself readily to numerous types of circuit connections. Thus, as shown in Fig. 4, the coils 1, 3, 5 and 7 may be connected in series with a fixed or adjustable capacitor C to provide a highly efficient permeability tuner especially suitable for radio broadcast receivers. The parallel connection of the coils shown in Fig. 5 is recommended for short wave tuners. In Fig. 6 three of the coils (1, 3 and 5) are connected in parallel and the fourth coil 7 is coupled thereto and forms, with the condenser C, a tuned circuit in which the tuning response band is spread.

Various modifications of the invention will suggest themselves to those skilled in the art. By way of example: the adjusting mechanism may be designed to move the cores into and out of the coils at different rates, thus any desired function of frequency vs. mechanical movement may be obtained. Also, the same coils may be used for several bands merely by connecting the coils in parallel or in series or by using only part of the coils. The Q may be controlled with frequency to provide a rising Q, decreasing Q or constant Q by using cores of different permeability for each coil.

Various other modifications of the invention will suggest themselves to those skilled in the art. It is to be understood therefore that the foregoing is to be interpreted as illustrative and not in a limiting sense except as required by the prior art and by the spirit of the appended claims.

What is claimed is:

1. A variable permeability inductance device comprising a plurality of coils suitably connected and arranged in the form of a closed polygon each side of which is constituted by one of said coils, a magnetic core individual to each of said coils and adapted to be accommodated therein, and means for causing relative movement between said cores and coils.

2. A variable permeability inductance device comprising a plurality of coils suitably connected and arranged in the form of a closed polygon each side of which is constituted by one of said coils, a magnetic core individual to each of said coils and adapted to be accommodated therein, and means for simultaneously moving said cores with respect to said coils.

3. The invention as set forth in claim 2 and wherein the device comprises four coils which are arranged in the form of a square.

4. A variable permeability inductance device comprising a plurality of discrete coils suitably connected and arranged in the form of a closed polygon each side of which is constituted by one of said coils, a magnetic core slidably adjustable within each of said coils to vary the inductance thereof, and means for effecting the simultaneous adjustment of the several cores.

5. A variable permeability inductance device comprising a plurality of coils arranged end to end so that each forms the side of a polygon to simulate a closed inductance loop, a magnetic core slidably adjustable within each of said coils to vary the inductance thereof, and means for effecting the simultaneous adjustment of the several cores, said adjusting means comprising a member provided with a plurality of cam surfaces, each individually, cooperatively related with one of said cores.

CHANDLER WENTWORTH.

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