Feb. 22, 1955 W. FARBANISH 2,702,860

LOOP ANTENNA

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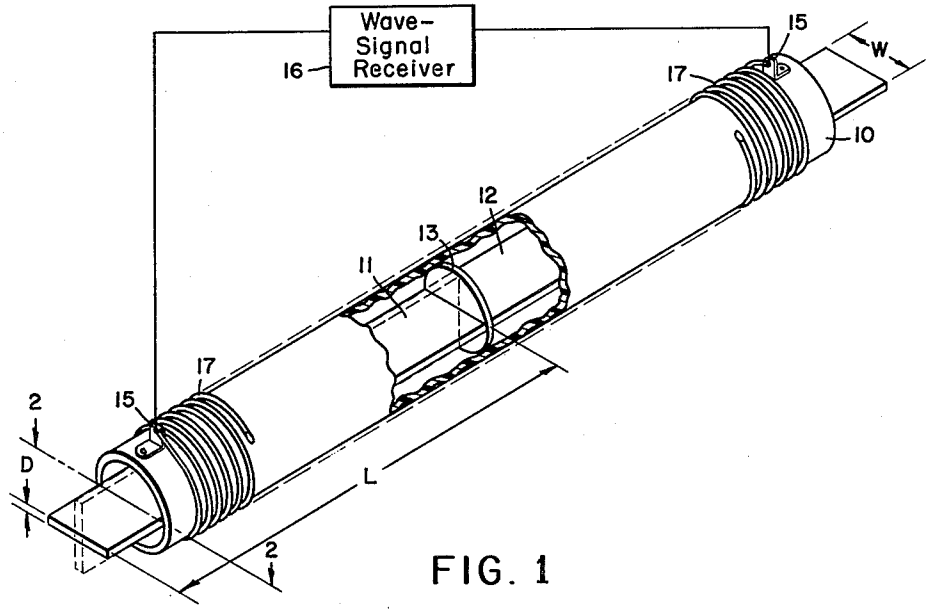


FIG. 1

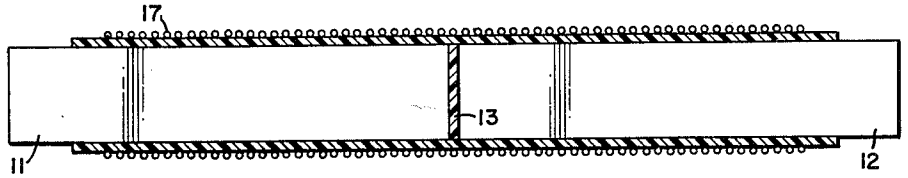


FIG. 2

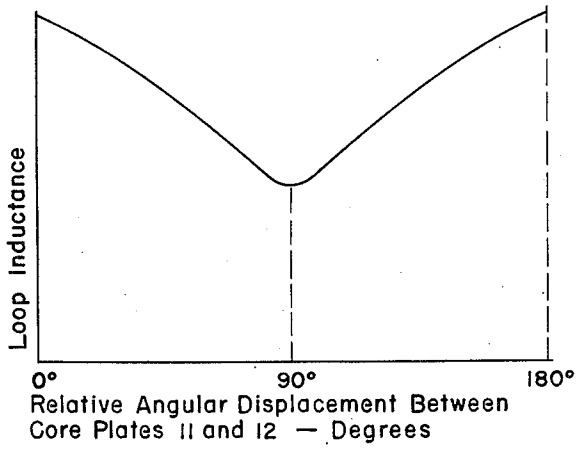


FIG. 3

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LOOP ANTENNA

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4 Claims. (Cl. 250—33.67)

This invention relates to a new and improved loop antenna operable over a range of frequencies; the antenna structure is particularly valuable when employed in an apparatus for receiving signals in the standard broadcast band extending from approximately 540 to 1600 kilocycles, and accordingly will be described in that connection.

It has long been a practice of radio manufacturers to incorporate, within the confines of the cabinet structure, a suitable and effective receiving antenna. The advantages of loop antennas are well known; however, the space requirements of known types of loop antennas have presented a serious design limitation in view of the public demand for reduction in size of certain types of radio receivers. This public demand together with a desire on the part of radio manufacturers to reduce the amount of material required to manufacture an individual receiver has introduced many problems, among which is that of providing a compact yet effective built-in loop antenna. One type of antenna which has found general acceptance consists of a "pancake" type of coil comprising a plurality of concentric turns of conductive wire lying in a common plane cemented to a mounting board of low loss high dielectric material. Another antenna in general use consists of a rod or cylinder of ferromagnetic material and a helical coil comprising a large number of turns of conductive wire wound around the core. The above-referred to antennas have both been used satisfactorily in many receivers. However, these two antennas and generally all antennas of a similar type have the common disadvantage that it is virtually impossible to manufacture coils or loops in mass production to exact specification, and it has therefore been customary practice to trim or tune the loop of each receiver after assembly of the loop with the chassis. In an antenna of the "pancake" type, this adjustment is usually accomplished by hand and is made by increasing or decreasing the number of turns of conductive wire. In the type of antenna comprising a helical coil wound around a ferromagnetic core, adjustment may be made by withdrawing a portion of the core from the field of the coil in a longitudinal direction to effect the desired change in inductance. Thus, the trimming of known types of loop antennas requires either a tedious cut-and-try hand operation to achieve the optimum inductance by progressive removal of fractional portions of wire turns, or the provision of a certain amount of cabinet space required for no other purpose than to permit partial withdrawal of a ferromagnetic core from within the field of the antenna loop.

It is an object of this invention, therefore, to provide a new and improved loop antenna structure which may be encompassed within the cabinet of a wave-signal receiver to occupy a minimum of space.

It is a further object of this invention to provide a new and improved loop antenna structure in which adjustment or trimming of the inductance may be accomplished without the necessity of performing tedious hand operations and without effecting a change in the physical size of the antenna.

It is a corollary object of this invention to provide a loop antenna structure having performance characteristics comparable with those achieved with previously known loop antennas while effecting a material conservation of both space and material.

It is an additional object of this invention to provide a new and improved loop antenna structure which is simple and expedient to construct and convenient and economical to manufacture.

In accordance with the invention, a loop antenna structure operable over a range of frequencies comprises a hollow dielectric coil form and at least two flat core plates. The core plates are each substantially rectangular in cross section and are mounted within the coil form in spaced longitudinal alignment with each other, and at least one of the core plates is rotatable about a self-contained axis with respect to the other core plate. A helical coil comprising a plurality of closely adjacent mutually insulated turns of conductive wire encompasses the coil form and the core plates, whereby the inductance of the antenna may be adjusted by rotating one of the core plates with respect to the other.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood, however, by reference to the following description taken in connection with the accompanying drawing, in the several figures of which like reference numerals indicate like elements, and in which:

Figure 1 is a perspective view of an antenna structure according to the invention;

Figure 2 is a sectional view taken along line 2—2 of Figure 1; and

Figure 3 is a graphical representation of an operating characteristic of the antenna of Figures 1 and 2.

The antenna illustrated in perspective in Figure 1 comprises a hollow coil form **10** of dielectric material, such as Bakelite; the coil form serves as a support for the remainder of the antenna structure. Although coil form **10** is shown as a single continuous dielectric cylinder, it may conform to any suitable cross section. Two core plates **11** and **12**, of flat or rectangular cross section and consisting essentially of a ferromagnetic material, preferably molded or extruded sintered ferrite such as presently manufactured by the Sprague Electric Company and commercially known as "Ferroxcube," are mounted within coil form **10** in longitudinal alignment and are spaced by a dielectric disc **13** which serves as a means of preventing longitudinal abutment of the core plates but may be omitted or replaced by any other means for accomplishing the same purpose. The length L and width W of each of the plates **11** and **12** are substantially greater than its thickness D. One of the core plates is rotatable about a self-contained axis with respect to the other core plate; for example, core plate **12** may be secured by gluing or in any other convenient manner to coil form **10** while core plate **11** is merely inserted in snug but movable engagement with coil form **10** to be rotatable about its own longitudinal axis, or if desired both core plates may be rotatable about respective self-contained axes. In the preferred embodiment core plates **11** and **12** are contained within coil form **10**, and core plate **11** rotates about the common longitudinal axis of coil form **10**. Core plate **11** is shown in dotted outline in a position 90° from horizontal to indicate the degree of adjustment allowed by this structure.

Two connecting lugs **15** are affixed to the coil form and provide means for electrically connecting the antenna to a wave-signal receiver **16** such as a small table model or portable radio receiver, here indicated in block outline. A helical coil **17** encompasses coil form **10** and core plates **11** and **12**, and the terminals of coil **17** are respectively electrically connected to the two lugs **15**. Coil **17** comprises a plurality of closely adjacent mutually insulated turns of conductive wire encompassing coil form **10** and core plates **11** and **12**. This insulated relationship may be achieved by adequately spacing the turns, or preferably by making the coil from an insulation-covered wire of high conductivity.

As seen more clearly in the cross-sectional view of Figure 2, helical coil **17** includes a large number of turns which lie closely adjacent to each other and which are wound in such a manner as to conform substantially to the circumferential surface of coil form **10**. Coil form **10**, as more clearly indicated in this view, has an inside diameter substantially equal in width to the core plates

and a length somewhat shorter than the overall length of the two core plates **11** and **12** and the spacing disc.

As is well known, the use of loop antennas necessitates an individual inductance trimming adjustment to match the input circuits of the receiver with which the antenna is assembled, if optimum receiver operation is to be achieved. In the type of loop antenna which comprises a plurality of concentric turns of conductive wire lying in a common plane, necessary inductive adjustment is accomplished by initially winding the loop to provide an inductance at the maximum end of the manufacturing tolerance range and subsequently, after assembly to the chassis, decreasing the number of turns of wire until the loop inductance is properly matched to the receiver input circuit; this is no mere adjustment but rather a delicate and time consuming cut-and-try manual operation requiring a considerable amount of skill and experience on the part of the operator. In a loop antenna of the type which comprises a ferromagnetic core and a helical coil wound around the core, inductance variation or trimming may be effected by longitudinal movement of the core, but this necessitates the provision of cabinet space for the sole purpose of permitting partial longitudinal withdrawal of the core from the field of the coil.

With a loop antenna constructed in accordance with the invention, adjustment of the loop inductance is achieved by varying the effective permeability of the core. The effective permeability is a direct function of the reluctance of the gap between the two plates and since the permeability of disc **13** is approximately unity, as in all insulations, the reluctance of the gap between the two plates is not affected by the presence of the disc. When the two core plates **11** and **12** are oriented within the coil form in the same plane, spaced only by dielectric insulator **13** as indicated in full outline in Figure 1, the reluctance of the gap between the two core plates is a minimum and therefore the loop inductance is a maximum.

On the other hand, when the plates are oriented at 90° with respect to each other, as shown in dotted outline in Figure 1, the area of the gap is minimum, the reluctance is maximum and the inductance is a minimum. On further rotation of core plate **11**, the inductance increases until, when the plates are in the same plane the inductance again reaches a maximum, since the reluctance of the gap is minimum. This characteristic is graphically portrayed in Figure 3, in which the loop inductance is plotted as a function of the relative angular displacement between the two core plates. In an illustrative embodiment of the invention actually constructed and tested, in which two core plates 4$\frac{9}{16}$ inches long, $\frac{3}{4}$ of an inch wide and .093 of an inch thick were inserted within a coil form and wrapped with 89 turns of 2$\frac{0}{38}$ litz wire, celanese served, producing an initial inductance of 265 micro-henries, a 16% variation in the loop inductance was achieved by varying the relative angular displacement between the core plates through an angle of 90°.

The novel structure achieves a satisfactory solution to a problem existing in prior art by providing a new and improved loop antenna structure in which trimming of the loop inductance may be conveniently accomplished without a change in the physical size of the antenna and without performing delicate and time consuming cut-and-try wire-trimming operations.

While a particular embodiment of the invention has been shown and described modifications may be made and it is intended in the appended claims to cover all such

modifications as may fall within the true spirit and scope of the invention.

I claim:

1. An antenna structure operable over a range of frequencies comprising: a hollow dielectric coil form; at least two flat ferromagnetic core plates, each substantially rectangular in cross section, mounted within said coil form in spaced longitudinal alignment with each other, the length and width of each of said core plates being substantially greater than its thickness and at least one of said core plates being rotatable about a self-contained axis with respect to the other of said core plates; and a helical coil comprising a plurality of closely adjacent mutually insulated turns of conductive wire encompassing said coil form and said core plates, whereby the inductance of said coil may be adjusted by varying the rotational orientation of said core plates with respect to each other.

2. An antenna structure operable over a range of frequencies comprising: a hollow dielectric coil form; at least two flat core plates, each substantially rectangular in cross section and consisting essentially of a ferromagnetic material, mounted within said coil form in spaced longitudinal alignment along a common axis, the length and width of each of said core plates being substantially greater than its thickness and at least one of said core plates being rotatable about said common axis with respect to the other of said core plates; and a helical coil comprising a plurality of closely adjacent mutually insulated turns of conductive wire encompassing said coil form and said core plates, whereby the inductance of said coil may be adjusted by varying the rotational orientation of said core plates with respect to each other.

3. An antenna structure operable over a range of frequencies comprising: a hollow cylindrical coil form; at least two flat core plates, each substantially rectangular in cross section and consisting essentially of a sintered ferrite material, mounted within said coil form in spaced longitudinal alignment along the axis of said cylindrical coil form, the length and width of each of said core plates being substantially greater than its thickness and at least one of said core plates being rotatable about said axis with respect to the other of said core plates; and a helical coil comprising a plurality of closely adjacent mutually insulated turns of conductive wire encompassing said coil form and said core plates, whereby the inductance of said coil may be adjusted by varying the rotational orientation of said core plates with respect to each other.

4. An antenna structure operable over a range of frequencies comprising: a hollow dielectric cylindrical coil form; at least two flat core plates, each substantially rectangular in cross section and consisting essentially of a sintered ferrite material, mounted within said coil form in spaced longitudinal alignment along the axis of said cylindrical coil form, the length and width of each of said core plates being substantially greater than its thickness and at least one of said core plates being rotatable about said axis with respect to the other of said core plates; and a helical coil comprising a plurality of closely adjacent mutually insulated turns of conductive wire continuously engaging the circumferential surface of said coil form and encompassing said core plates, whereby the inductance of said coil may be adjusted by varying the rotational orientation of said core plates with respect to each other.

No references cited.