May 7, 1968 J. A. MAASS 3,382,472

RELATIVELY MOVABLE COILS IN SLOTTED CORES

Filed July 6, 1966

FIG. 1

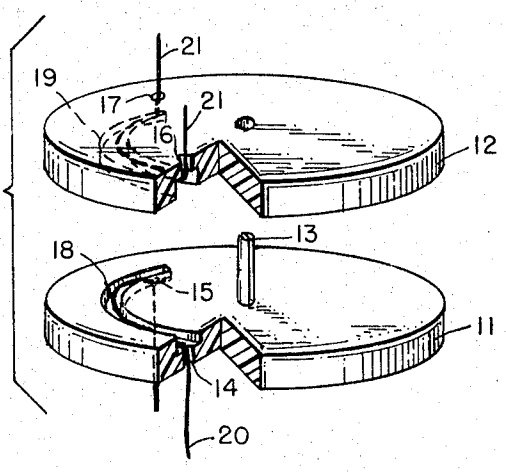


FIG. 2

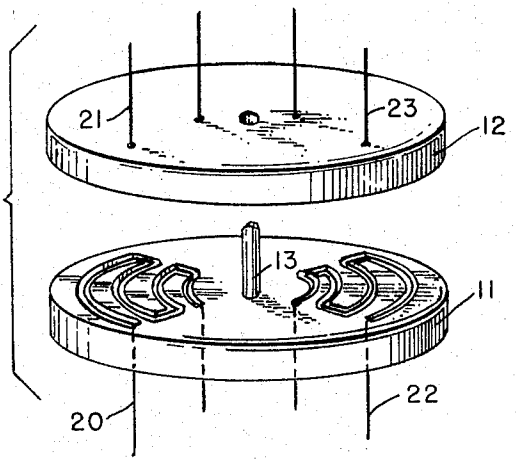
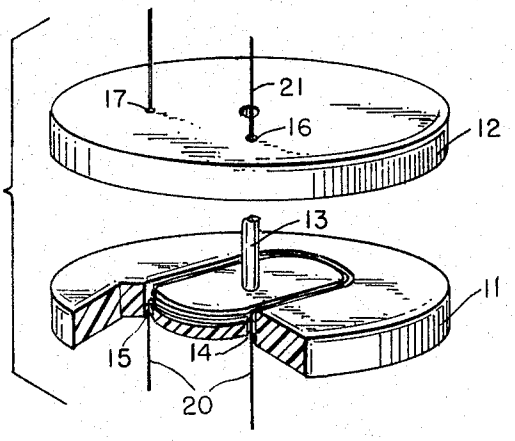


FIG. 3



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RELATIVELY MOVABLE COILS IN SLOTTED CORES

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ABSTRACT OF THE DISCLOSURE

A transformer with an inductive coupling coefficient that is adjustable over a wide range having two ferromagnetic bases with each base having a surface with the slot and a wire disposed in each slot. The surfaces are held in abutment and rotating the surfaces with respect to each other varies the coupling coefficient between the wires in the slots.

The present invention relates to transformers and more particularly to transformers with an adjustable inductive coupling coefficient.

When the flux field of one inductance coil is linked with the turns of another inductance coil, the coils are considered to be inductively coupled. The effect of the coils on each other is called the mutual inductance. If one of the coils has an inductance L_1, and the other has an inductance L_2, the maximum value of mutual inductance has been theoretically calculated as $\sqrt{L_1L_2}$. In actuality this maximum has not been obtained and, accordingly, it has been useful to describe the ratio of actual mutual inductance, M, of two coils to the theoretical maximum $\sqrt{L_1L_2}$ as the coefficient of coupling, k, which is expressed by the formula

$$k=\frac{M}{\sqrt{L_1L_2}}$$

As the actual mutual inductance increases, the value of the coefficient of coupling approaches 1. In practice, coupling coefficients larger that .33 have not been obtained for mutual inductance with air core transformers or .5 in the case of powered-iron core transformers. Overlapping windings have been used to achieve slightly higher coupling coefficients. The difficulty in obtaining a large coupling coefficient is due to the fact that the coils including those wound on the same coil form, produce flux fields which are not entirely common to the conductors of which the inductance coils are made.

In the past, values of mutual inductance of .5 or slightly higher have been acceptable for most uses. However, the increase in the number and kind of devices employing double tuned filters such as broad band i.f. amplifiers have presented a need for inductive couplings by means of coils with very small inductance values and large adjustable coefficients of coupling. The present invention fulfills this need.

An object of this invention is the provision of an inductive coupling with an adjustable coefficient of coupling.

Another object is to provide an adjustable inductive coupling with a wide range of coupling coefficient values including very high coupling coefficients.

A further object is the provision of a high mutual inductance between elements with small inductive values.

Still another object is to provide a transformer that is easy to construct and adjust.

The exact nature of this invention as well as other objects and advantages thereof will be readily apparent from consideration of the following specification relating to the annexed drawing in which:

FIG. 1 is an exploded view, partly in section, of a preferred embodiment of the invention;

FIG. 2 illustrates an exploded view, of a modification of the invention; and

FIG. 3 shows an exploded view, partly in section, of yet another modification of the invention.

Referring now to the drawings wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 (which illustrates a preferred embodiment) first and second ferromagnetic bases **11**, **12**, illustrated as circular discs, said bases being rotatably mounted on shaft **13** so that they abut each other and can be rotated with respect to each other. Base **11** is provided with a pair of holes **14**, **15**, and base **12** with a correspondingly aligned pair of holes **16**, **17**. Arc shaped recesses or slots **18**, **19**, extend between the ends of the holes on the mutually opposing sides of the bases **11** and **12**, respectively, the slots also being mutually aligned. In base **11**, wire **20** passes through hole **14**, along slot **18** and through hole **15** to form one of the coils in the transformer. The other coil is formed in base **12** by wire **21** which passes through hole **16**, along slot **19** and through hole **17** so as to make the two coils mirror images of each other when directly opposed. In this position practically all of the magnetic field that could be produced by one or both of the wires will be confined in the ferromagnetic material in such a manner that the flux field will be almost completely common to both coils thereby yielding a high mutual inductance. As the bases are rotated with respect to each other the portion of the coils opposing each other, and therefore sharing the same field, decreases thereby decreasing the mutual inductance and coefficient of coupling. If the relative rotation is continued until no portion of the two coils are overlapping, the ferromagnetic material then acts to prevent the two fields from being common thus providing a coefficient of coupling that is substantially zero.

It is apparent that extra turns may be added as necessary and that more than one coil may be mounted on each base. FIG. 2 shows an embodiment wherein wire **20** in base **11** is provided with a plurality of turns and wire **22** is also wound to provide an additional inductance coil. Wires **21** and **23** are shaped on base **12** to provide mirror images of coils made by wires **20** and **22**, respectively, when directly opposed. Additional holes and slots may be provided as necessary.

In some cases it is not possible to wind the necessary plurality of turns as shown in FIG. 2. Another embodiment, providing for more turns in the wire, is shown in FIG. 3. In this embodiment, slots **18** and **19** comprise parallel straight slot sections connected at their ends by arc shaped slot sections whose concave side face each other. A plurality of turns may be wound in slot **18** with a mirror image of the coil (not shown) formed in base **12**. Mutual inductance can be lowered to almost zero by rotating the bases so that the straight portions of slots **18** and **19** are perpendicular to each other. The mutual inductance will be low even though the oppositely disposed coils are not shielded from each other by the bases because of the orthogonally arranged lines of force.

Various modifications may obviously be resorted to by those skilled in the art without departing from the spirit and scope of the invention, as hereinafter defined by the appended claims, as only preferred embodiments thereof have been disclosed.

What is claimed is:

1. A transformer with an adjustable inductive coupling coefficient comprising a first ferromagnetic base including a surface having a slot therein, a first wire disposed in said slot in said first base, a second ferromagnetic base including a surface having a slot therein, a second wire

disposed in said slot in said second base, and means for holding the slotted surfaces of said bases in abutment and for substantially confining said first and second wires in ferromagnetic material, said means including means for allowing movement of said surface and slot of one of said bases relative to said surface and slot of the other of said bases, said slots being positioned such that relative movement of said surfaces varies the alignment and inductive coupling coefficient between said first and second wires.

2. The device as claimed in claim 1 and wherein said first and second bases each include at least two holes therethrough and the ends of the first wire pass through the holes in said first base and the ends of the second wire pass through the holes in said second base.

3. The device as claimed in claim 1 and wherein the slot and wire in said first base is a mirror image of the slot and wire in said second base when directly opposed.

4. The device as claimed in claim 1 and wherein the slots in said first and second bases each have parallel straight portions connected at their ends by arcuate portions.

5. The device as claimed in claim 4 and wherein the first and second wires each comprise a plurality of loops.

6. The device as claimed in claim 5 and wherein the recess and wire in said first base is a mirror image of the recess and wire in said second base when directly opposed.

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