Oct. 27, 1959 H. B. REX 2,910,662

PRINTED TRANSFORMER

Original Filed Feb. 16, 1950

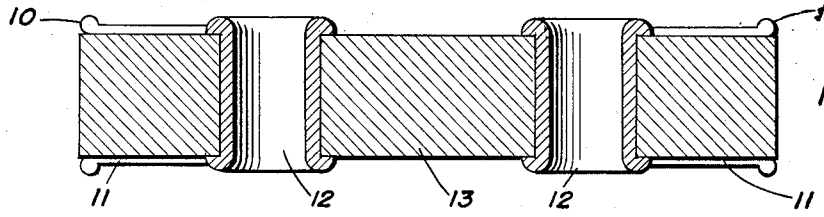


FIG. 2

FIG. 1

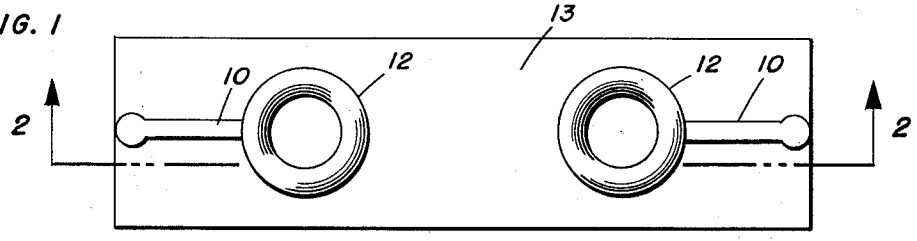
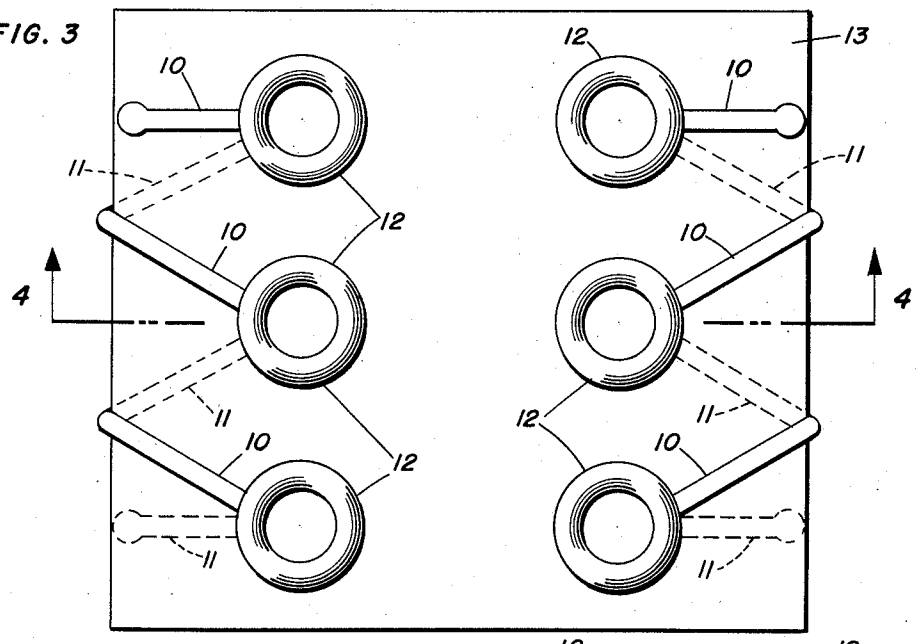


FIG. 3



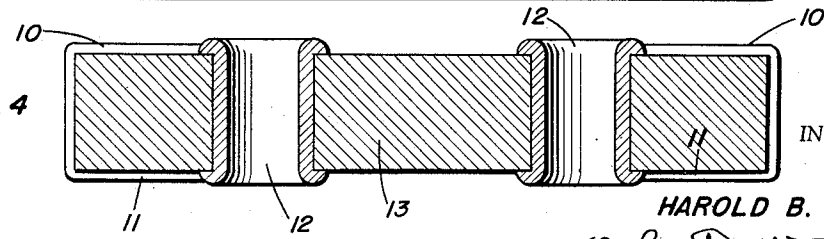


FIG. 4

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PRINTED TRANSFORMER

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Application July 3, 1953, Serial No. 372,209, which is a division of application Serial No. 144,565, February 16, 1950. Divided and this application June 29, 1956, Serial No. 595,025

6 Claims. (Cl. 336—200)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This application is a division of copending application Serial No. 372,209, filed July 3, 1953, now abandoned which, in turn, is a division of application Serial No. 144,565, filed February 16, 1950, now abandoned.

The present invention relates to transformer induction coils, and more particularly to transformer induction coils for printed circuits provided with a magnetic flux permeable core to increase the inductance of the coils.

In general, the present invention contemplates the enhancement of the practicability and versatility of printed electrical circuits by providing improved transformer induction coils therefor. The term printed circuits as used herein refers, generally, to that type of circuit which is described by an electrically conducting medium applied to an electrically insulating base, to form a circuit substantially coplanar with the base, and further refers to such circuits whether formed by a printing, stenciling, tracing, or electrodeposition process, or by laying out electrically conducting material to form a circuit substantially coplanar with the base, or by other means. Induction coils for such circuits are usually constructed by describing spirals or the like of the electrically conducting material upon the electrically insulating base. The present invention is an improvement of induction coils, wherein the mutual inductance between a pair of coils is increased by providing such coils with a common magnetic flux permeable core, such as a ferrite salt.

It is an object of the present invention to provide a transformer for printed circuits having a magnetic flux permeable core for obtaining a high degree of inductive reactance per ampere turn.

Another object of the present invention is to provide a transformer for printed circuits formed on a magnetic flux permeable and electrically nonconducting core for obtaining a high degree of inductive reactance per ampere turn.

It is another object of the present invention to provide a flat printed transformer having a high degree of mutual inductance wherein bulky core structure is avoided.

It is another object of the present invention to provide a printed transformer on a base material which functions as a magnetically permeable core.

Another object of the present invention is to provide a transformer for printed circuits such as mentioned above, wherein the magnetic flux permeable core is formed of a ferrite material.

Other objects and advantages of the present invention will be apparent to those skilled in the art from a consideration of the following detailed description thereof, made in conjunction with the accompanying drawings in which like numerals refer to like or corresponding parts, and wherein:

Fig. 1 discloses a printed transformer embodying the principles of the present invention;

Fig. 2 is a cross section of Fig. 1 taken along a line substantially corresponding to line 2—2 of Fig. 1;

Fig. 3 is a top view of multiturn printed transformer according to the invention;

Fig. 4 is a cross section of Fig. 3 taken along line 4—4 in Fig. 3.

As shown in Figs. 1 and 2, two single loop printed induction coils, each comprising two printed leads **10** and **11** and a conducting rivet **12** through the ferrite plate **13** are formed on the ferrite disk or plate. As is immediately apparent, one of said two loops may function as a transformer primary and the other as a transformer secondary, and the degree of coupling between the two coils is determined by the space therebetween. Each of these two coils may be multiloop coils if so desired as shown in Figs. 3 and 4. In the latter arrangement, a plurality of single loop coils, each formed by a printed lead **10**, a printed lead **11**, and a rivet **12**, are serially joined to form primary and secondary windings.

The plate **13** is preferably formed of a material of high magnetic permeability such, for example, as copper ferrite or a similar ferrite.

Upon the application of a fluctuating current to the induction coil including rivet or rivets **12**, the magnetic flux permeable plate **13** functions to increase the inductive reactance of the induction coil above that which would be obtained in the absence of the ferrite plate **13**.

Thus, the present invention provides for a printed transformer which is extremely simple in construction and yet provides for a high degree of inductive reactance in each coil per ampere turn thereof. The transformer disclosed herein may be employed either in printed circuits or as an element in conventional three dimensional circuits.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An electrical transformer comprising a ferrite plate, an electrically conducting rivet positioned through said plate, and two printed electrically conducting leads described on said plate, each printed on a different surface thereof, electrically connecting with said rivet to complete an electrically conducting loop through said plate, means for connecting a source of current to said leads to produce a field of magnetic flux around said rivet in said ferrite plate, a second electrically conducting rivet positioned through said plate and spaced within the flux field of said first mentioned rivet to establish substantial interlinking of magnetic flux around said rivets in said ferrite plate, and two additional printed electrically conducting leads described on said plate, each printed on a different surface thereof, and each electrically connecting with said second rivet to complete a second electrically conducting loop through said plate, said rivets being located inward from the edges of said ferrite plate to provide a continuous magnetic circuit through said loops between the edges of said plate and said elements.

2. An electrical transformer comprising, a ferrite plate, an electrically conducting element positioned through said plate, and two printed electrically conducting leads described on said plate, each of said leads being printed on a different surface thereof and electrically connecting with said conducting element to complete an electrically conducting loop through said plate, means for connecting a source of current to said leads to form a field of

magnetic flux in said plate around said element, a second electrically conducting element positioned through said plate and spaced within the flux field of said first mentioned conducting element for establishing a predetermined degree of mutual coupling therebetween, and two additional conducting leads described on said plate, each of said additional conducting leads being printed on a different surface thereof and electrically connecting with said second conducting element to complete a second electrically conducting loop through said plate, said elements being located inward from the edges of said plate so that a continuous magnetic circuit is completed through said loops between the edges of said plate and said elements.

3. An electrical transformer comprising a magnetically permeable substantially non-conducting plate, an electrically conducting element positioned through said plate, a first pair of printed electrically conducting leads described on said plate, each of said leads being printed on a different surface thereof and electrically connecting with said conducting element to complete an electrically conducting loop through said plate, means for connecting a source of current to produce a field of magnetic flux around said element in said plate, a second electrically conducting element positioned through said plate and spaced within the flux field of said first mentioned conducting element for establishing considerable interlinking of magnetic flux therebetween, and a second pair of conducting leads described on said plate, each of said second pair of leads being printed on a different surface thereof and electrically connecting with said second conducting element to complete a second electrically conducting loop through said plate, said elements being located inward from the edges of said plate so that a continuous magnetic circuit is completed through said

loops between the edges of said plate and said elements.

4. The combination as recited in claim 3 wherein said first pair of printed leads are codirectional and substantially parallel one to the other, and wherein said second pair of printed leads are codirectional and substantially parallel one to the other.

5. The combination as recited in claim 3 wherein all the said conducting leads describe straight lines.

6. An electrical transformer comprising, a magnetically permeable substantially non-conducting plate, a first group of electrically conducting elements positioned through and around said plate, printed electrical conductors joining said conducting elements in sequence on alternate sides of said plate to form an electrically conducting multiloop coil, means for applying a current to said coil to produce a field of magnetic flux therethrough and therearound, a second group of electrically conducting elements positioned through and around said plate for intersecting said magnetic flux field, and printed electrical conductors joining said second conducting elements in sequence on alternate sides of said plate to form a second electrically conducting multiloop coil for establishing mutual inductive coupling between said coils.

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