March 3, 1964 G. A. SHIFRIN 3,123,787

TOROIDAL TRANSFORMER HAVING A HIGH TURNS RATIO

Filed June 30, 1960

Fig. 1.

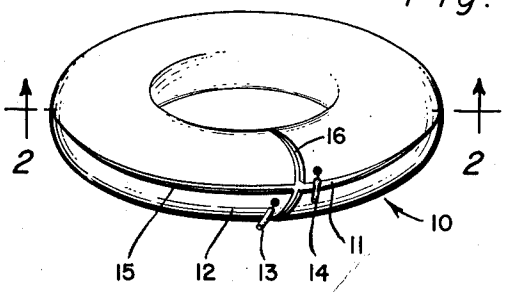



Fig. 4.

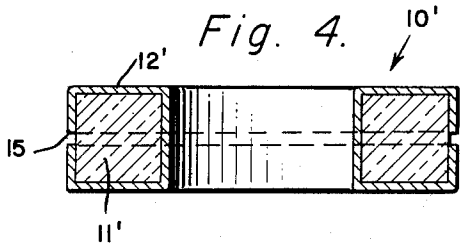
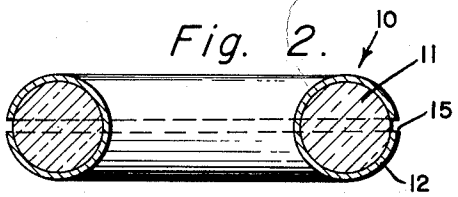



Fig. 2.



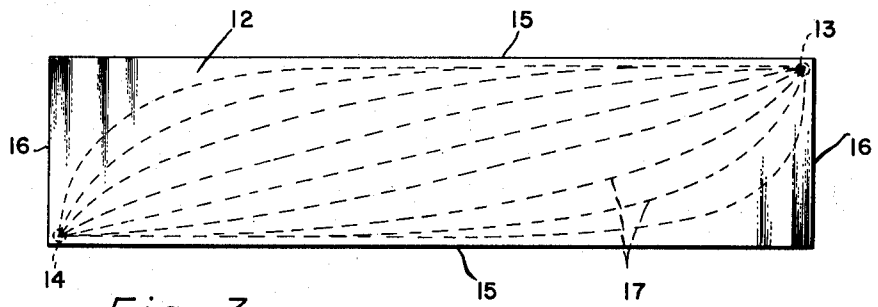




Fig. 3.

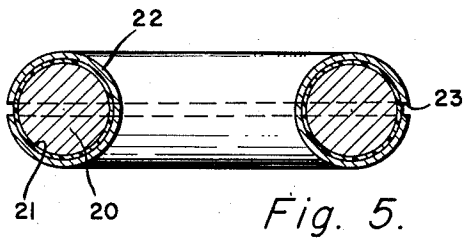
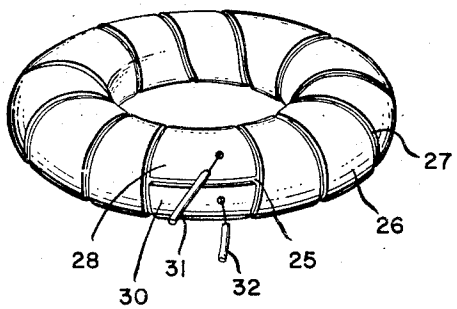



Fig. 6.

Fig. 5.

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United States Patent Office 3,123,787 Patented Mar. 3, 1964



3,123,787

# TOROIDAL TRANSFORMER HAVING A HIGH TURNS RATIO

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Filed June 30, 1960, Ser. No. 40,052
2 Claims. (Cl. 336—229)

The present invention relates generally to a transformer winding construction. The invention finds particular utility in connection with transformers having a high turns ratio.

In constructing transformers with a high turns ratio, considerable difficulty is experienced in providing adequate coupling between primary and secondary windings. For example, transformers employed in a scale reading magnetic head employ a single turn thereon. In such an instance, electrical coupling is a serious problem, inasmuch as it is difficult for a small number of turns uniformly to be effective throughout a core. Additionally, transformers wound about a toroidal core have become relatively small and in the order of .50" in diameter and .080" in height, for example. In manufacturing such small devices and in the use thereof, it is important that low electrical leakage be achieved even though a small number of turns is employed, and that efficiencies be maintained as high as possible. Through use of cores constructed from a ferrite material, some problems in transformers of this type have been eliminated, inasmuch as no insulation is required between the material of the windings and the core. However, electrical coupling problems in such structures are still present.

It is therefore one important object of the present invention to provide an improved transformer winding construction wherein the windings thereon are applied by means of plating techniques.

It is another important object of the invention to provide a composite transformer winding about an annular core and wherein a deposited coating on the core material is selectively removed in specific areas whereby to define one or more windings about the core.

A further object of the invention is to provide a transformer arrangement having a high turns ratio and a high degree of electrical coupling that is substantially uniformly effective throughout a core.

Other and further important objects of the invention will become apparent from the disclosures in the following detailed specification, appended claims and accompanying drawing, wherein:

FIGURE 1 is a perspective view showing a typical transformer arrangement having the present windings deposited thereon;

FIG. 2 is an enlarged sectional view through the core and windings as taken substantially as indicated by line 2—2, FIG. 1;

FIG. 3 is a generally schematic development of a single winding removed from the core material and showing a general current flow pattern distributed thereon;

FIG. 4 is a view similar to FIG. 2 showing the present windings applied to a core of a different configuration;

FIG. 5 is a view also similar to FIG. 2 showing the present winding as applied to a core of conductive material; and

FIG. 6 is a perspective view similar to FIG. 1 showing a multi-turn transformer winding as constructed in accordance with the invention.

With reference to the drawing and with reference primarily to FIG. 1, it is to be noted that a single winding is illustrated. In this instance, the transformer is indicated at 10 and includes a toroidal core 11 of a ferrite material and a deposited winding 12 that is positioned in



intimate contact with the core 11, as will be described in detail hereinafter. The core 11 is generally circular in cross section. A pair of leads 13 and 14 are suitably connected to the winding 12 as by soldering or the like.

As shown in FIGS. 1 and 2, the winding 12 is in the form of a plated film of copper, silver or the like onto the core 11, there being a peripheral perforation or groove 15 and a circumferential groove 16 in the plated film, which serve to define edges of the winding 12. The winding 12 may be of any suitable electrically conductive material, and for most low current applications, is of approximately .001" to .0015" in thickness. The grooves or perforations 15 and 16 may be in the order of .002" to .003" in width, these perforations being as small as possible, commensurate with the voltage to be applied to the winding and such as to eliminate any possibility of arcing between portions of the winding. In constructing the winding of this invention, the toroidal core material is first made conductive through electro-less deposition of material such as copper thereon. Thereafter the coating or plated film may be electroplated thereon in the usual manner. Inasmuch as a ferrite material is used for the core 11, no insulation is required between the core and the winding 12. After disposition of the plated film of conductive material on the core, the grooves or perforations 15 and 16 are produced by acid etching or the like, suitable masks or a coating of an acid resist material being used to confine the etching to the desired areas.

As shown in FIG. 3, the single turn provided by the winding 12 about the core 11, if removed and opened into a flat development, would appear as a rectangle. The connections to the winding are represented at 13 and 14 and correspond to the similarly identified leads. In this illustration, the current flow pattern is represented by the dotted lines 17 and it may be seen that this pattern is well distributed throughout the winding and therefore about the core 11. Accordingly, a high degree of electrical coupling is provided throughout and about the core.

In connection with the manufacture of the present high turns ratio type of transformer windings, it is to be understood that the deposited winding or windings may be applied to the core as by any suitable means and that other means then described, such as evaporation or chemical deposition of the conductive material, may be used without departing from the spirit and scope of the invention.

With reference to FIG. 4, an alternative form of the invention is illustrated wherein like components are indicated by single primed reference numerals. The construction of FIG. 4 is substantially the same as the construction illustrated in FIG. 2, with the exception that the core 11' is square in cross-section rather than circular, as in the form of the invention illustrated in FIGS. 1 and 2. While a core that is circular in cross-section is preferred in most applications, a square or rectangular cross-sectional core may be used also without departing from the spirit and scope of the invention.

A further modification of the invention is illustrated in FIG. 5 wherein a toroidal core 20 is constructed from a conductive material such as iron. In this instance, a layer of an insulating material 21 is disposed about the core 20 with the coating or plated film defining a winding 22 being deposited or plated onto an outer surface of the insulating material 21. In this instance, the deposited or plated material is etched or otherwise suitably removed as at 23 to define the parameters of the winding 22. Known plating or depositing techniques may be used for applying the winding 22 to the outer surface of the insulating material 21.

In FIG. 6, another embodiment of the invention is illustrated wherein a core 25 has a plurality of windings 26 disposed or plated thereon and positioned thereabout as

by the techniques outlined hereinbefore. The parameters of the windings 26 are defined by a helical groove or perforation 27. In this instance, ends of the windings are indicated at 28 and 30 to which suitable leads 31 and 32 are attached as by soldering or the like.

It may thus be seen that a high turns ratio transformer winding is produced in accordance with this invention and that electrical coupling between the windings and the core is maintained at a high level. While the present invention is adapted particularly for those transformer windings wherein a high turns ratio is desired, the invention may also be applied to a multi-turn construction of the type illustrated in FIG. 6. Transformer windings produced in accordance herewith are highly efficient, relatively inexpensive and may be mass produced, unlike wire-wound arrangements that must be individually handled. In instances requiring high voltage, it is apparent that the thickness of the coating or plated film defining the windings and the width of the grooves or perforations may be suitably adjusted to satisfy such requirements.

Having thus described the invention of the present several embodiments thereof, it is desired to emphasize the fact that many further modifications may be resorted to in a manner limited only by a just interpretation of the following claims.

I claim:

1. In a toroidal transformer adapted to have a high turns ratio with optimum coupling between windings, the combination comprising: a toroidal core of ferrite material and having an axis, a single turn electrical winding disposed on said core, said winding being a uniform electrically conductive coating enclosing substantially all surfaces of said toroidal core, said coating having a first slit extending circumferentially and coaxially around said toroidal core, said coating having a second slit extending transversely to said first slit and annularly around said toroidal core in a plane which extends longitudinally through said axis and intersecting said first slit, the intersection of said slits defining four corners of said coating, and a pair of electrical terminal connections made to diagonally opposite corners of said coating to provide a substantially uniform electrical current distribution in said winding and around said core when said winding is energized.



2. In a toroidal transformer adapted to have a high turns ratio with optimum coupling between windings the combination comprising: a toroidal core of conductive material and having an axis, an insulating coating enclosing all surfaces of said toroidal core, a single turn electrical winding disposed on said core, said winding being a uniform electrically conductive coating over said insulating coating and substantially enclosing all surfaces thereof, said conductive coating having a first slit extending circumferentially and coaxially around said toroidal core, said conductive coating having a second slit extending transversely to said first slit and annularly around said toroidal core in a plane which extends longitudinally through said axis and intersecting said first slit, the intersection of said slits defining four corners of said conductive coating, and a pair of electrical terminal connections made to diagonally opposite corners of said conductive coating to provide a substantially uniform electrical current distribution in said winding and around said core when said winding is energized.


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