

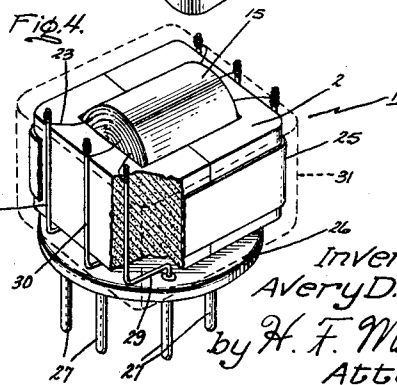
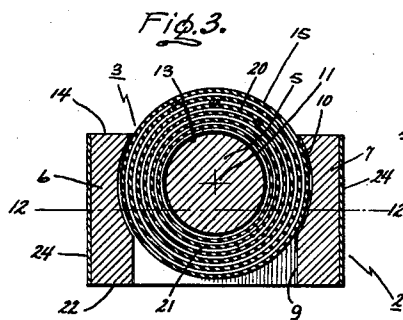
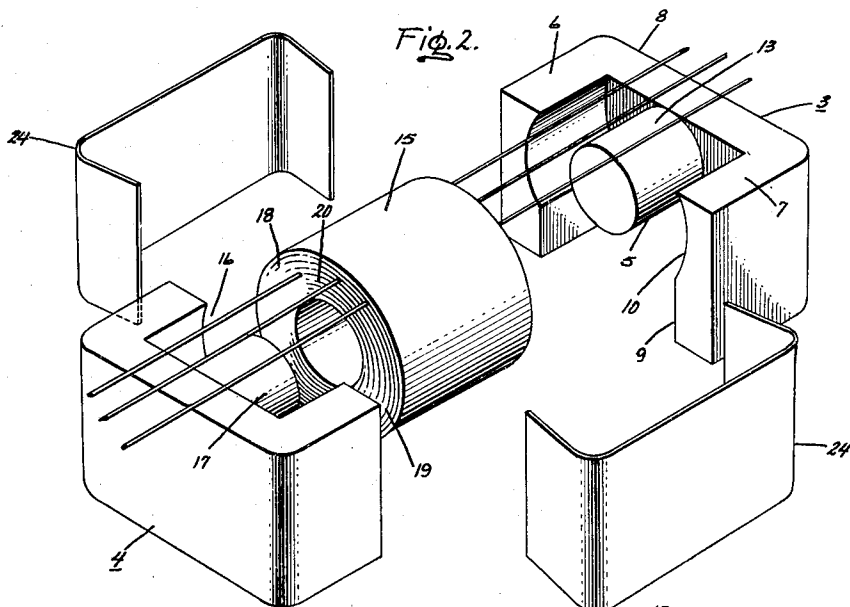
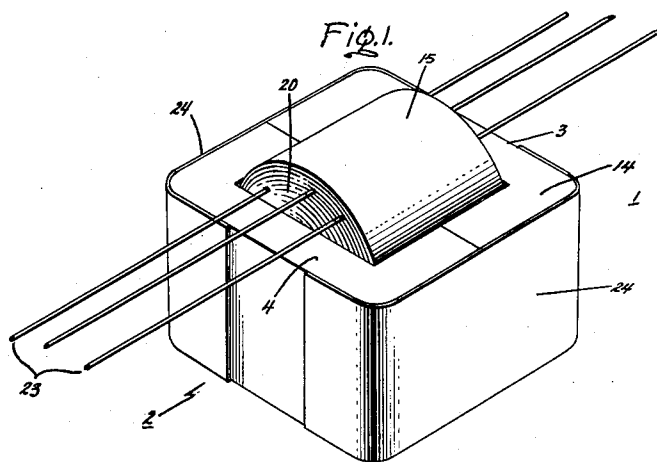
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INDUCTIVE DEVICE

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1

3,007,125

INDUCTIVE DEVICE

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This invention relates to inductive devices, such as transformers and reactors, and more particularly to the core and coil assembly for such devices.

In the design of certain types of transformers and reactors, particularly high frequency and pulse transformers and high frequency reactors employed in electronic circuitry, it is common to employ core members formed of sintered magnetic material. Furthermore, there has been a decided trend toward miniaturization of electronic components, particularly for use in air-borne equipment, and transformer and reactor designs must necessarily follow this trend. In addition, it has been desirable to provide miniature transformers and reactors capable of utilization with printed wiring boards, either by plugging-in analogous to vacuum tubes, or by being directly connected into the printed circuit.

The foregoing design objectives must naturally be accomplished without sacrifice in the electrical and magnetic characteristics of such transformers and reactors. In the particular case of pulse transformers, the leakage inductance and distributed capacitance must be kept to a minimum in order to provide fast rise time, and at the same time, the overall magnetic circuit reluctance must be small in order to provide a low droop characteristic. Prior miniature transformer and reactor designs known to the applicant have been deficient in one or more of the desired characteristics and have further been difficult to manufacture and assemble with accompanying high per unit cost. It is therefore desirable to provide an inductive device, and particularly the core and coil assembly therefor, which is especially suited for miniaturization, the device possessing the desired electrical and magnetic characteristics, readily lending itself to utilization with pin-type terminals, occupying minimum space, and further which is readily assembled and thus involving low per unit cost.

It is therefore an object of my invention to provide an improved core and coil assembly for an inductive device.

Another object of my invention is to provide an improved core and coil assembly for an inductive device, particularly suited for miniaturization.

A further object of my invention is to provide an improved core and coil assembly for an inductive device possessing the desirable features set forth above.

A still further object of my invention is to provide an improved core member for an inductive device.

My invention, in its broader aspects provides a core and coil assembly for an inductive device comprising a core member formed of magnetic material having a central winding leg portion and a pair of yoke portions joining opposite ends of the winding leg portion. A coil is positioned on the winding leg portion with opposite sides being embraced by the yoke portions, the winding leg portion of the core being offset from the horizontal median plane of the core so that one side of the coil projects substantially farther beyond the adjacent surface of the core than does the opposite coil side from the respective core surface. In the preferred embodiment of my invention, a core member is formed of molded magnetic material with the central winding leg portion having a generally cylindrical configuration. The coil is annular in form and the axial center line of the winding leg portion is offset from the horizontal median plane of the core with one edge being substantially flush with one surface of the core so that one side of the coil projects

2

substantially beyond that surface of the core and the other side extends no farther than the opposite surface of the core; the coil leads are brought out from the projecting side of the coil and extend over the respective surface of the core.

Further objects and advantages of my invention will become apparent by reference to the following description and the accompanying drawing, and the features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawing:

FIG. 1 is a view in perspective showing the assembled core and coil of my invention;

FIG. 2 is an exploded view in perspective further showing my improved core and coil assembly;

FIG. 3 is a cross-sectional view of the improved core and coil assembly of FIGS. 1 and 2; and

FIG. 4 is a view in perspective showing the positioning of my improved core and coil assembly on a pin-type base and its encapsulation in a block of solidified molding material.

Referring now to the drawing, my improved core and coil assembly, generally identified as 1, comprises a core 2 formed of two identical, generally E-shaped sections 3 and 4. The core sections 3 and 4 are preferably formed of sintered magnetic material, such as a manganese-zinc ferrite, this material being molded under compression and then fired as is well known in the art; sintered cores are commercially available and therefore further description of the specific constituents and methods employed in producing such cores is not necessary for an understanding of this invention. It will however be understood that cores molded from powdered iron or a ferrite with a plastic binder would be equally usable in my invention and therefore the term "molded magnetic material" as hereinafter employed is intended to apply to either sintered ferrite cores, or to cores formed of powdered iron molded in a plastic binder.

The center leg 5 of each of the core sections 3 and 4 is generally cylindrical in form, as shown, whereas the outer legs 6 and 7 and the bar portion 8 have a generally rectangular cross section; the inner surfaces 9 of the outer legs 6 and 7 are however formed with axially extending concave cut-out portions 10 curved on a radius swung from the axial center line 11 of the center leg 5, as will be hereinafter more fully described. Furthermore, and with particular reference to FIG. 3, it will be seen that the axial center line 11 of the cylindrical center leg 5 of each core section 3 and 4 is offset from the horizontal median plane of the core 2, as shown by the line 12-12, the upper side 13 of the cylindrical center leg 5 preferably being flush with the upper surface 14 of the core 2, as shown. The identical E-shaped core sections 3 and 4 are arranged with the end surfaces of their legs 5, 6 and 7 in abutting alignment, as shown in FIG. 1, with a suitable annular coil 15 being positioned on the center legs 5 as shown.

It will now be seen that when the core sections 3 and 4 are assembled in abutting relationship with the coil 15 thereon, the cylindrical center legs 5 form the winding leg portion of the core while the outer legs 6 and 7 respectively form the yoke portions joining the ends of the winding leg portion. It will further be seen that the yoke portions formed by the outer legs 6 and 7 of the core sections 3 and 4 respectively define coil-receiving windows 16 and 17 with the opposite sides of the winding leg portion formed by the center legs 5, the opposite sides 18 and 19 of the annular coil 15 being positioned in the windows 16 and 17 and embraced by the yoke portions formed by the outer legs 6 and 7. It will

now further be seen, with particular reference to FIG. 3, that the cut-out portions 10 of the outer legs 6 and 7 of the core sections 3 and 4 conform to and accommodate the sides of the coil 15.

It will now be seen that with the axial center line 11 of the winding leg portion of the core 2 formed by the center legs 5 offset from the horizontal median plane 12, as described above, side 20 of coil 15 projects substantially above the upper surface 14 of core 2 whereas the opposite coil side 21 does not extend beyond the other surface 22 of the core 2; it will be readily seen that the opposite surfaces 14 and 22 of the core 2 are generally parallel as shown. Suitable electrical leads 23 are brought out from the side 20 of coil 15 which projects beyond surface 14 of core 2 and extend over surface 14 as shown. It will be readily understood that coil 15 may include a plurality of primary and secondary windings in the case of a transformer, or may be formed of a single winding in the case of a reactor. The core sections 3 and 4 with the coil 15 assembled thereon may be held in their assembled abutting relation in any suitable manner, as for example by suitable spring clips 24 or by adhesive tape 25 as shown in FIG. 4, or glue.

Referring now to FIG. 4, it will be seen that the core and coil assembly 1 may be positioned on a pin type base 26 having a plurality of suitable pins 27 secured thereto and adapted for insertion in a conventional tube socket; base 26 may be formed of any suitable insulating material, as is well known in the art. Suitable leads 28 are welded to pins 27; it will be seen that the bottom surface 22 of the core 2 rests on portions 29 of suitably insulated leads 28 which are bent at right angles to pins 27 and that portions 30 of leads 28 at right angles to portions 29 are brought up along the sides of the core 2, with the electrical leads 23 from the coil 15 being suitably connected respectively thereto, as by soldering. The entire assembly may then be encased in a block of suitable molded plastic, shown here in dashed lines 31.

It will now be seen that offsetting the winding leg portion of the core 2 formed by the center legs 5 of the core sections 3 and 4 permits the electrical leads 23 of the coil 15 conveniently to be brought out from the side 20 of the coil so that they are readily accessible; cores formed of molded magnetic material commonly occupy a somewhat greater volume than comparable cores formed of a stacked plurality of laminations and therefore, with the winding leg portion of the core centrally located as has been common practice, the coil has been substantially encased by the yoke portions of the core thus making it difficult to bring out the leads. In addition, in instances where it is desirable to mount the core and coil assembly on a small pin base, as shown in FIG. 4, this arrangement permits the bottom surface 22 of the core to rest flatly upon the base thus simplifying the over-all assembly; it will be seen that the core and coil assembly in any event requires a given volume and if it is desired that the core and coil be positioned within a rectangular case or be molded in rectangular form as shown in FIG. 4, arranging the coil 15 so that it is offset and projects beyond only one side of the core requires no additional over all volume while simplifying assembly of the core onto the base 26.

The provision of the cylindrical winding leg portion of the core permits a maximum of core area for a given perimeter, thus reducing the mean length of turn in the coil 15 and in turn permitting the use of a minimum size coil. As indicated heretofore, in the particular case of a pulse transformer, the rise time is a function of the distributed capacitance and leakage inductance of the windings, and thus the smaller the coil, the smaller is the leakage inductance and distributed capacitance. Furthermore, in accordance with my invention, the winding leg portion of the core 2 formed by the center legs 5 of the core portions 3 and 4 has a smaller cross-sectional area than the sum of the cross-sectional areas of the yoke

portions formed by the end legs 6 and 7 of the core sections 3 and 4. As pointed out heretofore, it is desirable that the core have as low a reluctance as possible in order to provide a low droop characteristic. Thus, in accordance with my invention, the cross-sectional area of the winding leg portion is decreased (without however causing it to saturate during normal operating conditions) in order to permit the use of as small a coil as possible, the yoke portions being in turn enlarged in cross-section in order to keep the overall magnetic circuit reluctance low. The reduction in diameter of the coil 15 thus permitted in turn permits the overall height of the final unit to be reduced; height reduction is important in many printed circuit arrangements.

In a typical miniature pulse transformer constructed in accordance with my invention, the core 2 was formed of sintered ferrite material and was approximately .570 inch square and .300 inch high. The center legs 5 of the core sections 3 and 4 had a diameter of .200 inch with the cut-out portions 10 being formed on a radius of .190 inch from the axial center line 11 of the center legs 5. The winding leg portion of the core formed by the two center legs 5 was .325 inch long and the inner surfaces 9 of the outer legs 6 and 7 were spaced apart by .324 inch. The coil 15 assembled on the above described core had a diameter of .360 inch and a length of .300 inch and the entire assembly when molded in block 31 of plastic material was .750 inch square and .650 inch high, exclusive of the pins 27.

It will now be readily seen that I have provided a core and coil assembly for an inductive device, particularly suited for application to miniature transformers and reactors, which is particularly characterized by its simplicity, ease of assembly, and minimum size, all without sacrifice of the desired electrical and magnetic characteristics.

While I have illustrated and described a particular embodiment of my invention, further modifications and improvements will occur to those skilled in the art and I desire that it be understood therefore that this invention is not limited to the particular form shown and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A core and coil assembly for an inductive device comprising: a core member formed of magnetic material having a central winding leg portion, and a pair of yoke portions joining opposite end of said winding leg portion and respectively defining coil receiving windows with opposite sides thereof; and a coil positioned on said winding leg portion with opposite sides thereof respectively in said windows and embraced by said yoke portions; said winding leg portion being offset from the horizontal median plane of said core so that one side of said coil projects substantially farther beyond the adjacent surface of said core than does the opposite coil side from the respective core surface and so that the opposite coil side is substantially encased by said yoke portions.

2. A core and coil assembly for an inductive device comprising: a core member formed of magnetic material having a substantially cylindrical central winding leg portion, and a pair of yoke portions joining opposite ends of said winding leg portion and respectively defining coil receiving windows with opposite sides thereof; and a substantially annular coil positioned on said winding leg portion with opposite sides thereof respectively in said windows and embraced by said yoke portions; said winding leg portion having its axial center line offset from the horizontal median plane of said core so that one side of said coil projects substantially beyond the axially extending surface of said core adjacent thereto and so that the opposite coil side is substantially encased by said yoke portions, said axially extending sur-

5

face adjacent said opposite coil side providing a base for the core and coil assembly.

3. A core and coil assembly for an inductive device comprising: a core member formed of molded magnetic material having parallel opposite surfaces, a substantially cylindrical winding leg portion, and a pair of yoke portions joining opposite ends of said winding leg portion and respectively defining coil receiving windows with opposite sides thereof; said yoke portions respectively having a generally rectangular cross-section; and a substantially annular coil positioned on said winding leg portion with opposite sides thereof respectively in said windows and embraced by said yoke portion; said winding leg portion having its axial center line offset from the horizontal median plane of said core so that one side of said coil projects substantially beyond said axially extending surface of said core adjacent to said coil side and so that the opposite coil side is substantially encased by said yoke portions, said opposite axially extending surface of said core providing a base for the core and coil assembly; the inner surface of the side of each of said yoke portions having an axially extending concave cut-out portion conforming to and accommodating the respective coil side.

4. A core and coil assembly for an inductive device comprising: a core member formed of molded magnetic material having parallel opposite surfaces, a substantially cylindrical winding leg portion, and a pair of yoke portions joining opposite ends of said winding leg portion and respectively defining coil receiving windows with opposite sides thereof; and a substantially annular coil positioned on said winding leg portion with opposite sides thereof respectively in said windows and embraced by said yoke portions; said winding leg portion having its axial center line offset from the horizontal median plane of said core so that one side of said coil projects beyond the axially extending surface of said core adjacent thereto and the opposite coil side is substantially encased by said yoke portion, the opposite axially extending surface adjacent to said opposite coil side providing a base for mounting the core and coil assembly; said coil having a plurality of leads brought out from said one side and extending over said adjacent axially extending surface of said core.

5. A core and coil assembly for an inductive device comprising: a core member having two identical generally E-shaped sections formed of molded magnetic material and having parallel opposite surfaces, said sections being arranged with the ends of their legs respectively in abut-

6

ting alignment, the center legs of said sections being generally cylindrical and forming a winding leg portion for said core, the outer legs of said core having a generally rectangular cross-section and forming yoke portions for said core; and a substantially annular coil positioned on said center legs with its opposite sides embraced by said outer legs; said center legs having their axial center lines respectively offset from the median plane of said core so that one side of said coil projects substantially farther beyond one surface of said core than does the opposite coil side from the opposite core surface.

6. A core member for an inductive device formed of molded magnetic material and having parallel axially extending surfaces, said member having a generally cylindrical winding leg portion and a pair of yoke portions joining opposite ends of said winding leg portion and defining coil receiving windows with opposite sides thereof, said yoke portions having a generally rectangular cross-section, said winding leg portion having its axial center line offset from the median plane of said core, the inner surface of the side of each of said yoke portions having an axially extending concave cut-out portion arranged to conform to and accommodate the side of a coil on said winding leg member and said offset of said winding leg portion being sufficient so that a coil disposed within said cutout portion will be disposed within one of said axially extending surfaces.

7. A generally E-shaped core member for an inductive device formed of molded magnetic material, the center leg of said core being generally cylindrical and having its axial center line offset from the horizontal median plane of said core, said core member having a pair of parallel axially extending outer surfaces, the inner surface of each of the outer legs being curved on a radius swung from said center line for conforming to and accommodating a coil on said center leg one of said parallel outer surfaces being located in a plane approximately tangent to said cylindrical center leg and the other of said parallel outer surfaces being disposed in a plane located at a perpendicular distance from said center line at least as great as said radius of said inner surface.

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