Oct. 25, 1960 M. O. KALB 2,958,060

INDUCTOR DEVICES

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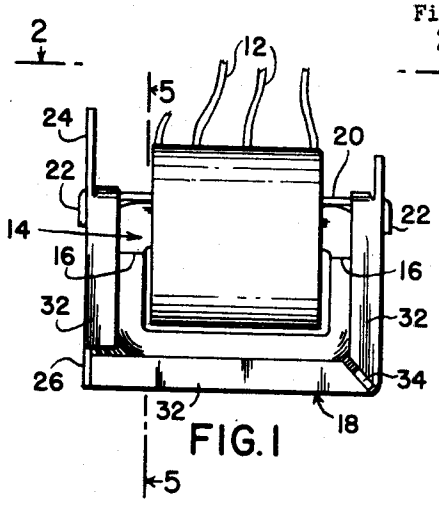


FIG. 1

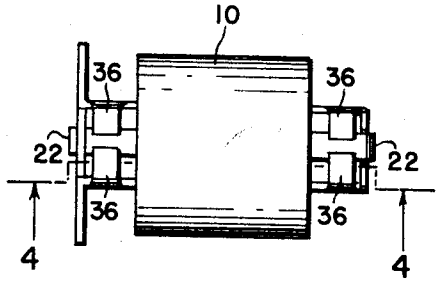


FIG. 2

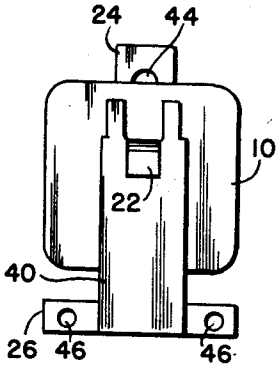


FIG. 3

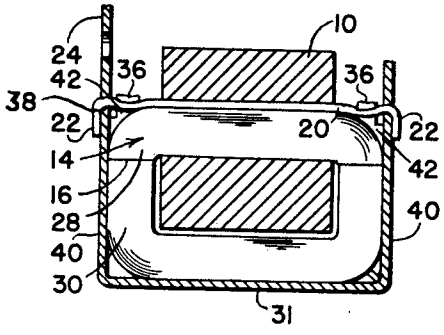


FIG. 4

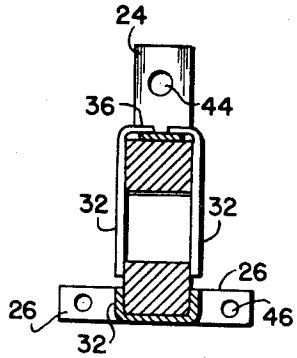


FIG. 5

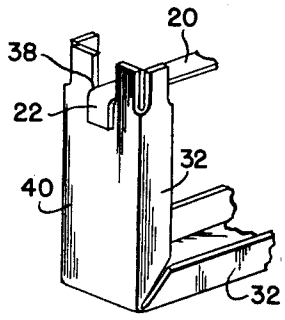


FIG. 6

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INDUCTOR DEVICES

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2 Claims. (Cl. 336—210)

This invention relates to electromagnetic inductor devices and, more particularly, to inductor devices utilizing cores wound from a continuous strip of magnetic material.

Magnetic cores formed of relatively thin, continuous strip magnetic material and wound to form laminated core elements are generally employed for inductors when it is desirable to obtain better magnetic properties than can be obtained when conventional stamped laminations are used. One reason for such improved magnetic properties is the fact that the grain of the iron material comprising the strip is so oriented as to be coincidental with the lines of magnetic flux set up therein.

In practice, the coil windings associated with a continuous type core are wound as separate units to a desired configuration and then mounted on the continuously wound core. Inasmuch as both the core and the coil windings are generally constructed as continuous ring elements, to arrange them in an interlocked relationship requires that the core itself be parted to permit insertion of the coil on one or more legs thereof. The core must then be closed again to establish a minimum residual gap or a selected gap thickness, particularly for applications where D.C. exists in the coil windings.

In the past, one of the methods for processing a wound, continuous strip core has comprised first consolidating the core after winding into a firm, relatively rigid configuration by impregnating the core with epoxy resin or the like and then separating it into two parts each of which generally has a C configuration, in the case where the consolidated core is substantially rectangular in shape. The cut ends of the component parts of the severed core are then ground to a smooth finish, and one of the members, having a core leg about which it is desirable that the coil be positioned, is inserted into a complementary central opening of a previously wound coil. The separated members of the core are then surrounded by a steel band which is first threaded through an opening provided in the coil so that it completely surrounds the core. Clamping pressure is applied to the band with a suitable banding tool so as to properly align the core members and bring the severed ends into juxtaposition.

In another well-known method for assembling a continuously wound core type of inductor, the core, after winding, is cut in one position only, generally adjacent to one corner in the case of a rectangular core. Insertion of the coil is then effected by bending outwardly a leg of the core adjacent to the cut so as to widen the gap therein sufficiently to allow proper insertion of the coil. After placing the coil over a selected leg, the core is bent back into its original arrangement and secured in a relatively rigid position by banding and clamping. Such a method imposes design limitations on the configuration of the core inasmuch as one leg of the core must be relatively long in relation to the core thickness in order that it may be opened up sufficiently to accept the coil. Furthermore, this method has a disadvantage in that,

during the course of the operation of opening and closing of the core, there is a tendency to cold work the annealed laminations which may decrease the permeability of the core and result in higher core losses.

Methods employed for constructing inductors utilizing continuously wound cores and the configurations resulting therefrom, particularly those methods and configurations discussed heretofore, are unsuited to economical production techniques in that the banding operation does not lend itself readily to automatic machine operations.

It is therefore an object of the invention to provide a method for assembling an inductor device having a core formed from continuously wound magnetic strip material which is adaptable to automatic assembly techniques.

It is a further object of the invention to provide a method and means for securing precise alignment of a continuously wound magnetic core of an inductor device after the coil has been affixed thereon, which means are readily adaptable to automatic assembly techniques.

It is yet another object of the invention to provide a combined clamping and mounting means for a magnetic core, said means providing a high degree of control of the clamping pressure applied to the core members.

For a better understanding of the invention, together with other and further objects thereof, reference is made to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a side elevation of an inductor embodying the principles of the invention.

Fig. 2 is a top plan view of the inductor of Fig. 1.

Fig. 3 is an end elevation of the inductor of Fig. 1.

Fig. 4 is a sectional side elevation taken on the line 4—4 of Fig. 2.

Fig. 5 is a sectional side elevation taken on the line 5—5 of Fig. 1.

Fig. 6 is a fragmentary perspective view of a portion of the inductor frame showing a step in the process of assembling the inductor of the present invention.

Referring now to the drawings, in Fig. 1 a completely assembled inductor is shown in general outline. The inductor has a coil 10 which may comprise a plurality of windings arranged in any suitable manner, such as concentrically or in juxtaposition with one another, and may be impregnated or covered with a suitable insulating material. The windings may be connected and arranged to provide a transformer, reactor, or any other type of conductor as may be desired. Connections may be made to coil windings 10 by means of terminal leads 12. Windings 10 are disposed about a continuously wound magnetic core 14 which is preferably formed by winding a continuous strip of magnetic core material having suitable dimensions into a desired configuration which, for purposes of illustration, is shown in the drawings as being substantially rectangular. As will be described in more detail hereinafter, the core 14 is severed along the line 16 so that the windings 10 may be slipped over one leg thereof during the assembly process.

A channel frame 18 encases core 14 about three sides thereof. Frame 18 may be stamped or bent from suitable sheet metal material of sufficient rigidity so that it is adapted to hold an assembled core in lateral alignment. A securing member or strip 20 passes through the central axial opening in winding 10 and is positioned in alignment with one peripheral surface of core 14 by means of ears or tabs 22. Frame 18 also has outwardly extending tabs 24, 26 which serve as brackets for conveniently and securely mounting the inductor unit where desired. Tabs 24, 26 are integral with frame 18 and while these tabs are shown merely for purposes of illustration on only one end of the inductor, it is understood that other tabs may be provided wherever desired on frame 18.

The method of assembly and the novel features of the inductor of the present invention formed by the steps of the method will now be described in more detail.

To assemble an inductor embodying the teachings of the present invention, core **14** is first wound from a suitable magnetic strip material into the desired configuration. Such material may be iron having special permeability or grain characteristics. With proper choice of core material having a preferred grain orientation, winding a core in a continuous fashion allows twenty-five to thirty percent more flux than non-oriented materials to be carried by the core for the same magnetizing force. Such a continuously wound core is generally rectangular in shape and is annealed after winding so that it will maintain a stable configuration.

Since the rectangular core must be severed to allow placement of the coil **10** thereon, the core is first impregnated with a suitable binding material, such as an epoxy resin, which fills the interstices between the windings and serves to consolidate them into a desired shape. The core is then cut at two places **16** lying in a common plane so as to divide it into two members having an I and a C shape **28**, **30** respectively (Fig. 4). The surface areas exposed by cuts **16** are preferably ground to a high degree of smoothness in order to insure close contact with each other when the core is again closed upon itself, so as to minimize air gap reluctance across the cut. However, it is understood that in some applications an air gap of specified thickness may be desired. In such case, a suitable spacer may be inserted between the surfaces represented by cuts **16**. Cuts **16** are preferably made as close as practical to two of the inner corners or fillets of core **14** so as to facilitate insertion of I-piece **28** in coil **10**. By cutting core **14** in the manner described, automatic assembly by suitable machines is facilitated since the mounting of coil **10** on core **14** requires only one simple linear motion of the I-piece **28** through the central axial opening of the coil **10**. Precise alignment in effecting this assembly operation is, therefore, not required since the curved outer contour of I-piece **28** at the corners acts as a lead-in or guide which assists in insertion of the I-piece.

To assemble the coil **10** and core **14** in frame **18**, the C-piece **30** may be inserted first in the channel frame, generally indicated as **18**, until the external longitudinal surface of C-piece **30** abuts the floor **31** of frame **18**. Frame **18** has a plurality of side flaps **32** attached to sides **40** and extending inwardly which serve to form the walls of the channel frame **18**. Flaps **32** have their ends suitably cut, such as ends **34**, so as to allow forming of the frame into a rectangular configuration without overlap. The open ends of frame **18** have tabs **36** integrally formed thereon which, during the assembly steps, are in an upwardly extending position, in order to allow core **14** to pass freely into its nesting position within frame **18**. After C-piece **30** has been positioned in frame **18**, I-piece **28** with associated coil **10** is next inserted within the frame. Binding strip **20** is then inserted through the central aperture of coil **10** and allowed to pass through slots **38** in each side **40** of frame **18** (Fig. 6). It will be noted that since the motion of binding strip **20** during the insertion operation is also a simple linear one, the insertion operation is easily adaptable to automatic machine assembly operations. The tabs **22** of strip **20** are then bent downwardly and tightly against the sides **40** of frame **18**, thus serving to apply a compressive force to frame **18** and bind it securely in position about the core **14**.

Upstanding tabs **22** on frame **18** are next pressed inwardly and tightly against strip **20** with sufficient force to cause the strip directly beneath tabs **36** to deflect into the spaces **42**, formed by the corners of the core **14** and sides **40** of frame **18**. This deflection of strip **20** serves to draw the sides **40** of frame **18** more tightly together but also allows freedom from close manufacturing tolerances for the component elements of the inductor. This insures tightness of assembly even though there may be some inaccuracy in the assembly operation. Accordingly, it will be seen that precise alignment of all of the component parts which form the inductor is not necessary to provide a tight and secure fit.

In the inductor shown in the drawings, frame **18** is provided with an upwardly extending tab or ear **24** having an aperture **44** therein for mounting purposes, and a pair of outwardly extending wings **26** with apertures **46** therein. Ear **24** and wings **26** provide convenient mounting brackets for mounting the inductor on electrical equipment where desired. It will be noted in the illustrated embodiment that ear **24** has an enclosed slot **38** therein for receiving an end tab **22** of strip **20** whereas slot **38** in the opposite frame wall **40** (Fig. 6) has an open side or mouth in order to facilitate linear insertion of closing strip **20** through coil **10**. However, a slot with an open side may be formed in both walls **40** to receive strip **20** in applications where ear **24** is not needed for mounting purposes.

It will be seen that the present invention provides a novel inductor assembly which is extremely compact and rigid, yet all motions employed in the assembly process are simple and linear in nature and therefore are ideally suited for economical mass production assembly techniques, either by hand or by machine. It will be further noted that, although core **14** shown for purposes of illustration was divided into C-I portions, it is understood that a conventional double-C-member core may be utilized in connection with the novel frame binding feature of the invention or the conventional bent-leg type of continuous core may also be used with the binding frame of the present invention. It will also be noted that the C-I core separating arrangement of the present invention facilitates quick assembly of the component elements of an inductor and is readily adaptable to the wrapped band method of binding.

While the present invention has been disclosed by means of specific illustrative embodiments thereof, it would be obvious to those skilled in the art that various changes and modifications in the means of operation described or in the apparatus, may be made without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. An electromagnetic induction device comprising a substantially closed loop magnetic core having rounded corners, a frame member partially encircling the outer periphery of said core with an open side exposing at least one of said rounded corners, said frame having slots therein near said open side, a closure member comprising a flat, resilient strip having tab portions on each end thereof and extending across the opening of said frame to complete the enclosure of said core, the ends of said closure strip passing laterally through said slots in said frame, said frame having means for preventing outward movement of said closure member away from said core when in assembled relationship, said tab portions being bent into locked contact with the walls of said frame, said closure member having an indented deformation projecting inwardly towards said rounded corner of said core to cause pressure to be exerted against said core and tension applied to said tabs to maintain constant pressure against the sides of said frame.

2. An electromagnetic induction device comprising a substantially closed loop magnetic core having rounded corners, a frame member partially encircling the outer periphery of said core with an open side exposing at least one of said rounded corners, said frame having slots therein near said open side, a closure member comprising a flat, resilient strip having tab portions on each end thereof and extending across the opening of said frame to complete the enclosure of said core, the ends of said

closure strip passing laterally through said slots in said frame, said frame having means for preventing outward movement of said closure member away from said core when in assembled relationship including outwardly extending tabs disposed adjacent said rounded corners and adapted to be bent over said closure member and in contact therewith, said strip tab members being bent into locked contact with the walls of said frame, said closure member being inwardly deformed towards said rounded corner of said core by the bending of said frame tabs thereover, to exert pressure against said core and apply tension to said tabs to maintain constant pressure against the sides of said frame.

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