Dec. 22, 1942. E. E. FRANZ 2,305,686

ELECTROMAGNETIC CORE

Original Filed Dec. 9, 1938

FIG. 1

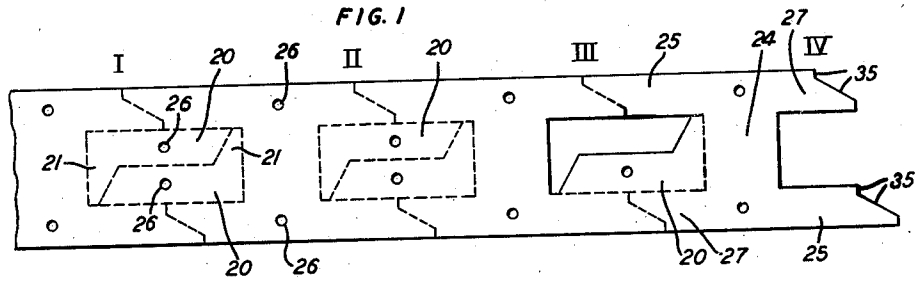


FIG. 2

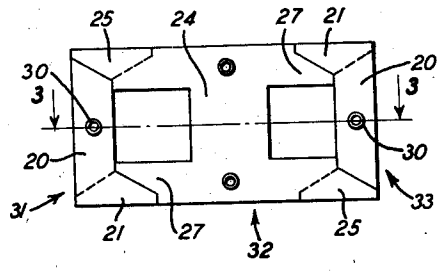


FIG. 4

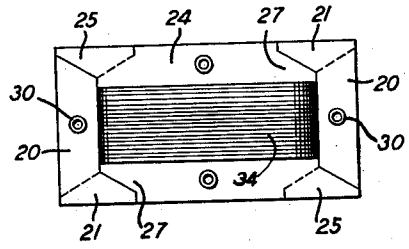
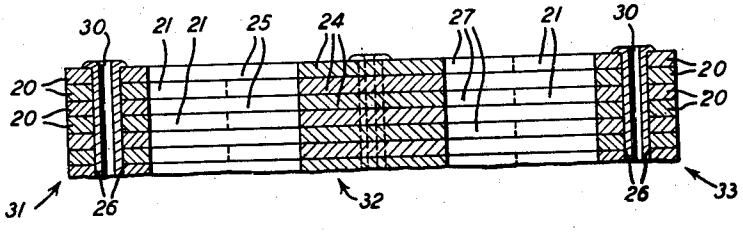


FIG. 3



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ELECTROMAGNETIC CORE

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2 Claims. (Cl. 175—21)

This invention relates to electromagnetic laminated cores assembled from sheet metal elements.

Coils are used in an endless variety of forms and ways in electrical apparatus, and generally speaking fall into two great classes, coreless coils and cored coils in which the windings surround cores of magnetic material. Cored coils very frequently are made with cores built up from assembled laminae of sheet material, in order to diminish energy waste due to eddy currents in the body of the core. Much ingenuity has been expended upon ways of manufacturing such laminated cores in order that the making of the cores and the assembling of the cores and their windings may be as simple, cheap and wasteless as possible. For various reasons difficulties have been encountered. Coils have been produced satisfactorily with cores which are wasteless in production, but with which the winding must be prewound on a spool or other support and then installed bodily upon the assembled or partly assembled core. In such structures space is taken up and wasted so far as the efficiency of the coil is concerned by the spool or support on which the coil is wound. Other laminated core coils have been produced in which the winding of the conductor has been done directly on the assembled or partly assembled core without the need of any special winding spool or frame. However, in many instances the laminae for assembling such cores cannot be produced wastelessly. Furthermore, in cases where the core is assembled in a prewound winding, the mechanical working of the laminar core material when the laminae are clamped or riveted together may seriously damage the magnetic properties of a core made of some of the recent high permeability alloys; and such cores cannot be then annealed to restore the desired properties with the insulated windings in place on them.

An object of the present invention is to provide a coil structure and a laminated core for a coil which shall present a coil having a core and winding combinable substantially without any electrically useless winding spool, frame or the like, in which the laminar core is composed of elements produced from sheet material in which a considerable range of ratio of winding volume to core is possible, which is adaptable equally to such constructions as shell type and core type transformers among others, and in which the core is so constructed that no working of the core material is required after the windings are installed.

With the above and other objects in view, a typical embodiment of the invention may comprise a coil having a core built up of layers, each layer consisting of two equally tall flat pieces punched or otherwise formed from magnetic sheet material, of which pieces each outer one may be L-shaped and the middle piece an H lying on its side and having long arms extending oppositely from opposite ends of its crossbar to abut the armless ends of the two L's and short arms respectively in line with its long arms and on opposite sides of the crossbar to abut the ends of the arms of the two L's.

Other objects and features of the invention will appear from the following detailed description of an embodiment thereof taken in connection with the accompanying drawing in which the same reference numerals are applied to identical parts in the several figures and in which—

Fig. 1 is a diagrammatic view of a strip of magnetic sheet material to show the wasteless production of core lamina parts therefrom;

Fig. 2 is a plan view of a core composed of the laminar parts of Fig. 1;

Fig. 3 is an enlarged sectional view on the line 3—3 of Fig. 2; and

Fig. 4 is a plan view of a coil wound on the core shown in Fig. 2.

Fig. 1 may be thought of as a ribbon of magnetic sheet material from which laminar pieces are to be cut for subsequent assembly into units of an electrical coil core, and on which the pieces are laid out to show how they may be cut from a parallel sided ribbon substantially without scrap or waste. There are two kinds of pieces shown, viz. L-shaped pieces indicated at **20** having arms **21** and H-shaped pieces indicated at **24** having relatively long arms **25** on opposite sides and opposite ends of the crossbar of the H and relatively short arms **27** in line with and opposite to the long arms. The L-shaped pieces have holes **26**, through which assembling rivets **30** are to be passed later. The H-shaped pieces have similar holes **26**.

In cutting the various pieces, of which there are only two kinds, as shown in Fig. 1, a set of four perforations **26** is first punched in the strip or ribbon at an operating station indicated at I. At station II an L-shaped piece **20** is punched out. At station III a second L-shaped piece **20** is punched out, and at station IV the H-shaped piece **24** is cut off.

The two L-shaped pieces are identically alike and interchangeable in assembly. Each is formed and proportioned to have the notched top of its long arm abut and fit accurately into notch **35**

of either long arm 25 of the H-shaped pieces while its short arm extends into and fits the notch 35 of the short arm of the H on the same side.

The two kinds of pieces shown in Fig. 1 having been prepared in sufficient number, are assembled by stacking and riveting into the three units shown in Fig. 2 at 31, 32 and 33, respectively. The unit 31 is a stack of the L-shaped pieces 26, piled with their armless ends in alternation. This stacked unit 31 is substantially smooth on all faces except at the ends of its two arms or extension to the right where the alternation of arms 21 and no arms presents a series of recesses.

The unit 33 is identical in form and structure to the unit 31, except that the alternations are reversed.

The unit 32 is a pile of H-shaped pieces laid with the crossbars in superimposed congruence and the long and short arms extending alternately to the left and right. This stack or unit 32 has all of its surfaces substantially smooth except the four extremities of its arms, which are recessed to correspond on one side to the projections between the recesses of the arms of the unit 31 and on the other to those of the unit 33.

The three stacks having been piled as described independently of each other, may be riveted, respectively, with rivets 30, or otherwise bound to form rigid units.

The material of the core pieces 20 and 24 in some instances will preferably be of silicon steel or of one or another of the high permeability nickel iron alloys known as permalloy. These materials may be given an extremely high permeability, or retentivity, or low hysteresis, or other desirable electromagnetic character by appropriate heat treatment. These materials, however, are extremely sensitive to mechanical working, or even shock, after having been so heat treated; and any slight working, such as that caused by the seating and swedging over of the rivets 38 in the present instance, may seriously impair the particular characteristic of the material.

In employing the present invention therefor, the heat treatment is deferred until the three units 31, 32 and 33 are individually complete as described, i. e. stacked and riveted, since, according to the invention, no further working or straining of the material of the cores need then occur.

To make such a coil as is shown in Fig. 4, it is then only necessary to wind the unit 32 and assemble the three units. The winding space between the arms of the H-shaped unit 32 is completely unobstructed. The winding of the insulated conductor may be done by hand or, preferably, by any suitable winding machine, until the requisite number of turns is in place on the unit 32. The units 31 and 33 are then assembled with the unit 32 to embrace the winding as shown in Fig. 4 and to have the relations to the unit 32 best shown in Figs. 2 and 3.

The complete core, shown in Figs. 2 and 3 without the winding 34, consists essentially of successive layers, each layer consisting of one H-shaped piece and two similar L-shaped pieces. The top layer has the L at the left right side up, as shown, and the L at the right upside down. The second layer has identically similar elements but in reverse symmetry. Every odd numbered layer is identically like the first, and every even numbered layer like the second. From this it follows that the division between the units 31 and 32 or between the units 32 and 33 is not a substantially smooth plane, but is a square angled zigzag with elements of one unit overlapping elements of the other by an amount equal to twice the area of a notch 35. This zigzag overlapping at the joints brings two desirable results. First, the gap reluctance of the assembled core's magnetic paths at the joints of the units is materially diminished as compared with a core where the corresponding joint is a plane face and there is no lateral contact between parts of the units. Secondly, the interfitting of the projections and recesses of the units provides a modicum of mechanical support of the units by each other and of frictional resistance to separation of the units, which renders the assembled core or coil much easier to handle and mount, due regard being had to the sensitivity of the material to shock or deformation.

It is also of importance that the H-shaped unit 32 offers no obstruction to the winding of the coil turns 34. Hence the coil need not be prewound on a spool, frame or other support for subsequent assembly with a core unit, as is the case, for example, with a coil core generally similar to that of Figs. 1 to 4 but composed of E-shaped pieces with a straight bar across the open side of each E. Hence, as clearly shown in Fig. 4, the entire cross section of each of the apertures or "windows" of the core is available to be filled with windings, as none of the window space need be wasted either to receive an electromagnetically inoperative winding spool or frame, or by clearance oversize internally and undersize externally of a prewound coil formed with adhesive or other means to maintain its form while being assembled on the core.

The core shown in Figs. 1 to 4 has the maximum symmetry in all ways possible to this mode of construction. The windows are square, the bar of the H is of the same shape and size as the windows, and each side of a window not made by the crossbar is the same size and shape as half the crossbar or window. The core cross section of the magnetic path is the same throughout, assuming that the flux divides equally on leaving the crossbar to pass around the two windows.

In another variation of the invention, if smooth butt joints between the units 31, 32 and 33 of Fig. 2 be desired, the units 31 and 33 may be composed of L-shaped pieces stacked in congruence and the H's in unit 32 may be stacked with their long arms all in congruence. The vertical faces of the ends of the arms of all three units will then be substantially smooth and the units may then be abutted without interfitting. Such a structure with coils on all three units could then be used wherever variable inductive coupling between coils is desired by separating or approximating the wound units.

The general structure for a laminated core coil which is wasteless in construction and which obviates any need for preformed or prewound windings is not claimed herein, being the general subject matter of copending application Serial No. 244,729, filed December 9, 1938, by the present inventor, upon which application U. S. Patent No. 2,235,425 was granted on March 18, 1941 and of which the present application is a division.

The embodiments of the invention herein disclosed are illustrative and may be modified and departed from in many ways without departing from the spirit and scope of the invention as pointed out in and limited solely by the appended claims.

What is claimed is:

1. In a laminated electromagnetic core, a lamina consisting of an L-shaped piece and an H-shaped piece and an L-shaped piece abutted together edgewise in that order, the two L-shaped pieces being so shaped and dimensioned as to be fittable together to form a substantially complete parallelogram which is itself fittable substantially without looseness into the space between the two arms of the H-shaped piece on the same side of the crossbar thereof to fill the said space completely and project outside the same when so fitted, the area of the parallelogram being substantially twice the area of the said space.

2. In a laminated electromagnetic core, a lamina consisting of an L-shaped piece and an H-shaped piece and an L-shaped piece abutted together edgewise in that order, the two L-shaped pieces being so shaped and dimensioned as to be fittable together to form a substantially complete parallelgram which is itself fittable substantially without looseness into the space between the two arms of the H-shaped piece on the same side of the crossbar thereof, together with the corresponding adjacent space of another H-shaped piece placed arm end to arm end beside the first named H-shaped piece.

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