Aug. 11, 1970 E. J. WILK 3,523,362

# METHOD OF MAKING ELECTROMAGNETIC CORES

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Fig. 1.

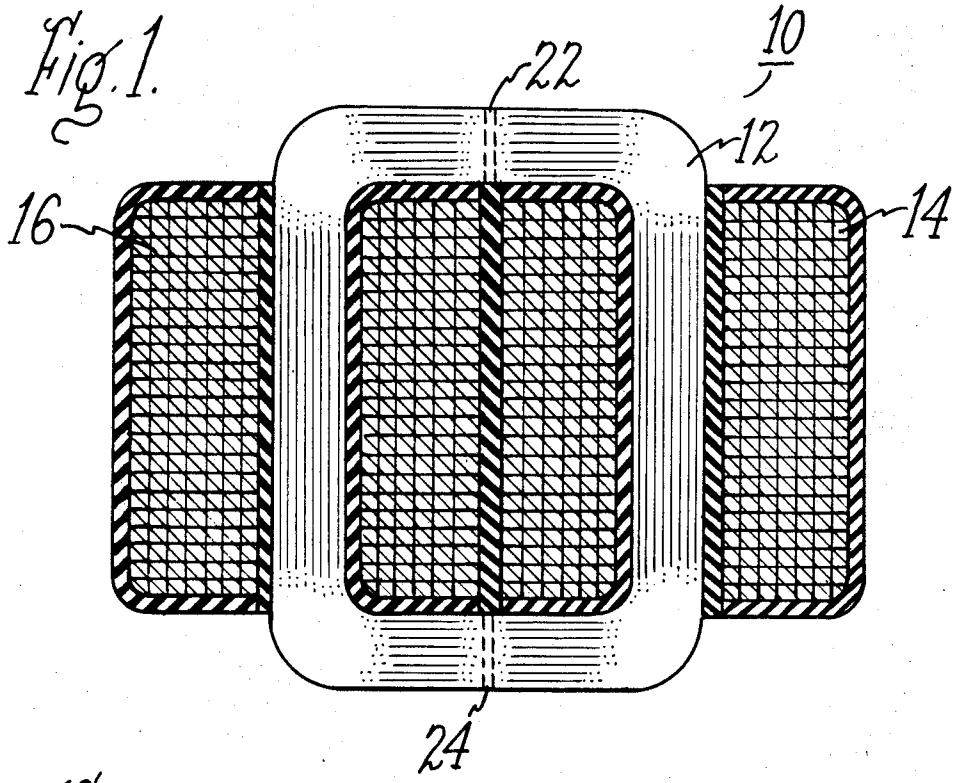
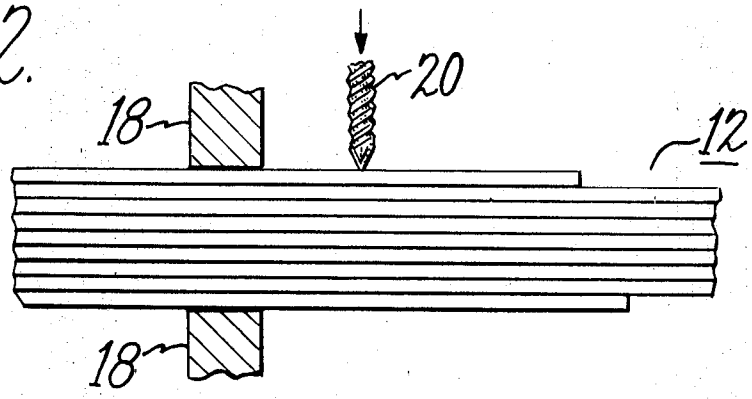



Fig. 2.




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Fig. 3.

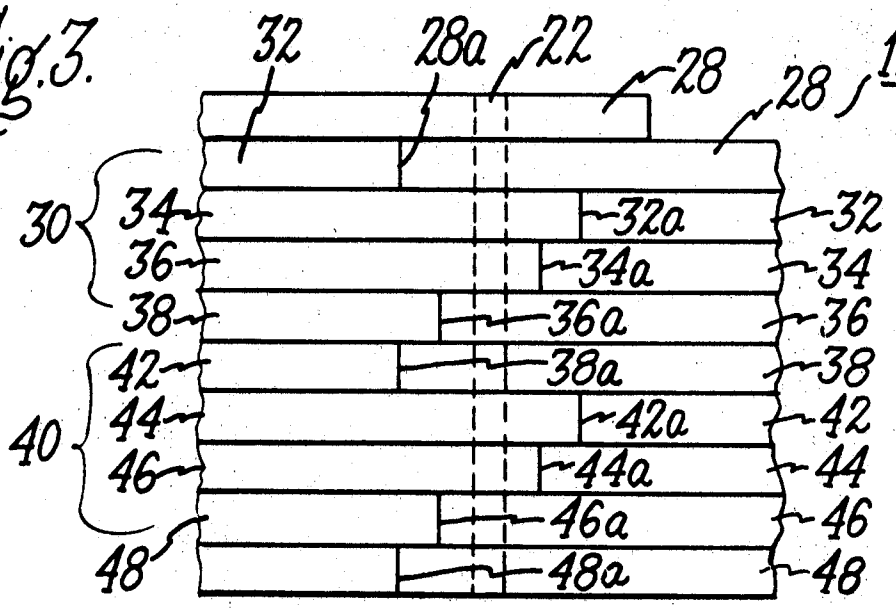



Fig. 4.

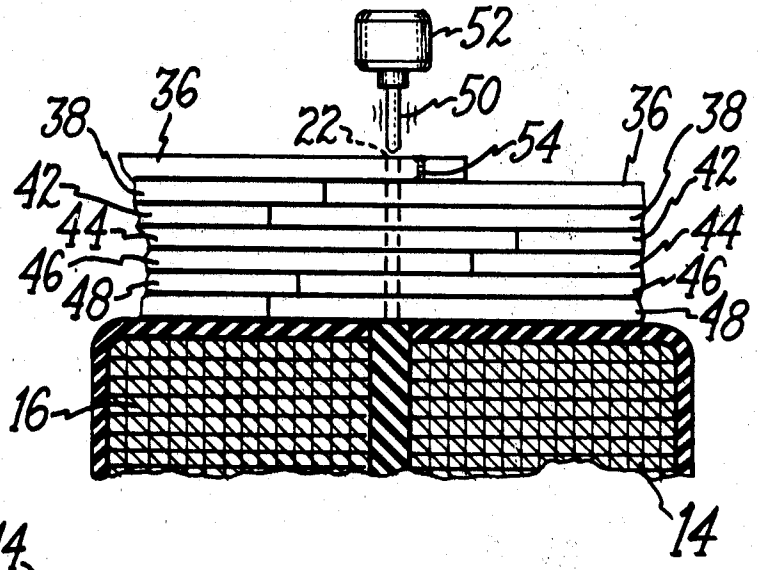
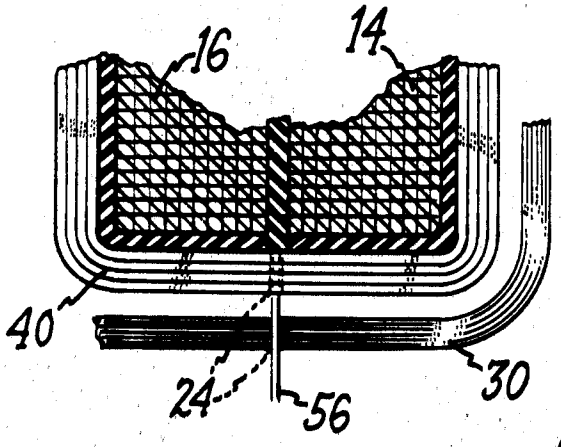



Fig. 5.




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Fig. 6.

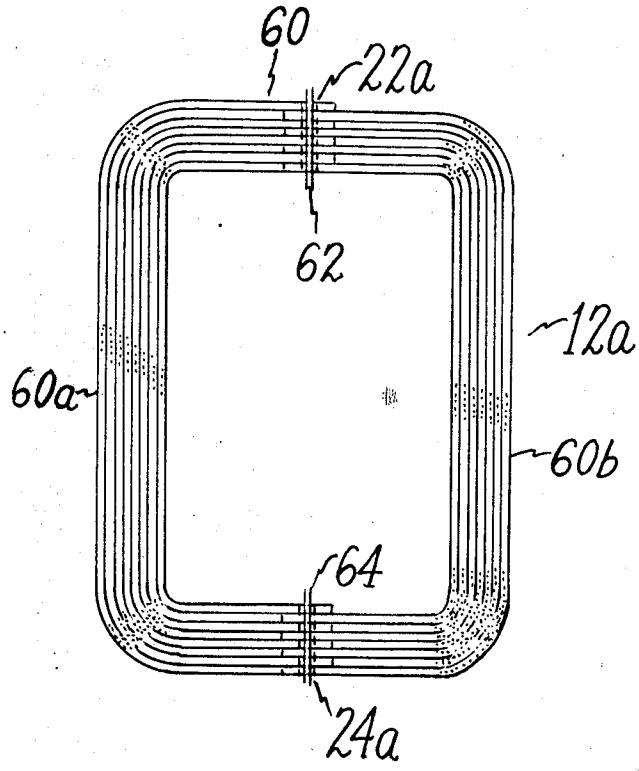
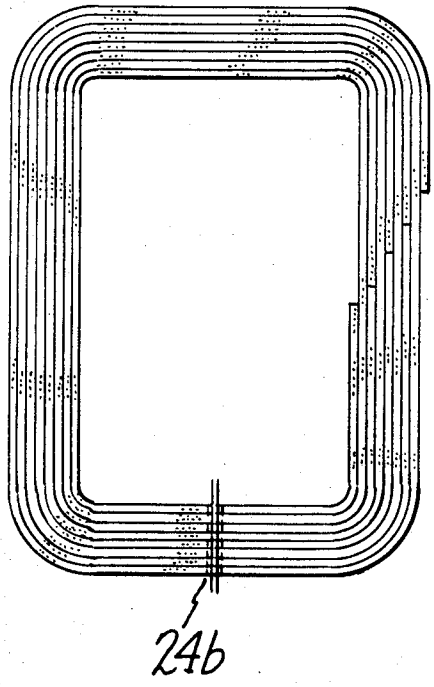



Fig. 7.




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3,523,362

# METHOD OF MAKING ELECTROMAGNETIC CORES

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Int. Cl. H01f 7/06
U.S. Cl. 29—605 4 Claims

## ABSTRACT OF THE DISCLOSURE

A spirally wound magnetic core is formed in the desired shape and annealed. Pilot holes are drilled through the yokes of the core. The core is then cut to desired length, such as one or two turn laminations. The core is assembled around a preformed winding with the pilot holes used to insure positive registration of the laminations during lacing. A pilot pin is used in one pilot hole during lacing while a vibrating pin is used in the other pilot hole to assure positive closure of the joints in each cut lamination.

## BACKGROUND OF THE INVENTION

This invention relates to electromagnetic cores and more particularly, to spirally wound cores which are formed and annealed prior to cutting.

In the electromagnetic core art, it is well known to use wound cores, forming them to the shape of the core to be used in the finished apparatus. The cores are then annealed in this shape. The annealed core may then be unwound and rewound on a preformed winding, or cut into laminations of one or two turns prior to lacing, on the preformed winding. Examples of these cores are found in the Granfield Pat. 2,160,588 and the Vienneau Pats. 2,305,649 and 2,305,650. It is also known to wind, cut a core into desired laminations, and then form into desired shape prior to annealing. An example of this is found in Somerville Pat. 3,327,373. While each of these known cores provides very efficient cores, each will not provide the lowest loss characteristics possible, due to lack of registration. That is, each winding or lamination of the core will not fall into the exact position or registration with the preceding lamination that it had when annealed. As will be understood, such cores are under strain, and thus introduce additional losses into the finished core.

It has recently been discovered that improved registration can be obtained if pilot holes are drilled in the core, after the core has been annealed, but prior to unwinding and cutting of the core. The pilot holes may be utilized during the lacing of the core to insure almost perfect registration of each lamination with the preceding lamination.

Therefore, it is an object of this invention to provide a more efficient electromagnetic core.

A further object of this invention is to provide an electromagnetic core in which the laminations in use have substantially the same registration as they had when annealed.

A still further object of this invention is to provide a novel method of making and assembling magnetic cores to provide improved registration between laminations.

Yet another object of this invention is to provide for pilot holes in electromagnetic cores to aid in accurately lacing such cores with preformed windings.

## BRIEF DESCRIPTION OF INVENTION

According to the preferred form of this invention, an electromagnetic core is spirally wound, formed and annealed to its desired shape. Pilot holes are drilled in at least one yoke of the formed, annealed core. The core is then cut into separate laminations and such cut laminations laced about a preformed coil. During lacing a vibrating pin is inserted through the pilot hole, to pull the joints of the laminations together and insure proper registration of the laminations.

The invention which is sought to be protected will be particularly pointed out and distinctly claimed in the claims appended hereto. However, this invention, and the manner in which its various objects and advantages are obtained, as well as other objects and advantages thereof, will be better understood from the following detailed description of a preferred embodiment thereof, especially when considered in the light of the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial sectional side elevational view of a core and coil structure made according to this invention;

FIG. 2 is a partial view of a spirally wound, annealed core showing the drilling of a pilot hole according to this invention;

FIG. 3 is an enlarged partial side elevational view of a drilled, annealed core showing a preferred cutting sequence for a single turn core according to this invention;

FIG. 4 is a partial side elevational view showing the preferred form of lacing a single turn core about a preformed winding, according to this invention;

FIG. 5 is a partial side elevation view showing the use of a registration pin during lacing;

FIG. 6 is a side elevation view of an interleaved C-type core with double pilot holes and cut in one-half turn increments; and

FIG. 7 is a side elevation view showing the preferred location of a single pilot hole when the core is cut in two turn increments.

## DESCRIPTION OF PREFERRED EMBODIMENTS

In a preferred form, this invention comprises an electromagnetic core which has been spirally wound and annealed. After annealing the core is drilled in at least one yoke to provide a pilot hole to aid in registration of the laminations during lacing. The drilled core is cut into laminations, preferably about the pilot hole. During lacing about a preformed coil, a vibrating pin is inserted into the pilot hole to pull the joints together and insure registration of the laminations. The vibrating pin is used with each group of laminations which has an overlapping lamination. After aligning, the overlapped lamination is spot welded, close to the centerline, and the next group of laminations laced on the coil. The resulting core is free of gaps and in substantially perfect registration.

Referring now to the drawings, FIG. 1 shows a core and coil assembly **10**, with the core being made and laced according to this invention. According to FIG. 1, a spirally wound core **12** is laced with a pair of prewound coils **14** and **16**. Of course, it will be understood that a pair of cores could be laced about a single preformed coil, or any other single or three phase construction desired can be used. Core **12** is spirally wound and formed into its desired shape and annealed, in the manner well known to those skilled in this art. After annealing, at least one pilot hole is drilled in the yoke of the formed and annealed core. As shown in FIG. 2, core **12** may be clamped in a press, as indicated at **18** and the pilot hole drilled by means of a drill **20**. In some instances it is desirable to drill a pilot hole in each yoke, as is indicated by **22** and **24** in FIG. 1. The second pilot hole is found very useful, especially in cores of heavy build, to more easily align the corners of each lamination prior to the use of the vibrating pin.

After the pilot hole or holes have been drilled, the annealed core **12** is cut with desired laminations, such as

one-half turn, one turn, one and one-half turns, or two turns. As will be understood, it is preferred that such cutting, when in one-half turns or in full turns, be provided with a stepped pattern to prevent flux loss at the joints. A preferred pattern for a single turn cut core is shown in FIG. 3. As can be seen from FIG. 3, which is a partial side elevation of an annealed and drilled core **12**, the first or outer turn or lamination **28** is cut or trimmed at its outer end to one side of pilot hole **22**. The inner end of lamination **28** is cut on the other side of pilot hole, as shown at **28***a*. This will provide a binding turn for the core. The next laminations are cut in a stepped sequence, beginning at the right of hole **22** at shown at **32***a*, with two cuts on each side of hole **22**, as indicated at **32***a*, **34***a* to the right of hole **22** and **36***a*, **38***a*, to the left of hole **22**. This will provide a packet **30** of four laminations, lamination **32**, **34**, **36** and **38**. The next four laminations are cut in the same sequence as is indicated at **42***a*, **44***a* to the right of hole **22** and **46***a*, **48***a* to the left of hole **22**. This will provide a second packet **40** of four laminations **42**, **44**, **46** and **48**, as shown. The entire core **12** is cut in this manner.

Of course, the core **12** may be cut with any desired number of laminations per packet depending on the size of the core and the stepping arrangement.

After core **12** is cut, it may be laced with a preformed coil or coils, such as coils **14** and **16**. FIG. 4 shows the preferred manner of lacing, according to this invention. One or more packets are wrapped or laced through the window of coils **14** and **16**, as is indicated by laminations **48**, **46**, **44** and **42** in FIG. 4. Then two laminations of the next packet, such as **38** and **36** are laced, as shown. This provides an overlapping lamination **36**. A tapered end vibrating pilot pin **50**, vibrated by any type of vibrator **52** is then inserted into pilot hole **22** and vibrated to pull the joints snugly together. After the joints have been closed, the outer lamination is spot welded as at **54** to hold the assembled laminations in proper registration. These steps are repeated, lacing on more packets, and then a portion of a packet, closing the joints with a vibrating pilot pin and then welding, until the entire core has been laced about the preformed coil or coils. Single turn cores of lesser builds needs only be welded at the overlapping outer turn.

When the cores are of heavy build, it is desirable to use a registration pin with pilot hole **24** in the uncut yoke. This is shown in FIG. 5. After the first inch or so of the core is assembled the lamination packets begin to lose registration due to the larger radii of the corners. A registration pin **56** may be inserted into hole **24** of the assembled laminations, such as packet **40**, as shown in FIG. 5. The next laminations to be laced, such as packet **30**, are then threaded over registration pin **56**, to aid in proper registration of the corners of the packet **30** with packet **40**. Of course, it is still necessary to use vibrating pilot pin **50** to accurately close the joints and insure proper registration of the upper portion of the core, as previously described.

FIG. 6 shows a C core in which the spirally wound core **12***a* has been annealed, drilled and cut into half turns. In this type core, each lamination is cut in each yoke. As in the core of FIG. 3, the outer lamination **60** will be cut or trimmed close to pilot hole **22***a*. The outer lamination **60** will then be cut in a half turn, close to pilot hole **24***a*, to provide half lamination **60***a*. The next cut will be made close to hole **22***a* to provide half lamination **60***b*. The core will be cut in half turns, with each half turn having at least one pilot hole therein, as shown. The core may then be assembled with a coil or coils using a registration pin **56** and the vibrating pilot pin **50**, as shown in FIGS. 4 and 5. This will provide a half turn core free of gaps with substantially perfect registration.

FIG. 7 shows the invention applied to a two turn cut spirally wound core. In FIG. 7, the annealed core **12***b* has been drilled, as at **24***b* and then cut into approximately 2 turn lengths. After each few laminations are assembled on a coil or coils, a vibrating pin such as **50** is inserted into pilot hole **24***b* to close the joints and insure accurate registration of the laminations. It is generally not necessary to spot weld the overlapped turn since the closed turn will hold the assembly together during further lacing.



As will be apparent, an insulated pin or other type fastener may be placed in the pilot hole after it has been brought into registration by the vibrating pin. The insulated pin, such as is shown at **62**, **64** in FIG. 6 and **72** in FIG. 7, may be used to secure the assembled laminations without use of welding. Obviously, such insulated pins may also be used to reinforce a welded assembly, if desired.

From the above description it will be apparent that this invention provides a core which may be assembled with a preformed coil or coils while obtaining accurately closed joints and substantially exact registration of all of the laminations in the core. While the invention has been illustrated and described with reference to a preferred embodiment, it will be obvious to those skilled in the art that it is not limited thereto. The scope of this invention will be apparent from the appended claims.

What is claimed as new and desired to secure by Letters Patent of the United States is:

**1.** A method of assembling a wound, formed and annealed electromagnetic core with a preformed coil which comprises:

(a) drilling at least one pilot hole in a yoke of said core;

(b) cutting said core into a predetermined number of laminations with reference to said pilot hole;

(c) lacing a number of said cut laminations about a preformed core with an outer overlapping lamination;

(d) placing a vibrating pin in said pilot hole of said laced laminations to close the joints in said laminations;

(e) continuing to lace and vibrate said cut laminations until said core is entirely laced about said preformed coil.

**2.** A method of assembling a wound, formed and annealed electromagnetic core with a preformed coil as set forth in claim **1** in which said overlapped lamination is spot welded.

**3.** A method of assembling a wound, formed and annealed electromagnetic core with a preformed coil as set forth in claim **1** in which an insulated pin is placed in said pilot hole after vibrating said laced laminations to secure said laced laminations.

**4.** A method of assembling a wound, formed and annealed electromagnetic core with a preformed coil as set forth in claim **1** in which a second pilot hole is drilled in the other yoke of said core and a registration pin is inserted in said second pilot hole of said number of laced laminations and other laminations are threaded over said registration pin as said other laminations are laced about said preformed coil.


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