

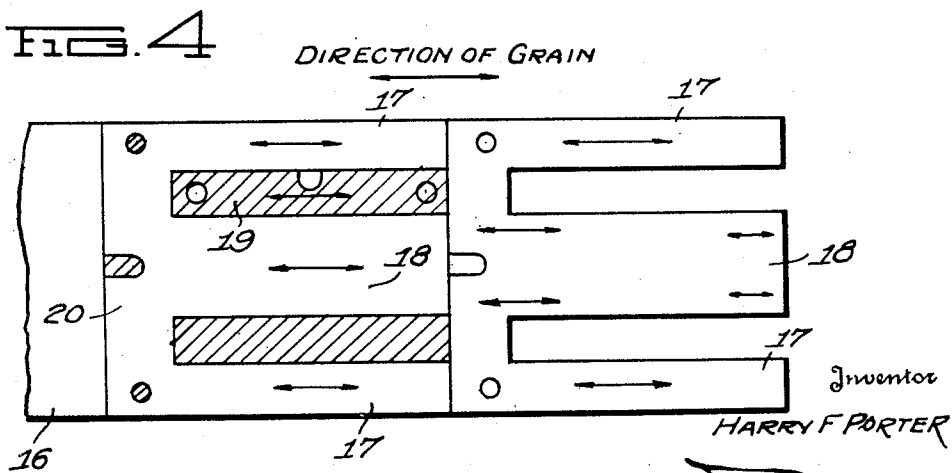
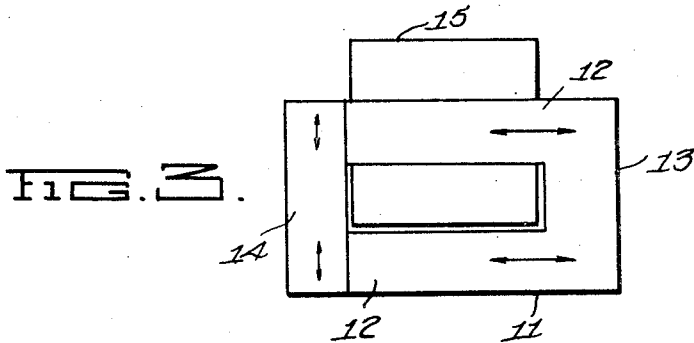
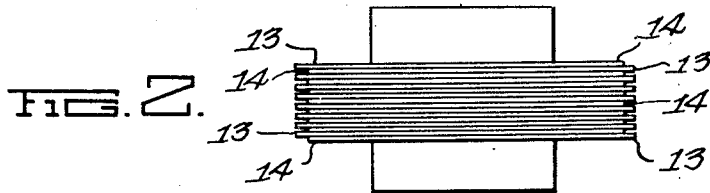
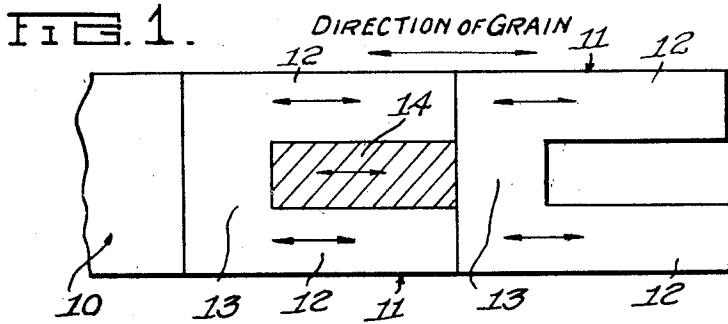
Nov. 29, 1949

H. F. PORTER
LAMINATED CORE

2,489,977

Filed Dec. 3, 1946

2 Sheets-Sheet 1



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FIG. 6.

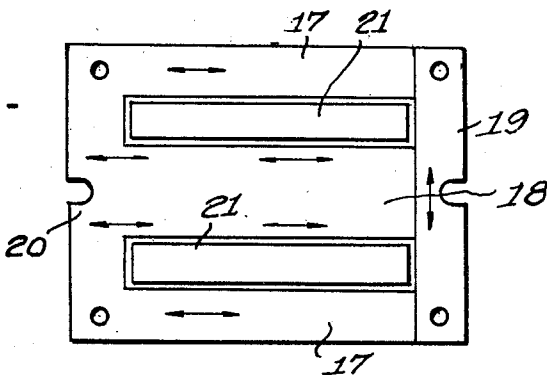


FIG. 5.

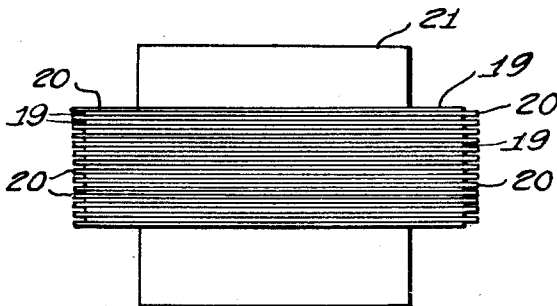


FIG. 7.

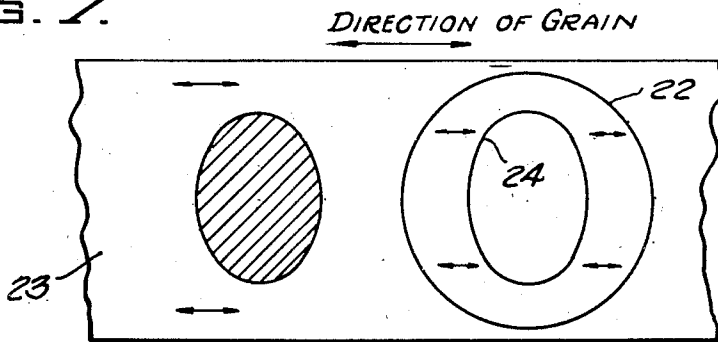
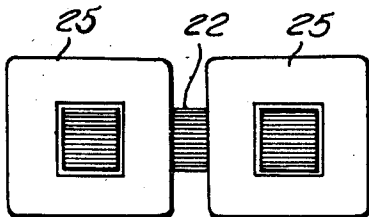


FIG. 8.



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UNITED STATES PATENT OFFICE

2,489,977

LAMINATED CORE

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Application December 3, 1946, Serial No. 713,628

1 Claim. (Cl. 175-356)

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The invention relates to the art of electromagnetic induction apparatus, and particularly to the manufacture of laminated cores for transformers and the like.

It is known that oriented silicon steel exhibits properties of high magnetic permeability and low hysteresis losses in the direction of its elongation from rolling. The value of this superiority in performance is particularly pronounced at rather high flux densities, permitting reduction in the size of power transformers where the cores are designed to make use of the highly directional magnetic superiority.

Various types of cores have been developed to accomplish this result, notably, wound cores and those made up of stamped laminations. It has been found that laminated cores are superior to wound cores because they are accurate as to dimension and all parts can be assembled totally free of mechanical strain or distortion. Further, the reluctance of the core joints can be reduced to very low values as compared to wound cores which are cut after annealing in final shape. Such wound cores entail a double butt joint in the core path. Spirally wound cores develop final strains after assembly that increase the hysteresis losses and excitation voltamperes somewhat above the minimum values obtainable in stamped lamination cores properly fabricated and assembled. Stamped lamination cores have many advantages over wound cores, and particularly are their advantages definite and pronounced in the construction of fractional kva. transformers.

Prior to the advent of this invention, it has been the practice to stamp core laminations with the legs and end sections of the same width or cross sectional area. Oriented steel laminations so stamped present cross grain areas which are of lower permeability than those in which the magnetic flux parallels the direction of the grain. In consequence, the distribution of permeability as well as core loss throughout the length of the magnetic circuit has not been uniform.

An object of this invention is to provide a core lamination of oriented steel having a major portion disposed in the direction of the best properties of the steel and a minor portion at 90° to the direction of rolling but proportioned so as to provide a uniform distribution of core loss and uniform magnetic reluctance throughout the length of the magnetic circuit.

A further object is to provide an oriented steel core lamination wherein a major flux path lies in the direction of the best properties of the metal and a minimum flux path length of greater width than the major flux path extends transversely of the direction of the best properties of the metal.

With the foregoing and such other objects in view as will be apparent to those skilled in the art, the invention consists in the novel construction,

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combination, and arrangement of parts hereinafter described and claimed and illustrated in the accompanying drawings, in which:

Figure 1 is a plan view illustrating the manner of stamping out core laminations from a strip of rolled oriented steel;

Figure 2 is an elevation of an assembly of a core made up of laminations formed as in Figure 1, with a coil positioned thereon;

Figure 3 is a horizontal section taken through Figure 2.

Figure 4 is a view similar to Figure 1 but illustrating another structural embodiment of core laminations;

Figure 5 is an elevation of an assembly of laminations formed as in Figure 4, with a coil positioned thereon;

Figure 6 is a horizontal section taken through Figure 5;

Figure 7 is a plan view illustrating the manner of stamping still another form of core laminations; and

Figure 8 is a vertical section through an assembly of laminations formed as in Figure 7, with coils mounted thereon.

In the practice of this invention, the core laminations are formed by stamping from a strip of rolled silicon steel. Elongation of the metal occurs in the rolling process and the grain is caused to lie in the direction of elongation. Magnetic permeability is highest in this direction and hysteresis loss is lowest. With reference to this directional advantage, the steel is oriented.

In the embodiment shown in Figures 1, 2 and 3, a thin strip of rolled silicon steel 10, advanced from left to right in Figure 1, is subjected to a stamping operation for the successive severance of substantially U-shaped laminations 11 having a pair of spaced parallel legs 12 of identical width and an integral bight portion 13. In forming the legs 12, the strip of metal stamped from the blank 10 provides a bar 14 of rectangular shape elongated in the direction of the best properties of the steel. It is dimensioned in width to equal the width of a leg, and in length to equal the overall width of the lamination so that, as shown in Figure 3, it may be assembled with the ends of the legs 12 to complete the flux path for the magnetic circuit.

The bight portion 13 extends transversely between the legs 12 at right angles thereto, so that its major axis is perpendicular to the major axis of the lamination and is, therefore, transversely directed with respect to the grain direction of the steel. This cross-grain disposition of the portion 13 makes it inherently less permeable and higher in core loss than those portions such as the legs 12 and end bar 14 which substantially parallel the direction of the best properties of the steel. Normally, if the width of the cross-grain portion 13

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were the same as that of the leg 12 or the bar 14, the magnetic reluctance and core loss would be higher in the portion 13 than in any other portion of the lamination. As a result, there would be an unequal distribution of magnetic reluctance and core loss over the extent of the flux path.

This invention obviates such an undesirable condition by providing a wider flux path in those portions of the lamination where the flux path is required to follow a course at right angles to the direction of best magnetic performance. In order to achieve this result, the portion 13 is made wider in the direction of its minor axis than the width of either leg 12 or the bar 14, so that it is wider than the space between the legs giving an increased cross section area of metal with lower flux density and consequent reduction in magnetic reluctance to compensate for the cross-grain lower permeability characteristics of the metal at that point.

The final assembly comprises a core formed of a requisite number of superposed laminations with a coil 15 mounted on one bank of the legs 12, and with the laminations alternately reversed to dispose an equal number of portions 13 and bars 14 at each end of the core.

In the embodiment shown in Figures 4, 5 and 6, the same principle is employed in the formation of E-type core lamination. The blank strip 16 of rolled silicon steel is stamped to provide two outer legs 17 of equal width and a coextensive center leg 18 of double the width of a single outer leg. One of the rectangular strips of metal 19 which is stamped from the blank 16 in forming the legs provides an end bar for assembling at the leg ends to complete the path of the magnetic circuit. This bar has its longer dimension in the direction of the best magnetic properties of the metal, as also are the legs 17 and 18. The width of the bar is the same as that of an outer leg 17 and its length equals the overall width of the lamination.

The vertical leg portion 20 of the E lamination extends transversely of the grain direction of the metal, which requires the flux path to be at right angles with respect to the direction of the best magnetic properties of the steel. In order to compensate for the lower permeability and higher core loss incident to cross grain flux travel, the portion 20 is made wider in the direction of its minor axis than the width of either outer leg 17 or the bar 19. In consequence, it is wider than the space between adjacent legs.

In making up the final assembly of core and coil, the laminations are superposed in alternately reversed relation. The coil 21 is mounted on the center leg 18.

Figures 7 and 8 illustrate a core construction wherein each lamination is in itself an integral closed magnetic circuit. In forming each lamination, a circular portion 22 of the desired overall size is stamped from a blank 23 of cold-rolled silicon steel having pronounced superiority of magnetic properties in the direction of rolling. An elliptical center section is removed in the same operation, leaving an elliptical center opening 24. The necessary widening of the flux path at those portions in which it traverses the direction of the best magnetic properties of the metal is obtained by disposing the minor axis of the elliptical aperture 24 parallel to the direction of

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the best properties of the metal. The coils 25 are mounted over the portions of lesser width. Alternatively to the lamination form shown in Figure 7, the center opening may be of circular shape and the exterior configuration may be elliptical.

All forms of the invention embody the same principle of having a predominant portion of the core lamination extending in the direction of the best magnetic properties of the metal, and with that portion in which the flux path flows across the metal grain being widened to the proper proportions to effect a uniform magnetic reluctance and a uniform core loss over the entire extent of the magnetic circuit.

It is to be understood that the invention is not restricted to the matter herein described and illustrated. It is intended that within the scope of the invention as claimed, changes and modifications of structural details and arrangement of parts may be made as desired.

I claim:

Electromagnetic induction apparatus comprising a core of superposed identical alternately reversed laminations of magnetic metal each consisting of an end portion, a pair of outer legs and a middle leg integral therewith and extending perpendicularly therefrom in parallel spaced relation in the direction of the best magnetic properties of the metal, the spaces between said legs being equal as to width and length, all said legs being equal in length and the outer legs being equal in width, said end portion integral with the legs extending transversely of the direction of the best magnetic properties of the metal and being equal in length to the length of a leg and greater in width than the width of either outer leg and being also greater in width than the width of the space between adjacent legs, and a separate end piece abutting the free ends of said legs and of the same length and width as an outer leg, each said separate end piece having its major axis in the direction of the best magnetic properties of the metal and being less in width than said end portion integral with the legs whereby, in association with the adjacent alternate wider end portions, the opposite ends of the core are corrugated for low excitation and cooling; and a winding of current conducting coils mounted on the bank of superposed middle legs of the core laminations.

HARRY F. PORTER.

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