United States Patent

Meili

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[54] **LAMINATED MAGNETIC CORE FOR INDUCTION DEVICES AND LAMINATIONS FOR FORMING SUCH MAGNETIC CORE**

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[52] **U.S. Cl.** **336/134,** 336/178, 336/212, 336/234

[51] **Int. Cl.**.....**H01f 21/06,** H01f 27/24

[58] **Field of Search**.....336/130, 134, 178, 212, 214, 336/215, 234, 132

[56] **References Cited**

UNITED STATES PATENTS

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FOREIGN PATENTS OR APPLICATIONS

803,914 11/1958 Great Britain.....336/178

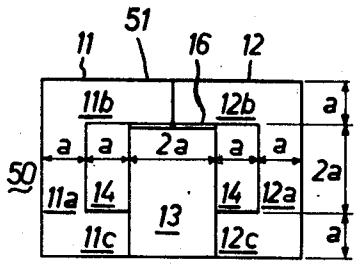
Primary Examiner—Thomas J. Kozma

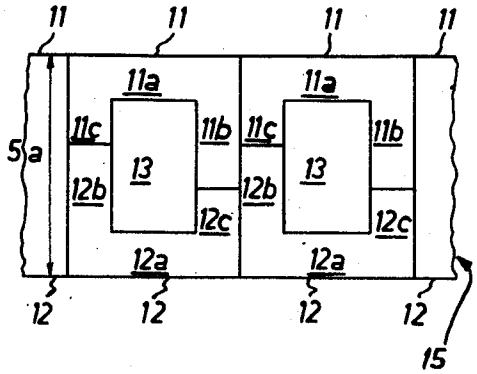
Attorney—Eric H. Waters et al.

[57] **ABSTRACT**

A laminated magnetic core for electric induction devices comprising a shell formed of laminations. Each of said laminations comprising two parallel yoke legs and two outer legs arranged between and perpendicular to such parallel yoke legs. A central leg is disposed parallel to the outer legs and forms with one of said parallel yoke legs an air gap. Each of the laminations of the shell embodying similar U-shaped lamination elements comprising a respective outer leg and unequal length yoke leg sections protruding from the ends of such respective outer legs. These lamination elements bear against one another at the end faces of their longer yoke leg sections to form a shell lamination for the magnetic core. Further, such lamination elements bear at the end faces of their shorter yoke leg sections against a central web forming the central leg and arranged between such shorter yoke leg sections.

8 Claims, 6 Drawing Figures





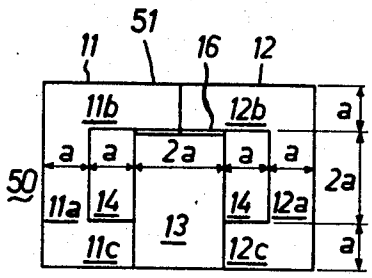


Fig.1

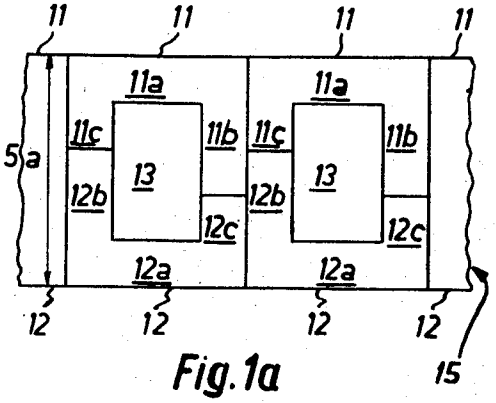


Fig.1a

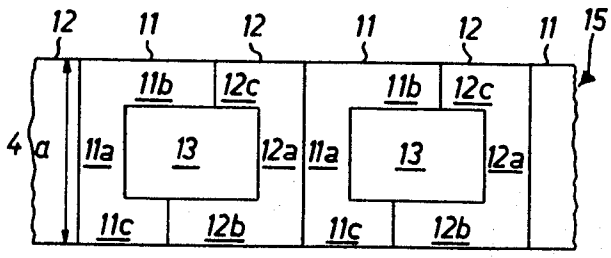


Fig.1b

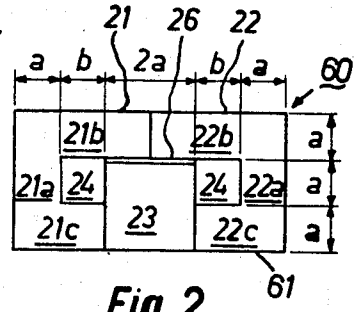


Fig.2

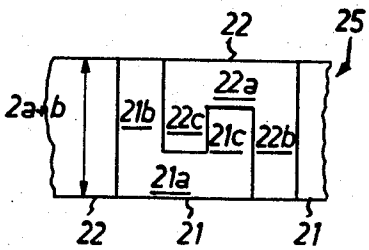


Fig.2a

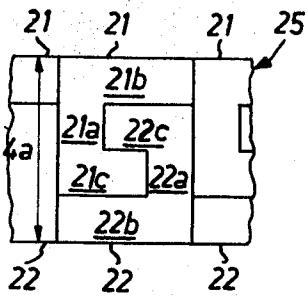


Fig.2b

LAMINATED MAGNETIC CORE FOR INDUCTION DEVICES AND LAMINATIONS FOR FORMING SUCH MAGNETIC CORE

BACKGROUND OF THE INVENTION

The present invention broadly relates to improvements in laminated magnetic cores for electric induction devices and also pertains to new and improved punched magnetic core laminations for such cores, such magnetic core comprising a shell formed of two yoke legs which are parallel to one another, two outer legs disposed between and extending perpendicular to such parallel yoke legs and a central leg which is parallel to the outer legs, which central leg together with one of the yoke legs forms an air gap.

Laminated shell cores for electric induction devices are known to the art which possess an E-shaped component with equal length legs which are interconnected with one another through the agency of an I-shaped portion serving as a yoke. The individual laminations of such laminated magnetic core are stamped-out of a sheet metal member without waste by means of the so-called DIN-cut, wherein in each case two E-shaped portions having their legs abutting one another at their ends are simultaneously stamped-out and from the windows formed by the abutting legs there are stamped-out two I-shaped portions.

However, if it is desired to form for such shell core an air gap between the central leg of the E-shaped portions and the I-shaped portion, then, the I-shaped portion must be appropriately spaced from the E-shaped portion, so that air gaps appear also between the outer legs and the I-shaped portion, something which is undesired because of the occurring stray or leakage flux.

Now, in British Pat. 671,823 there is described a laminated magnetic core which is constructed similar to the previously described shell core, and wherein the last-mentioned drawbacks are overcome in that an essentially I-shaped yoke leg constructed widened at its ends bears against the outer legs of the equal length legs of the E-shaped portion, whereas between the central leg and the central portion of the yoke leg which is narrow in contrast to the ends there is formed an air gap.

However, this air gap cannot be changed in size, since when the magnetic core is assembled together the spacing between the central leg and the yoke leg cannot be altered.

Additionally, if the individual laminations are stamped-out without waste similar to the previously described DIN-cut, then, apart from the I-shaped portion also the legs of the E-shaped portion possess unequal width.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide a new and improved construction of laminated magnetic core for induction devices which overcomes the previously mentioned drawbacks, the inventive magnetic core being formed of novel punched laminations.

Another objective of this invention is to provide a laminated magnetic core, the air gap between the central or middle leg and one yoke leg of which can be varied and the laminations of which additionally can be stamped-out from sheet metal without waste.

Now in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, the laminated magnet core of the present invention is manifested by the features that shell possesses similar U-shaped shell or lamination elements formed from a respective outer leg and unequal length yoke leg sections or portions which protrude from the ends of such outer legs. The U-shaped shell or lamination elements bear against one another at the free end faces of their longer yoke leg sections and the end faces of their shorter yoke leg sections abut against a central web arranged between the shorter yoke leg sections and embodying the central leg.

U.S. Pat. No. 3,201,731 teaches to the art forming the laminations from U-shaped shell portions with different length legs by punching such out from a strip of constant width, wherein, in each case, two laminations which mutually interengage with one another with their shorter legs between the legs of the other lamination so as to form a gapless rectangle are conjointly punched-out. With a shell core as illustrated in the previously mentioned United States Patent and formed of such type punched-out laminations and in contrast to the inventive magnet core, it is necessary that four such laminations be assembled together in order to form a shell core cross-section. Additionally, such shell core does not possess at its central leg any adjustable air gap.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawing wherein:

FIG. **1** is a plan view of a first embodiment of magnetic core for electric induction devices formed of sheet metal laminations constructed according to the teachings of the present invention;

FIG. **1***a* and **1***b* illustrate the punching cuts used for fabricating the sheet metal laminations for the magnetic core of FIG. **1**;

FIG. **2** is a plan view of a second embodiment of magnet core for an electric induction device formed of sheet metal laminations; and

FIGS. **2***a* and **2***b* illustrate the punching cuts used for fabricating the sheet metal laminations for producing the magnetic core of FIG. **2**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings, each of the laminated magnet cores **50** (FIG. **1**) and **60** (FIG. **2**) as illustrated in the drawings will be seen to respectively embody a central or middle leg **13** and **23** and a respective shell **51** and **61** surrounding such legs consisting of two outer legs **11***a*, **12***a* and **21***a*, **22***a* respectively and two yoke legs **11***b*, **12***b* and **11***c*, **12***c* and **21***b*, **22***b* and **21***c*, **22***c* respectively and forming the magnetic short-circuit path. The cross-section of the relevant central leg is essentially twice as large as that of the shell, since the total magnetic flux in the central leg is subdivided in such a manner that only one half of the flux flows through the shell. Consequently, with constant thickness of the magnetic core the central leg can be twice as wide as the jacket.

Now referring more specifically to the embodiment of laminated or stacked magnetic core as depicted in FIG. 1, each shell 51 embodies a stack of laminations each formed of two similar U-shaped lamination or shell elements 11 and 12. Each such lamination element 11 and 12 comprises a respective outer leg 11*a* and 12*a* and two yoke leg portions or sections 11*b*, 11*c* and 12*b*, 12*c* respectively, extending perpendicular to the associated outer leg 11*a* and 12*a* respectively and protruding from the ends of such outer legs, as shown. Both of the lamination elements 11 and 12 abut against one another at the free ends of their longer yoke leg sections 11*b* and 12*b*. In the intermediate space formed by both shorter yoke leg sections 11*c* and 12*c* there is accommodated a central web 13 which is disposed parallel to the outer legs 11*a* and 12*a*, this central web 13 embodying the central leg and simultaneously filling-out the intermediate compartment or space formed at the lamination and which is located between the shorter yoke leg sections 11*c* and 12*c*. A respective window opening 14 is formed between the central web or leg 13 and each of the outer legs 11*a* and 12*a*, as shown.

The central web or leg 13 together with the yoke leg formed from the longer yoke leg sections 11*b* and 12*b* forms an air gap 16. For the purpose of adjusting the size of this air gap 16 the central web 13 can be displaceably guided in its lengthwise direction by means of the shorter yoke leg sections 11*c* and 12*c*.

The dimensions of the laminated magnet core 50 are chosen in such a manner that the laminations thereof can be fabricated by means of a punching or stamping-cut to be described more fully in conjunction with the showing thereof depicted in FIGS. 1*a* and 1*b*. With a lamination width of dimension *a* and a central web width of 2*a*, there is obtained a magnet core having the outside dimensions 4*a* to 6*a* and with window opening openings 14, the height of which amounts to 2*a* and the width of which amounts to *a*. The length of the shorter yoke leg sections 11*c* and 12*c* amounts to 2*a* and is smaller by the amount *a* than the length of the longer yoke leg sections 11*b* and 12*b*.

FIGS. 1*a* and 1*b* illustrate the manner in which the lamellae of the lamination or shell elements 11 and 12 with their unequal length yoke leg sections 11*b* and 12*c* and 11*c* and 12*b* bearing against one another, together with a lamellae of the central web 13, can be assembled together into a gapless rectangle with the side lengths possessing the dimensions 4*a* and 5*a*. The individual rectangles can be lined up adjacent one another into a strip 15 of constant width, possessing the dimension 5*a* in FIG. 1*a* and the dimension 4*a* in FIG. 1*b*. The individual sheet metal laminations of the laminated magnetic core importantly can be punched-out of such sheet metal strips 15 without waste when there is provided the rectangular arrangements depicted in FIGS. 1*a* and 1*b*.

The laminations forming the shell 61 of the magnet core 60 illustrated in FIG. 2, similar to the magnetic core illustrated in FIG. 1, each consist of two similar U-shaped lamination or shell elements 21 and 22, each of which possesses a respective outer leg 21*a* and 22*a* equipped with a respective yoke leg section 21*b*, 21*c* and 22*b*, 22*c* which protrude from and extend perpendicular to the associated outer legs 21*a* and 22*a*. The lamination elements 21 and 22 which abut one another by means of the free ends of both of their longer yoke leg sections or portions 21*b* and 22*b* form a lamination 61 which possesses an intermediate space between the shorter yoke leg sections 21*c* and 22*b*, as shown. This intermediate space is filled by a central or middle web 23 which is disposed parallel to the outer legs 21*a* and 22*a* and embodies the central leg. This central web 23, similar to the central web 13 of FIG. 1, can be displaced in its lengthwise direction, so that there is obtained an adjustment of the air gap 26 at the central or middle leg. Between the central leg 23 and outer legs 21*a* and 22*a* there are formed window openings 24.

With a lamination width of dimension *a* and a central web width of 2*a* this magnet core possesses a height of the window openings 24 of *a*. The width *b* of this window opening 24, on the otherhand, can be freely selected. The shorter yoke leg sections 21*c* and 22*c* are shorter by the amount *a* than the longer yoke leg sections 21*b* and 22*b* respectively. It is thus possible to form magnetic cores which possess outside dimensions of 3*a* and 4*a* + 2*b*.

In FIGS. 2*a* and 2*b* there is illustrated the manner in which two respective lamellae of the lamination elements 21 and 22 can be interleaved or interfitted in pairs with one another. The respective shorter yoke leg sections 21*c* or 22*c* of the one lamination element 21 or 22 always engages between the yoke leg sections 22*c*, 22*b* or 21*b*, 21*c* of the other jacket element and fills the space forming the window openings 24. Each two lamellae of the lamination elements 21 and 22 form a gapless rectangle with the sides having the dimensions 4*a* and 2*a* + *b*.

The lamellae of the lamination or shell elements 21 and 22 can be punched-out in the form of such abutting rectangles from a strip 25 of constant width, possessing the dimension 2*a* + *b* (FIG. 2*a*) and the dimension 4*a* (FIG. 2*b*). The central webs or legs 23, which possesses a square cross-section with a side length dimension of 2*a*, are likewise punched-out free of waste from a second sheet metal strip (not illustrated) having a width possessing the dimension 2*a*.

With the laminated magnet core of the type illustrated in FIGS. 1 and 2 the respective air gap 16 or 26 at the relevant central web or leg 13 or 23 can be easily adjusted without having to tolerate any undesired air gap at the lamination 51 or 61 respectively.

The described magnetic cores 50 and 60 are preferably used for inductance or choke coils for the operation of fluorescent tubes. In so doing, it is important to dimension the magnet core in such a fashion that without economical or technological drawbacks there is obtained a low constructional height of the series connected devices. Above all it has been found that the magnetic core of FIG. 1, owing to its cross-sectional dimensions of 4*a* and 6*a* is particularly suitable for series connected devices. The height of this magnetic core in relation to its width is in a ratio of 1:1.5, rendering possible the economical construction of series connected devices of low structural height, whereby material can be saved at the socket of the fluorescent tubes, also bringing with it advantages as concerns lighting technology and aesthetic effect.

If with the embodiment of FIG. 1 there is selected for the dimension *a* the value of 6.4 cm., then, there is obtained a magnetic core with the particularly favorable cross-sectional dimensions of 38.4 × 25.6 cm.

If the magnetic cores are arranged in a housing formed of sheet iron, then, in certain cases it is desired to incorporate such iron sheet metal housing as active component in the magnetic circuit. In this case the lamination elements are reduced in their width by an amount corresponding to the thickness of the sheet iron used for the housing, so that the width thereof is a little smaller than half the width of the central web.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims. Accordingly,

What is claimed is:

1. A laminated magnetic core for induction devices comprising a shell formed of laminations and possessing two yoke legs parallel to one another and two outer legs arranged between and perpendicular to said parallel yoke legs, a central leg disposed parallel to said outer legs and forming with one of said parallel yoke legs an air gap, each of said laminations embodying similar substantially U-shaped lamination elements comprising a respective outer leg and unequal length yoke leg sections protruding from the ends of said respective outer legs, said lamination elements bearing against one another at the end faces of their longer yoke leg sections to define one of said parallel yoke legs with the remaining shorter yoke leg sections defining the other parallel yoke leg, and a central web embodying said central leg arranged between said shorter yoke leg sections, said lamination elements bearing at the end faces of their shorter yoke leg sections against said central web disposed between said shorter yoke leg sections.

2. The laminated magnetic core as defined in claim 1, wherein said yoke leg sections and said outer legs possess essentially the same width and in relation to said central web practically half the width thereof, and wherein the length of each outer leg corresponds to the width of said central web, each longer yoke leg section being three times as long as wide, and each longer yoke leg section being longer by an amount corresponding to its width than the length of each shorter yoke leg section, the length of said central web essentially corresponding to three times the width of said outer leg, so that two of said lamination elements with the end faces of their yoke leg sections bearing against one another together with said central web surrounded by said two lamination elements can be assembled together into a gapless rectangle.

3. The laminated magnetic core as defined in claim 1, wherein said yoke leg sections and each said outer leg essentially possess the same width and with respect to said central web practically one-half of the width thereof, said central web essentially being as long as it is wide, the length of each outer leg corresponding to its width, each said longer yoke leg section being longer than each said shorter yoke leg sections by an amount corresponding to its width, so that two lamination elements mutually engage with their shorter yoke leg sections between the yoke leg sections of the other lamination element so as to be assembled together into a gapless rectangle.

4. The laminated magnetic core as defined in claim 1, wherein said central web arranged between both of said shorter yoke leg sections is guided to be displaceable in its lengthwise direction by said shorter yoke leg sections.

5. A lamination for the magnetic core of electric induction devices comprising similar substantially U-shaped lamination elements each possessing a respective outer leg and unequal length yoke leg sections protruding from the ends of its associated respective outer leg, said lamination elements bearing against one another at the end faces of their longer yoke leg sections to define one parallel yoke leg with the remaining shorter yoke leg sections defining another parallel yoke leg, and a central web arranged between said shorter yoke leg sections, said lamination elements bearing at the end faces of their shorter yoke leg sections against said central web.

6. The laminated magnetic core as defined in claim 5, wherein said yoke leg sections and said outer legs possess essentially the same width and in relation to said central web practically half the width thereof, and wherein the length of each outer leg corresponds to the width of said central web, each longer yoke leg section being three times as long as wide, and each longer yoke leg section being longer by an amount corresponding to its width than the length of each shorter yoke leg section, the length of said central web essentially corresponding to three times the width of said outer leg, so that two of said lamination elements with the end faces of their yoke leg sections bearing against one another together with said central web surrounded by said two lamination elements can be assembled together into a gapless rectangle.

7. The laminated magnetic core as defined in claim 5, wherein said yoke leg sections and each said outer leg essentially possess the same width and with respect to said central web practically one-half of the width thereof, said central web essentially being as long as it is wide, the length of each outer leg corresponding to its width, each said longer yoke leg section being longer than each said shorter yoke leg sections by an amount corresponding to its width, so that two lamination elements mutually engage with their shorter yoke leg sections between the yoke leg sections of the other lamination element so as to be assembled together into a gapless rectangle.

8. The laminated magnetic core as defined in claim 5, wherein said central web arranged between both of said shorter yoke leg sections is guided to be displaceable in its lengthwise direction by said shorter yoke leg sections so as to form an adjustable size air gap.

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