

Description

BACKGROUND OF THE INVENTION

1) Field of the Invention

The present invention relates to a wound core of a transformer to which cylindrical coil bobbins are applied and a method for manufacturing the same.

2) Description of the Related Art

As wound cores of transformers to which cylindrical coil bobbins are applied, circular cross sectional cores, which have advantages in that they are very thin, very small, and very light, the like, recently have been used (see: Japanese Examined Patent Publication (Kokoku) Nos. 60-28375 and 61-22851, Japanese Unexamined Patent Publication (Kokai) No. 55-132027 and GB-A-692 845).

In the above-mentioned wound core, however, the beginning and end portions of a wound strip material may be deviated from the wound center thereof, and as a result, when a pressure welded coil bobbin is applied to the wound core and is rotated, the wound core scratches the inner surface of the coil bobbin, thereby seriously hindering the winding operation. Also, it sometimes becomes impossible to perform a pressure welding operation because the coil bobbin has split into two pieces, as explained later in detail.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a wound core which avoids the scratching of the inner surface of the coil bobbin and allows the pressure welding of the coil bobbin, even when the beginning and end portions of the wound core are deviated from the center position.

According to the present invention there is provided a wound core to which a cylindrical coil bobbin for windings is applied, said core being formed by winding a flat strip of core material about a predetermined axis such that the width of the wound strip extends substantially parallel to the said axis, the strip being wound such that the core is symmetrical about a plane perpendicular to the said axis, and the width of the strip varying along its length such that the periphery of a cross-section through the core in a plane perpendicular to the strip and parallel to the said axis defines a portion of the circle, characterised in that the said cross-section periphery comprises an elliptical portion extending through the said plane of symmetry and circular portions of equal radius of curvature, centred on a common point, and extending from op-

posite ends of the elliptical portion, the distance to the said common point from any point on the elliptical portion except its end being less than the radius of curvature of the circular portions.

The said cross-section periphery may comprise a straight portion extending between ends of the circular portions remote from the said elliptical portions.

Alternatively, the said cross-section periphery may comprise two elliptical portions each of which extends through the said plane of symmetry, a radially outer elliptical portion extending between ends of the circular portions furthest from said axis and a radially inner elliptical portion extending between radially inner ends of the circular portions nearest to the said axis.

As a further alternative the said cross-section periphery may comprise a straight portion extending between ends of the circular portions remote from the said elliptical portions, the circular portions extending such that the tangent to the circular portions at the said ends are parallel to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more clearly understood from the description as set forth below with reference to the drawings, wherein:

Fig. 1 is a cross-sectional view of a prior art wound core having a circular cross-section, to which a cylindrical coil bobbin is applied;

Fig. 2 is a cross-sectional view for explaining a problem in the wound core of Fig. 1;

Figs. 3A and 3B are cross-sectional views illustrating

embodiments of the wound core according to the present invention;

Fig. 4 is a cross-sectional view of the wound core of Fig. 3A to which a cylindrical coil bobbin is applied;

Fig. 5 is a perspective view illustrating the entire transformer including the wound core of Fig. 3A; Fig. 6A is a plan view of the wound core of Fig. 3A;

Fig. 6B is a cross-sectional view taken along the lines of B-B of Fig. 6A;

Figs. 7 and 8 are plan views explaining methods of cutting the strip of Fig. 3A;

Fig. 9A is a plan view of the wound core of Fig. 3B, which is applied to a single-phase shell type transformer;

Fig. 9B is a cross-sectional view taken along the lines B-B of Fig. 9A;

Fig. 10A is a plan view of the wound core of Fig. 3B, which is applied to a tripod three-phase type transformer;

Fig. 10B is a cross-sectional view taken along the lines B-B of Fig. 10A;

Figs. 11 and 12 are plan views explaining methods of cutting strips for the wound core of Fig. 3B;

Figs. 13 and 15 are plan views explaining methods of cutting strips for the wound core of Fig. 3B; and

Fig. 14 is an enlargement of a part of Fig. 13.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before describing the present invention, the prior art wound core will be explained with reference to Figs 1 and 2. In Fig. 1, a wound core 1 is obtained by winding strip material having excellent magnetic characteristics, which material is cut in advance to predetermined shapes. That is, the cross section of the wound core 1 is circular. For this wound core 1, two split pieces for a cylindrical coil bobbin 2 are pressure welded at pressure welding faces 3, and the windings (not shown) are wound onto the coil bobbin 2 by rotation. Therefore, in this case, an air gap 4 between the wound core 1 and the coil bobbin 2 is reduced, thus obtaining excellent magnetic characteristics.

In the wound core 1 of Fig. 1, however, the beginning and end portions of the stripped material may be deviated from the wound center thereof, as indicated by arrows X and Y in Fig. 2, in accordance with the winding apparatus (not shown) or the terminal processing operations. As a result, when the pressure welded coil bobbin 2 is rotated, the core 1 scratches the inner surface of the coil bobbin 2, particularly at the pressure weld portions 3, so that it is impossible to carry out a winding operation, and at worst, it becomes impossible to perform a pressure welding operation upon the coil bobbin 2.

In the present invention, as illustrated in Fig. 3A, the cross section of the beginning and end portions of a wound core 1' is elliptic, and the cross sections of the other portions are circular, in the same way as in the prior art. Note, only one of the beginning and end portions need be elliptic.

Also, a wound core applied to a single-phase shell type transformer or a tripod three-phase transformer has a semicircular cross section. In this case, according to the present invention as illustrated in Fig. 3B, the beginning or end portion is elliptic, and the other portions are circular.

Referring to Fig. 4, the wound core 1' of Fig. 3A will be explained in detail. In Fig. 4, the cross sections of a beginning portion 11 and an end portion 12 of the wound core 1' are elliptic. Therefore, the air gap 4' between the beginning portion 11 and the end portion 12 and the coil bobbin 2 is larger, compared with the prior art as shown in Fig. 1, but, this is the minimum amount. In the wound

core 1' as shown in Fig. 4, even when the beginning portion 11 and the end portion 12 are deviated from the winding center position, the air gap 4' between these portions 11 and 12 and the coil bobbin 2 is large enough to avoid scratching of the inner surface of the coil bobbin 2, particularly, the pressure welding portions 3, or allow the pressure welding of the coil bobbin 2 are avoided.

Also, in the wound core 1' of Fig. 4, the thickness t' thereof is smaller than the thickness t of the prior art wound core 1 of Fig. 1. Therefore, the entire length L of the wound core 1' as shown in Fig. 5, i.e., the total length of a transformer, is reduced, thus reducing the size of the transformer.

Note that, in the above-mentioned embodiment, although both the beginning and end portions are elliptic, only one thereof need be elliptic. In this case, the effect is a little reduced, but is still better than that of the prior art.

The wound core 1' of Fig. 3A is illustrated in entirety in Fig. 6A. Note that Fig. 6B is a cross sectional view taken along the lines B-B of Fig. 6A. In view of the efficiency of utilization of the material and the ease of the cutting operation, when cutting strips for the wound core 1', one of the straight sides of a material remains linear, and the other side is cut in accordance with a predetermined curve as illustrated in Fig. 7. Alternatively, both of the straight sides of a material remain linear, and cutting is carried out along two predetermined curves as illustrated in Fig. 8. In Fig. 8, one of the curves has concave portions opposing convex portions of the other curve, thereby enhancing the material efficiency.

Note that, in practice, the length of a strip for one wound core 1' is very large, for example, about 20 m, but the width thereof is very small, for example, about 1 to 3 cm. Therefore, even when one side of the strip is straight and only the other side thereof is curved, the strip can be wound to form the wound core 1' as illustrated in Figs. 6A and 6B. Also, it is easy to determine the curves of Figs. 7 and 8 by calculation in accordance with the shape of the wound core 1', as illustrated in Figs. 6A and 6B, and by the thickness of the material. Alternatively, a rectangular wound core can be cut and rounded to obtain the wound core 1' as illustrated in Fig. 3A, and the obtained wound core 1' then developed to obtain a model strip. As a result, the above-mentioned curves can be determined by actually measuring the width of the model strip.

The semicircular wound core 1'' of Fig. 3B is applied to wound cores 21 and 22 of a single-phase shell type transformer as shown in Figs. 9A and 9B, or to an outer core 23 and inner cores 24 and 25 of a tripod three-phase transformer as shown in Figs. 10A and 10B, and the cutting of the strips is carried out as shown in Fig. 11 or 12, in

the same way as in Figs. 7 and 8. In Figs. 11 and 12, however, sharp portions are generated in the cutting angle, as indicated by an arrow X in Fig. 11 or arrows Y and Z in Fig. 12. If such cutting is carried out by a slitter apparatus, the slitter apparatus must be stopped at such portions X, Y, and Z, and these portions cut by other means. Therefore, since the slitter apparatus usually operates so that the material moves at a speed of more than 200 m/min, the efficiency of the operation is remarkably reduced, thus increasing the cost of manufacturing the transformers (wound cores).

In Fig. 13, which is a modification of Fig. 11, a material 31 has two straight lines on both sides. One of the sides 31a remains straight, and cutting is performed on the other side along a predetermined curve 31b, and thus a plurality of strips 32 are obtained. Note that the above-mentioned predetermined curve 31b is set so that the strips 32 are wound on a predetermined mold, thus obtaining the semicircular cross-sectional wound core 21, 22, or 23 as shown in Figs. 9A, 9B, 10A, and 10B. That is, cutting is carried out along a line and/or a mild sloped curve 31c. Note that, in each of the cut strips 32, the length is actually about 500 times the width. Therefore, the curve 31c is a very mild sloped curve, as indicated by Fig. 14 which is an enlargement of Fig. 13. For example, the entire length of a strip is 20 m, and the mild sloped portion is about 5 cm. This portion is also wound as the wound case, and therefore, there is little loss. As a result, it is possible for the slitter apparatus (see Japanese Examined Patent Publication (Kokoku) No. 60-28375 and Japanese Unexamined Patent Publication (Kokai) No. 55-132057) to carry out a cutting operation along the curves 31b and 31c without stopping.

In Fig. 15, which is a modification of Fig. 12, both straight sides 41a and 41b of a material remain straight, and cutting is carried out simultaneously along two predetermined curves 41c and 41d, thereby obtaining a plurality of strips 42 and 43. In this case, the concave and convex portions of a plurality of strips 42 oppose the convex and concave portions of a plurality of strips 43, respectively, thereby increasing the efficiency of utilization of the material.

Note that the cutting method as shown in Figs. 13 and 15 can be easily carried out by using the slitter apparatus as shown in Japanese Examined Patent Publication (Kokoku) No. 60-28375 or Japanese Unexamined Patent Publication (Kokai) No. 55-132027.

As explained above, according to the present invention, even when both or one of the beginning and end portions are deviated from the wound center position, scratching of the inner surfaces of coil bobbins can be avoided and the pressure

welding of the coil bobbins can be allowed. Also, strips for semicircular cross-sectional wound cores having an excellent operational efficiency can be obtained.

Claims

1. A wound core to which a cylindrical coil bobbin for windings is applied, said core (1', 1'') being formed by winding a flat strip of core material about a predetermined axis such that the width of the wound strip extends substantially parallel to the said axis, the strip being wound such that the core is symmetrical about a plane perpendicular to the said axis, and the width of the strip varying along its length characterised in that the periphery of a cross-section through the core (1' 1'') in a plane perpendicular to the strip and parallel to the said axis comprises an elliptical portion extending through the said plane of symmetry and circular portions of equal radius of curvature, centred on a common point, and extending from opposite ends of the elliptical portion, the distance to the said common point from any point on the elliptical portion except its end being less than the radius of curvature of the circular portions.
2. A wound core according to claim 1, wherein the said cross-section periphery comprises a straight portion extending between ends of the circular portions remote from the said elliptical portions.
3. A wound core according to claim 1, wherein the said cross-section periphery comprises two elliptical portions each of which extends through the said plane of symmetry, a radially outer elliptical portion extending between ends of the circular portions furthest from said axis and a radially inner elliptical portion extending between radially inner ends of the circular portions nearest to the said axis.
4. A wound core according to claim 1, wherein the said cross-section periphery comprises a straight portion extending between ends of the circular portions remote from the said elliptical portions, and the tangents to the circular portions at the said ends are parallel to each other.

Patentansprüche

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the same way as in Figs. 7 and 8. In Figs. 11 and 12, however, sharp portions are generated in the cutting angle, as indicated by an arrow X in Fig. 11 or arrows Y and Z in Fig. 12. If such cutting is carried out by a slitter apparatus, the slitter apparatus must be stopped at such portions X, Y, and Z, and these portions cut by other means. Therefore, since the slitter apparatus usually operates so that the material moves at a speed of more than 200 m/min, the efficiency of the operation is remarkably reduced, thus increasing the cost of manufacturing the transformers (wound cores).

In Fig. 13, which is a modification of Fig. 11, a material 31 has two straight lines on both sides. One of the sides 31a remains straight, and cutting is performed on the other side along a predetermined curve 31b, and thus a plurality of strips 32 are obtained. Note that the above-mentioned predetermined curve 31b is set so that the strips 32 are wound on a predetermined mold, thus obtaining the semicircular cross-sectional wound core 21, 22, or 23 as shown in Figs. 9A, 9B, 10A, and 10B. That is, cutting is carried out along a line and/or a mild sloped curve 31c. Note that, in each of the cut strips 32, the length is actually about 500 times the width. Therefore, the curve 31c is a very mild sloped curve, as indicated by Fig. 14 which is an enlargement of Fig. 13. For example, the entire length of a strip is 20 m, and the mild sloped portion is about 5 cm. This portion is also wound as the wound case, and therefore, there is little loss. As a result, it is possible for the slitter apparatus (see Japanese Examined Patent Publication (Kokoku) No. 60-28375 and Japanese Unexamined Patent Publication (Kokai) No. 55-132057) to carry out a cutting operation along the curves 31b and 31c without stopping.

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welding of the coil bobbins can be allowed. Also, strips for semicircular cross-sectional wound cores having an excellent operational efficiency can be obtained.

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2. A wound core according to claim 1, wherein the said cross-section periphery comprises a straight portion extending between ends of the circular portions remote from the said elliptical portions.
3. A wound core according to claim 1, wherein the said cross-section periphery comprises two elliptical portions each of which extends through the said plane of symmetry, a radially outer elliptical portion extending between ends of the circular portions furthest from said axis and a radially inner elliptical portion extending between radially inner ends of the circular portions nearest to the said axis.
4. A wound core according to claim 1, wherein the said cross-section periphery comprises a straight portion extending between ends of the circular portions remote from the said elliptical portions, and the tangents to the circular portions at the said ends are parallel to each other.

Patentansprüche

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- Kernmaterial um eine vorgegebene Achse hergestellt wird, so daß sich die Breite des gewickelten Streifens im wesentlichen parallel zu dieser Achse erstreckt, wobei der Streifen derart gewickelt wird, daß sich der Kern symmetrisch um eine senkrecht zu der Achse verlaufende Ebene erstreckt und die Breite des Streifens entlang seiner Länge variiert, wobei ferner der Umfang eines Schnittes durch den Kern (1', 1'') in einer Ebene senkrecht zum Streifen und parallel zu der Achse einen elliptischen Abschnitt, der sich durch die Symmetrieebene erstreckt, und kreisförmige Abschnitte mit gleichem Krümmungsradius umfaßt, die auf einem gemeinsamen Punkt zentriert sind und sich von gegenüberliegenden Enden des elliptischen Abschnittes aus erstrecken, und wobei der Abstand zu dem gemeinsamen Punkt von jedem beliebigen Punkt auf dem elliptischen Abschnitt mit Ausnahme seines Endes geringer ist als der Krümmungsradius der kreisförmigen Abschnitte.
2. Wickelkern nach Anspruch 1, bei dem der Umfang des Schnittes einen geraden Abschnitt aufweist, der sich zwischen Enden der kreisförmigen Abschnitte entfernt von den elliptischen Abschnitten erstreckt.
3. Wickelkern nach Anspruch 1, bei dem der Schnittumfang zwei elliptische Abschnitte umfaßt, von denen jeder durch die Symmetrieebene verläuft, wobei sich ein radial äußerer elliptischer Abschnitt zwischen Enden der kreisförmigen Abschnitte, die am weitesten von der Achse entfernt sind, und ein radial innerer elliptischer Abschnitt zwischen radial inneren Enden der kreisförmigen Abschnitte, die am nächsten zur Achse liegen, erstreckt.
4. Wickelkern nach Anspruch 1, bei dem der Schnittumfang einen geraden Abschnitt umfaßt, der sich zwischen Enden der kreisförmigen Abschnitte entfernt von den elliptischen Abschnitten erstreckt, und bei dem die Tangenten an die kreisförmigen Abschnitte an diesen Enden parallel zueinander verlaufen.

Revendications

1. Noyau enroulé sur lequel est appliquée une armature de bobine cylindrique pour enroulements, ledit noyau (1', 1'') étant formé en enroulant une bande plate du matériau constituant le noyau autour d'un axe prédéterminé de façon à ce que la largeur de la bande enroulée s'étende sensiblement parallèlement audit axe, la bande étant enroulée de façon à

ce que le noyau soit symétrique par rapport à un plan perpendiculaire audit axe, et la largeur de la bande variant tout au long de sa longueur, caractérisé en ce que la périphérie d'une coupe transversale du noyau (1' 1'') dans un plan perpendiculaire à la bande et parallèle audit axe comporte une portion elliptique coupant ledit plan de symétrie et des portions circulaires ayant même rayon de courbure, centrées sur un point commun, et s'étendant à partir des extrémités opposées de la portion elliptique, la distance au dit point commun depuis n'importe quel point de la portion elliptique, à l'exception de ses extrémités, étant inférieure au rayon de courbure des portions circulaires.

2. Noyau enroulé selon la revendication 1, caractérisé en ce que la périphérie de la coupe transversale comporte une portion rectiligne s'étendant entre les extrémités des portions circulaires éloignées desdites portions elliptiques
3. Noyau enroulé selon la revendication 1, caractérisé en ce que la périphérie de la coupe transversale comporte deux portions elliptiques, chacune d'entre elles coupant le plan de symétrie, une portion elliptique radialement extérieure s'étendant entre les extrémités des portions circulaires les plus éloignées dudit axe, et une portion elliptique radialement intérieure s'étendant entre les extrémités radialement intérieures des portions circulaires les plus proches dudit axe.
4. Noyau enroulé selon la revendication 1, caractérisé en ce que la périphérie de la coupe transversale comporte une portion rectiligne s'étendant entre les extrémités des portions circulaires éloignées des portions elliptiques, les tangentes aux portions circulaires aux dites extrémités étant parallèles entre elles.