May 27, 1941. G. W. RAWLINGS 2,243,318

LAMINATED MAGNETIC ELEMENT

Filed Oct. 27, 1938 3 Sheets-Sheet 1

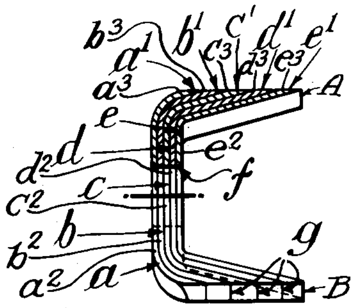


FIG. 1.

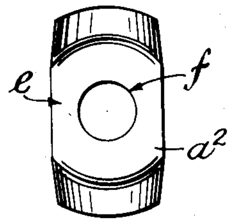


FIG. 2.

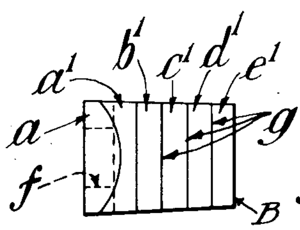


FIG. 3.

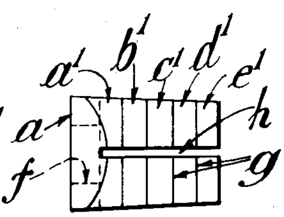


FIG. 4.

FIG. 5.

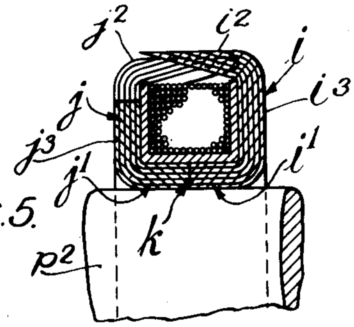
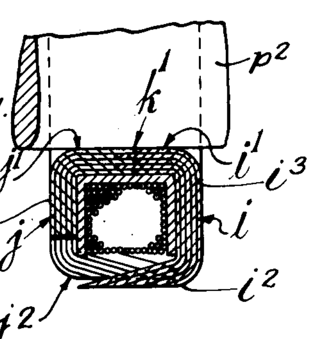


FIG. 5a.



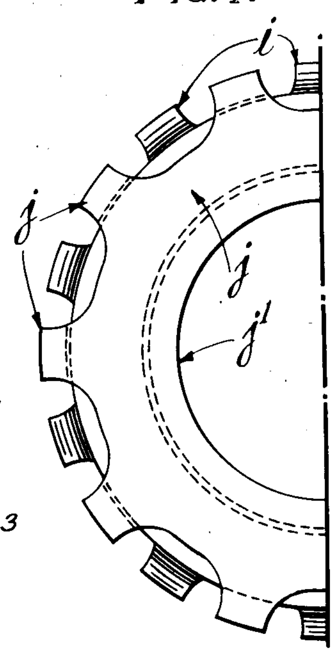


FIG. 6.

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LAMINATED MAGNETIC ELEMENT

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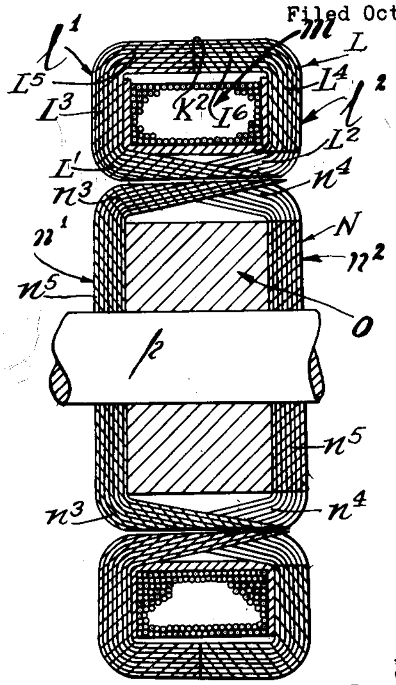

FIG. 7.

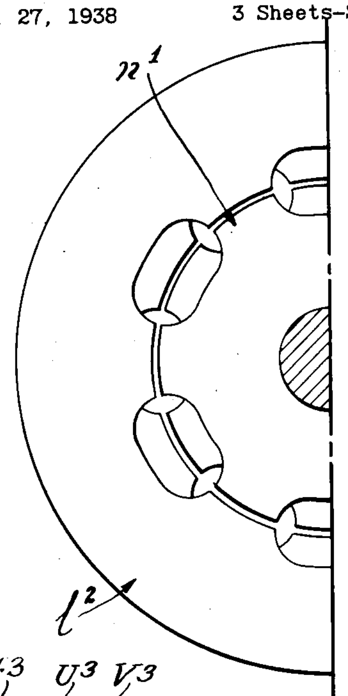

FIG. 8.

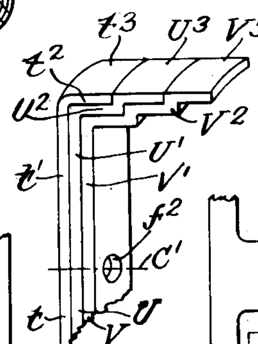

FIG. 11.

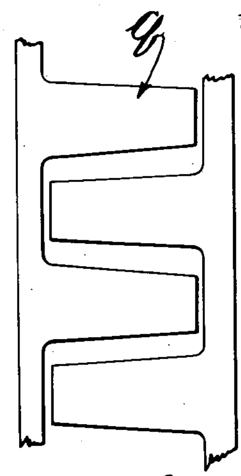

FIG. 9.

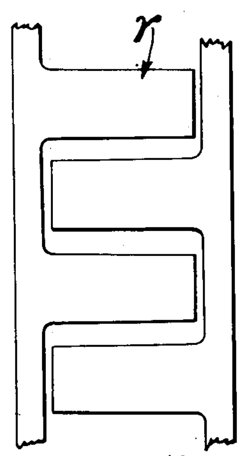

FIG. 10.

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LAMINATED MAGNETIC ELEMENT

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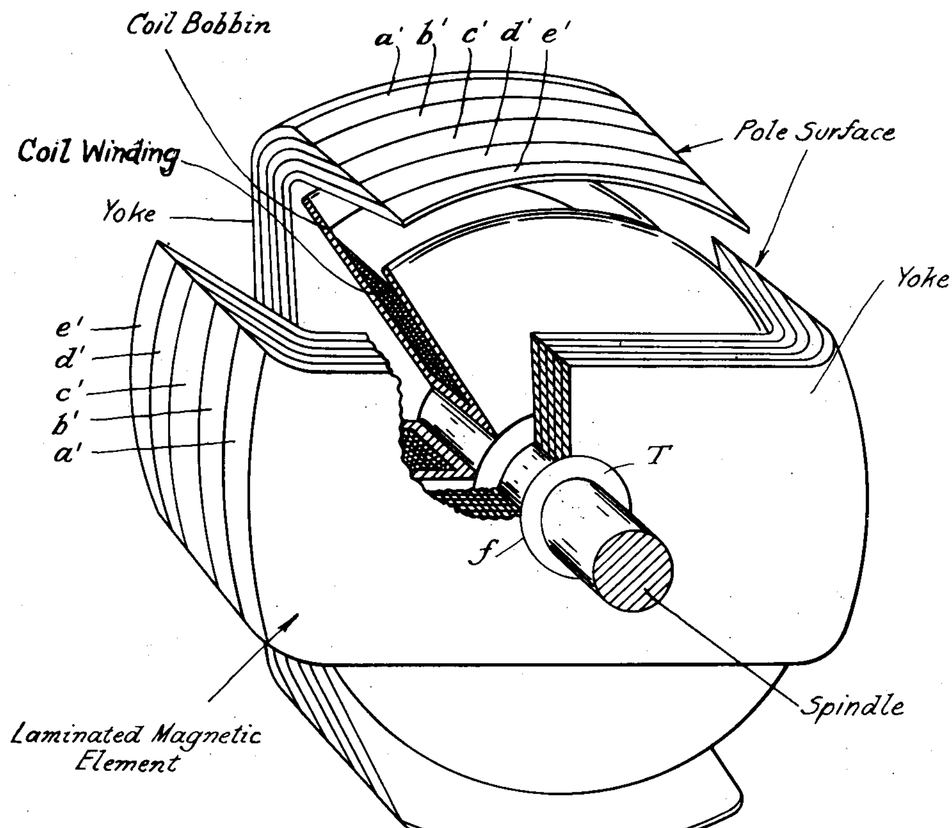

FIG. 12

Inventor:
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Patented May 27, 1941

2,243,318

UNITED STATES PATENT OFFICE

2,243,318

LAMINATED MAGNETIC ELEMENT

George William Rawlings, Willow Meer, Kenilworth, England

Application October 27, 1938, Serial No. 237,290
In Great Britain November 1, 1937

11 Claims. (Cl. 171—252)

This invention relates to laminated magnetic elements used in the construction of imbricated type armature and field cores, and other imbricated type magnetic circuits. The term "imbricated type armature or field core" is herein used to define the known type of armature or field core construction wherein the alternate poles are formed by the interdigitation of two sets of pole pieces, each set having a common yoke of such a form that when the two sets of pole pieces are interdigitated the magnetic circuit between them can be completed in such a manner that the iron circuit so formed can embrace a coil winding disposed concentric with the axis of the core and flux-linked with the two sets of interdigitated pole pieces.

It is an object of the present invention to provide an improved construction of laminated imbricated type armature or field core and a laminated magnetic element used in forming such cores. The laminated magnetic element of or for the laminated imbricated type armature or field core of the invention comprises a plurality of laminations nested one within another, each lamination having a yoke and a plurality of pole pieces extending laterally from the yoke, the pole pieces forming poles, each having a pole surface formed largely by end portions of the pole pieces. The pole pieces preferably have bevelled ends and when the laminations are nested together the pole pieces form poles and the bevelled ends collectively form a pole surface for each pole.

In the accompanying drawings:

Fig. 1 is a part sectional side elevation of a laminated magnetic element forming one-half of a 4-pole imbricated armature core.

Fig. 2 is a front elevation of the core of Fig. 1.

Fig. 3 is a plan of the laminated magnetic element of Fig. 1.

Fig. 4 is a plan showing a modification of Fig. 3.

Figs. 5 and 6 are sectional and front elevations of a 20-pole imbricated armature core.

Fig. 5*a* is a modified form of the core of Figs. 5 and 6.

Figs. 7 and 8 are sectional and part side elevations of a further example of the invention.

Figs. 9 and 10 are developed plans of alternative pole forms.

Fig. 11 is a fragmentary perspective view illustrating an alternative form of pole piece.

Fig. 12 is a perspective view with parts removed illustrating a rotor formed of the laminated elements of Figs. 1, 2 and 3.

As illustrated in Figs. 1 to 3, the laminated magnetic element is one-half of a 4-pole imbricated armature core as shown in Fig. 12 and comprises 5 laminations, *a, b, c, d,* and *e,* each of which is substantially U-shaped with flat yoke a^2, b^2, c^2, d^2, and e^2 having a central hole *f* by which the laminations are ultimately assembled on a spindle. The laminated magnetic element has an armature axis C through the hole *f* which is concentric with the center of the spindle or shaft upon which the magnetic element is to be mounted. Each lamination has also a pair of arms or pole pieces a^3, b^3, c^3, d^3, and e^3 bent laterally with respect to their respective yokes and inclined with respect to the armature axis C which are of curved cross-section, and the bevelled ends a^1, b^1, c^1, d^1, and e^1 form collectively two cylindrical or arcuate shaped pole surfaces. The pole pieces as assembled together form separate poles A and B, each of which has a pole surface formed substantially of the bevelled ends of the separate pole pieces. Each bevelled end is, therefore, a part of the pole surface.

The divisional lines *g* of the pole surface formed by the adjoining bevelled ends of the laminations are substantially parts of circles in planes at right angles to the armature axis, and in Fig. 3 appear as straight lines parallel to the planes of the yoke parts of the laminations and this is due to the formation of the curved inner faces of the arms as conical surfaces coaxial with the cylindrical outer pole surface. The shape and direction of the lines *g* may obviously be varied by altering the shape of the inner faces and therefore changing the formation of the lines of intersection.

Further division of the pole surfaces may be obtained, as shown in Fig. 4, by cutting one or more narrow slots *h,* in the arms which may be substantially closed in the bending operation.

A simple and preferred method of manufacture consists in super-imposing and assembling 5 equal lamination stampings on a locating pin at the end of a conical plug and shaping the laminations by one forming and one cutting operation by forcing the plug first into a taper-forming die and then through a ring shearing die. The outer cylindrical surfaces of the assembly, that is, the pole surfaces, may be formed by grinding off the ends of the pole pieces, forming the bevelled ends, which collectively comprise a pole surface.

As shown in Figs. 5 and 6, the 20-pole imbricated armature core is formed of a pair of interdigitated laminated magnetic elements *i* and *j,* the poles i^2 and j^2 of which are formed in the same manner as the poles of the 4-pole armature described above and the magnetic circuit between alternate poles is completed through inwardly turned annular flanges i^1 and j^1 which engage each other with substantial edge register between complementary laminations on the centre line k. The engaging end faces of these flanges i^1 and j^1 may be ground to reduce air gap reluctance. The yokes i^3 and j^3 of the core elements are more or less at right angles to the spindle p^2 and extend from the flanges to the pole pieces i^2 and j^2.

In the modification Fig. 5*a*, the engagement lines of the flanges of the several laminations are stepped as at k^1, so that the flanges are interleaved. In this form also the pole pieces may be slotted in the same manner as the pole illustrated in Fig. 4 for further division of the pole surface.

In Figs. 7 and 8 the invention is shown applied to a magneto electric machine of the type in which the armature core L encircles a permanent magnet field core N. In this construction l^1 and l^2 are a pair of interdigitated laminated magnetic core elements, each having six poles L^1 and L^2, the pair of elements being secured together with an electric coil m embraced between them and with the pole pieces equally spaced apart, such assembly forming the armature. Each core element is formed of a plurality of laminations having yokes L^3 and L^4, flanges L^5 and L^6 bent at right angles to the yokes and poles L^1 and L^2 inclined with respect to the yokes similar to the poles of Figs. 1 to 3. The flanges join along the line k^2 where the contact is such as to establish a good magnetic circuit. The field magnet core N comprises a pair of interdigitated laminated magnetic elements n^1 and n^2 each having six poles N^3 and N^4 assembled together to embrace a cylindrical permanent magnet o secured to a shaft or spindle p, preferably of non-magnetic material. Each magnetic element is formed of a plurality of laminations including a yoke n^5 having a hole by means of which the element is mounted upon the spindle p. The yokes are preferably at right angles to the axis of the spindle and the pole pieces of the poles are bent laterally with respect to the yokes and have pole surfaces similar to those of Figs. 1 to 3 which are arcuate and concentric to the spindle p. The cylindrical magnet is magnetised axially so that the alternate laminated pole pieces of the assembly are of opposite polarity. The construction therefore provides 12 reversals of polarity for each revolution of the armature.

When the construction is adapted for the purpose of a spark ignition magneto, the single coil m would be replaced by the necessary primary and secondary coils.

It will be appreciated that the permanent magnet o could be replaced by an electro-magnet coil, in which case the laminated elements n^1 and n^2 would preferably be constructed with annular flanges at the bore similar to those shown at i^1 and j^1 in Fig. 5 to complete the magnetic circuit independently of the shaft p. A motor or generator of this form could be arranged for either A. C. or D. C. working by the provision of suitable means of commutation or rectification.

In Figs. 9 and 10, are shown alternative pole forms, the relative effects and advantages of which will be known to a person familiar with the design of generators or motors, the poles q in Fig. 9 being tapered whilst the poles r of Fig. 10 are parallel sided.

The laminated magnetic element illustrated in Fig. 11 comprises a plurality of laminations e, u and v having yokes t^1, u^1 and v^1 arranged at right angles to the axis C^1 of the hole f^2 by means of which the element is mounted upon a spindle. The pole pieces t^2, u^2 and v^2 extend laterally with respect to the yokes and have arcuate surfaces t^3, u^3 and v^3. The pole pieces in their grouped arrangement form a pole and the arcuate surfaces thereof collectively form a pole surface.

The rotor illustrated in Fig. 12 is formed of two interdigitated laminated magnetic elements similar to those of Figs. 1 to 3. A sleeve or tube T is inserted in the hole f of the magnetic elements and this tube is reduced in diameter at its ends to form a slight shoulder against which the laminations are located and then the outer end of the tube is swaged over to secure the laminations thereon. It is, of course, understood that the bobbin is fitted on the tube between the sets of laminations before they are secured together. It is further understood that any other suitable means may be used for securing the laminations together, and in relation with respect to each other and the spindle, such as a threaded bushing and nuts, nuts screwed over a threaded spindle bearing against the laminations, or by pressing the laminations over the spindle to a snug fit.

As will be seen, in all forms of the core, the area of the pole surface is at least twice the minimum cross sectional area of the laminations and the laminations substantially follow the flux path in the core, and where more than 4 poles are provided, each lamination resembles a cup with castellated side.

It will be seen from the drawings that the laminations are formed of pieces of thin metal having broad surfaces and narrow edge surfaces. The term "broad surface" used in some of the claims refers to the kind of surfaces which are in contact by reason of the nesting of the laminations. As shown in the drawings the laminations are so arranged that the broad surfaces of the yokes are transverse to the longitudinal axis of the spindle.

The armature core construction such as shown in Figs. 1 to 5 may with advantage be combined with the invention described in my copending application Serial No. 141,669, filed May 10, 1937. That is to say, it is known that an imbricated armature of itself provides a load voltage/speed limitation due to its different internal flux path and different internal flux leakage paths as compared with a non-imbricated armature, but in spite of this difference an appreciable advantage in improved load voltage/speed control is obtainable from the said combination.

What I claim is:

1. A laminated magnetic element for an imbricated magnetic core comprising a plurality of laminations nested one within another, the laminations having pole pieces which form poles each of which has a pole surface, said pole pieces being inclined to the pole surface and having their ends bevelled so as collectively to form such pole surface, each lamination being substantially of the form of a conical cup with castellated side.

2. A laminated magnetic element for an imbricated magnetic core comprising a plurality of laminations nested one within another, each lamination having two or more pole pieces which collectively form poles each having a pole surface, the area of the pole surface being at least twice the minimum cross sectional area of the laminations, and each pole piece being divided by a slot.

3. A laminated imbricated magnetic core comprising two separate interdigitated laminated magnetic elements each including a plurality of laminations having a plurality of pole pieces, a yoke, and a flange portion, the pole pieces forming poles, each pole having a pole surface formed of end portions of the pole pieces, the ends of the flange portions of the laminations of the two elements uniting with substantial end register establishing a magnetic circuit between the two elements.

4. A laminated imbricated magnetic core comprising two separate interdigitated magnetic elements each formed of a plurality of laminations having pole pieces and a yoke, the laminations being nested together so that the pole pieces form poles, each pole having a pole surface comprising end portions of the pole pieces, said pole pieces extending laterally with respect to the yoke, and means for mounting the elements on a spindle with the laminations of the two elements in magnetic contact and the poles interdigitated spaced relation.

5. A laminated magnetic element arranged to be mounted around a spindle which comprises a plurality of laminations nested one within another, each lamination having a yoke the broad surfaces of which are transverse to the longitudinal axis of the spindle and pole pieces, each of said pole pieces being inclined with respect to the yoke, the ends of the pole pieces being bevelled and collectively form a pole surface for the element.

6. A laminated magnetic element arranged to be mounted around a spindle which comprises a plurality of laminations nested one within another, each lamination having a yoke the broad surfaces of which are transverse to the longitudinal axis of the spindle and pole pieces, each of said pole pieces extending laterally from the yoke and having a surface of arcuate form, the pole pieces forming poles for the element, each pole having a pole surface comprising the separate adjoining surfaces of the pole pieces.

7. A laminated magnetic element which comprises a plurality of laminations nested one within another, each lamination having a yoke and pole pieces, a spindle upon which the nested laminations are mounted, each of said pole pieces extending laterally from the yoke and having a bevelled end surface of arcuate form concentric with the axis of the spindle, the laminations nested together being so arranged that the pole pieces are grouped together forming poles, each pole having a pole surface comprising arcuate surfaces of the pole pieces.

8. A laminated magnetic element for an imbricated magnetic core arranged to be mounted around a spindle which comprises a plurality of laminations nested one within another, each lamination having a broad surface transverse to the longitudinal axis of the spindle, each lamination having two or more pole pieces which form poles, each pole having a pole surface, said pole pieces being inclined to the broad surfaces and having their ends beveled so as collectively to form the pole surfaces.

9. A laminated magnetic element for an imbricated core arranged to be mounted around a spindle which comprises a plurality of laminations nested one within another, each lamination having a yoke the broad surfaces of which are transverse to the longitudinal axis of the spindle and two or more pole pieces extending laterally from the yoke, the pole pieces collectively forming poles each having a pole surface formed of end portions of the pole pieces, the area of the pole surface being at least twice the maximum cross-sectional area of the laminations.

10. A laminated imbricated magnetic core as defined in claim 4 in which each lamination is so arranged with respect to the longitudinal axis of the spindle that the broad surface of the yoke is transverse to the said axis and the pole pieces are so bent that the broad surfaces thereof are arcuate and concentric with the said axis.

11. A laminated imbricated magnetic core as defined in claim 7 in which each lamination is so arranged with respect to the longitudinal axis of the spindle that the broad surface of the yoke is transverse to the said axis and the pole pieces are so bent that the broad surfaces thereof are arcuate and concentric with the said axis.

GEORGE W. RAWLINGS.

CERTIFICATE OF CORRECTION.

Patent No. 2,243,318. May 27, 1941.

GEORGE WILLIAM RAWLINGS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 75, for "e" after "laminations" read --t--; page 3, first column, line 4, claim 3, after "laminations" insert the words --nested one within another, each lamination--; line 22, claim 4, after "poles" insert --in--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of July, A. D. 1941.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

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Henry Van Arsdale,
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(Seal)