

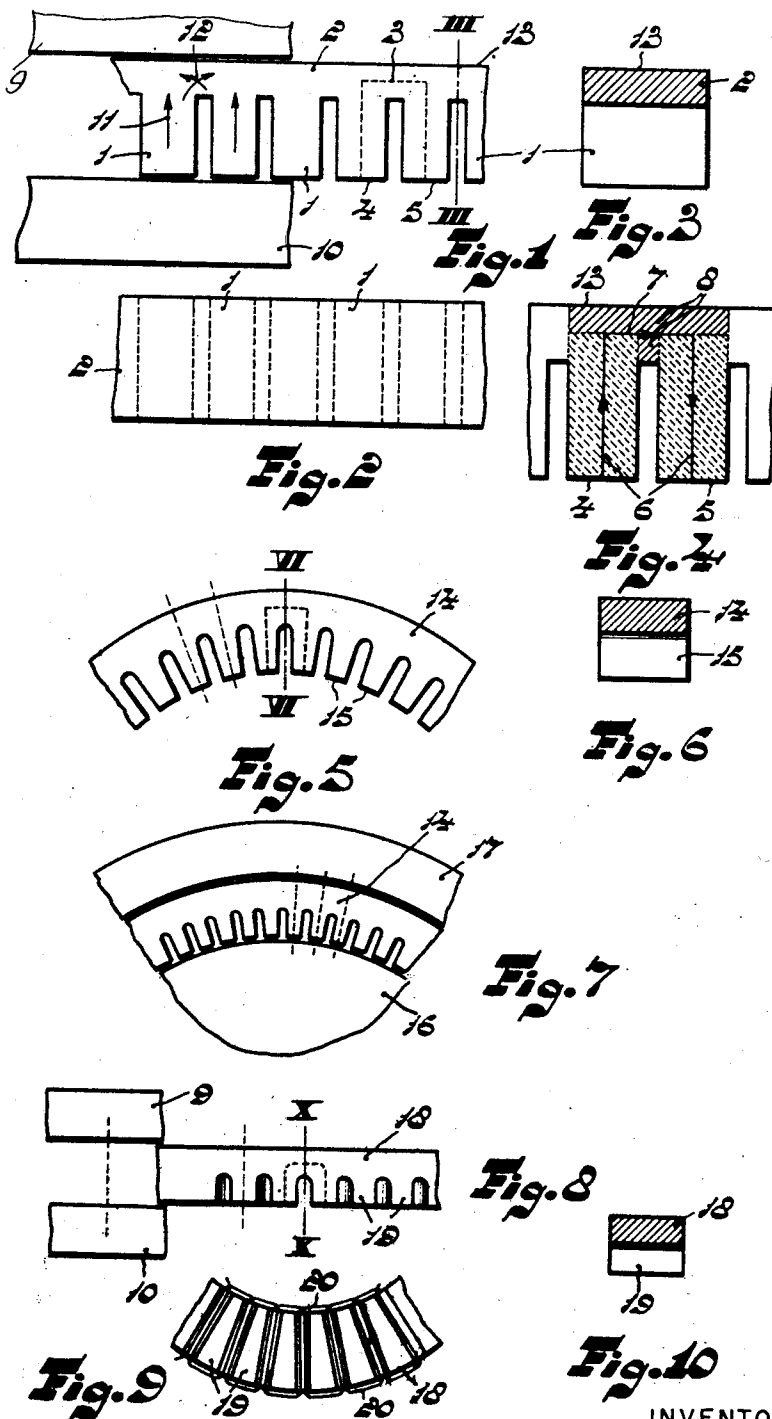
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PERMANENT MAGNET FOR DYNAMOELECTRIC MACHINES

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PERMANENT MAGNET FOR DYNAMOELECTRIC MACHINES

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The invention relates to a body of permanent magnet steel made in one piece and comprising a number of discrete poles, more particularly to an annular body comprising a great number of discrete poles, in which the mean path of the lines of force in the magnet steel between two adjacent poles is U-shaped. Such known, permanently magnetic bodies can be used in the form of rods, cylinders or tubes in various devices, for example in magnetic filters and electric machines, such as bicycle hub dynamos and the like. Although attempts have been made to manufacture such bodies from anisotropic magnet steel, this was found possible only if the shape and the dimensions of the bodies permitted of complicated arrangements for creating preferential directions in the entire U-shaped path of the lines of force in the magnet steel. Such methods are very complicated, particularly in mass production.

According to the present invention, the total length of the two limbs of a U-shaped body of the aforesaid kind is large compared with the length of the intermediate transverse connection—preferably more than one and a half time as large—and the material of the body is anisotropic magnet steel, of which the magnetic preferential direction in the entire body is at least substantially parallel to the direction of the limbs of the U-shaped body.

In the method of manufacturing the magnetic body according to the invention, in order to obtain the desired anisotropy the magnetic field is therefore applied during the cooling (hardening) of the material so that the direction of this field is parallel to the limbs of the U. This means that the transverse connection between the limbs of the U is not magnetised deliberately in its own direction, so that in this transverse connection no deliberately created anisotropic effect is obtained. It was surprising to find that nevertheless the resultant loss is comparatively low. In addition, for obtaining an economic product, the volume of magnetic material necessary for the transverse connection is generally required to be not more than 30% of the magnet steel volume of the two limbs, if they were secured to a soft-iron plate, as the yoke, and if they were thus capable of jointly yielding the desired magnetic power. This requirement determines at the same time the value of the ratio between the length of the two limbs and the length of the transverse connection of the U and this will be accounted for more fully in the description accompanying the drawing.

In order that the invention may be readily carried into effect, a number of examples will now be described in detail with reference to the accompanying drawing, in which the figures show diagrammatically several embodiments of the invention and in which:

Fig. 1 is a lateral view;

Fig. 2 is a plan view;

Fig. 3 is a cross-sectional view taken on the line III—III of a rod-shaped body according to the invention made in one piece;

Fig. 4 shows part of Fig. 1 on an enlarged scale;

Fig. 5 and Fig. 6 are a lateral view and a cross-sectional view respectively of one embodiment;

Fig. 7 shows a method of premagnetisation, and

Figures 8 to 10 are a lateral view, a plan view and a cross sectional view respectively of a further embodiment of the invention.

Figures 1 to 3 show a rod-shaped body 2 of permanent magnet steel, made in one piece and comprising a number of corporal poles 1, in which the mean path of the

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lines of force 3 in the magnet steel between two adjacent poles 4 and 5 of opposite polarities is U-shaped (Figure 1).

The total length 6 of the two limbs of the U (Figure 4) is large compared with the length 7 of the intermediate transverse connection, preferably more than one and a half time as large. When using conventional modern anisotropic magnet steels of the type described in the U. S. Patent #2,295,082 to G. B. Jonas this generally implies that the spacing between two adjacent poles 4 and 5 is comparatively small, since the sectional area of the poles at right angles to the path of the lines of force in the conventional constructions will be comparatively large owing to the unavoidably existing values of coercive force, remanence and $(BH)_{\max}$ of the said steels, from which the magnet length and sectional area can be calculated in the known manner. In view thereof, additional stray losses between the adjacent poles 4 and 5 must be taken into account.

After the length of the magnet is calculated, the magnet can be designed such that the length of each of the limbs 6 of the U-shaped mean path of the lines of force is equal to about half the total magnet length required. If the two poles 4 and 5 (hatched in broken lines in Figure 4) were secured to a soft-iron yoke plate, the magnet thus produced would satisfy the magnetic requirements. In the magnet body according to the invention, which precisely is to be made in one piece, the yoke is also made of anisotropic steel.

In Figure 4 is hatched the part 8 of magnet steel, which is used in excess due to this measure. Although at first sight this appears wasteful, the gain obtained in mass production is material if the excess use of magnet steel is less than 30% of the volume of the two poles hatched in broken lines, since additional manufacturing costs of mounting separate magnets on a yoke plate do not arise.

Such a magnet body can be hardened in a manner otherwise known (see, for example, U. S. Patent #2,295,082 to G. B. Jonas), for example between two magnet poles 9 and 10 (Figure 1) under the action of a magnetic field, the lines of force extending in the direction of the arrow 11. Theoretically it could be expected that the transverse connection between the two limbs would be magnetised precisely at right angles to the direction, in which the premagnetisation in this transverse connection would have to take place, in order to take full advantage of the transverse connection. That is to say that the transverse connection would yield a material reluctance to the detriment of the magnetic power which is supplied by the two limbs. However, it was surprising to find that this is not the case. This may be due to the fact that the lines of force, upon reaching the transverse connection, are liable to stray, as shown diagrammatically by the arrows 12 (Figure 1). This results in the transverse connection being magnetised at least more or less in the direction of the mean path of the lines of force (Figure 4), the reduced anisotropic properties of the transverse connection and the stray between the limbs 4 and 5 being apparently compensated by the greater quantity of magnet steel 8. If calculation and proportioning are effected correctly, it appears that after the final magnetisation of the magnet, for example in the manner shown in Figure 9, an iron plate cannot be held magnetically against the rear surface 13 of the magnet body. This shows that the number of stray lines of force on the rear surface 13 in line with the two limbs 4 and 5 is negligible, which would not be the case in the method of magnetisation as carried out, if the transverse connection were to constitute a material reluctance.

Figure 5 shows an annular magnet body 14, comprising radial poles 15. A cross-sectional view taken on the line VI—VI is shown in Figure 6 and Figure 7 shows a method of hardening the body between two poles 16 and 17. Such a magnet body is especially suited for use in a bicycle hub dynamo, in which a great number of poles is required for obtaining a sufficiently high frequency.

Figures 8, 9 and 10 show an annular magnet body 18, which is particularly suitable for use in a hub dynamo, the poles 19 extending in the axial direction sideways from the magnet body. This embodiment is more ad-

vantageous than that shown in Figure 5, since the pole surfaces, from which the magnetic lines of force emerge, are situated, on an average, on a greater diameter than in Figure 5, so that in principle a greater number of poles, for example 36, can be used. Such a magnet body can be premagnetized between poles 9 and 10 similar to that shown in Figure 1. The final magnetization can be effected with the use of a few turns 20, which are arranged to surround each pole and are fed from a current source, for example a capacitor battery.

What I claim is:

1. A magnetic assembly comprising an annular body constituted from a single piece of anisotropically-magnetized permanent magnet steel and having a plurality of separate spaced pole members extending therefrom, each of said pole members being adjacent a pole member of the opposite polarity on either side and having a preferential direction of magnetization in the direction of its length and being magnetized along said preferential direction whereby the main path of lines of force between the ends of said pole member is substantially U-shaped, said pole members being separated by a given distance and having a combined length which is substantially larger than the distance separating the pole members, said body having a preferential direction of magnetization which is substantially parallel to the preferential direction of magnetization of said pole members.

2. A magnetic assembly comprising an annular body constituted from a single piece of anisotropically-magnetized permanent magnet steel and having a plurality of separate spaced pole members extending radially therefrom, each of said pole members being adjacent a pole member of the opposite polarity on either side and having a preferential direction of magnetization in the direction of its length and being magnetized along said preferential direction and in a substantially radial direction toward said body whereby the mean path of lines of force between the ends of said pole members is substantially U-shaped, said pole members being separated by a given distance and having a combined length which is substantially larger than the distance separating the pole members, said body having a preferential direction of magnetization which is substantially parallel to the preferential direction of magnetization of said pole members.

3. A magnetic assembly comprising an annular body constituted from a single piece of anisotropically-magnetized permanent magnet steel and having a plurality of separate spaced pole members extending axially outwardly therefrom, each of said pole members being adjacent a pole member of the opposite polarity on either side and having a preferential direction of magnetization in the direction of its length and being magnetized along said preferential direction whereby the mean path of lines of force between the ends of said pole members is substantially U-shaped, said pole members being separated by a given distance and having a combined length which is substantially larger than the distance separating the pole members, said body having a preferential direction of magnetization which is substantially parallel to the preferential direction of magnetization of said pole members.

4. A magnetic assembly comprising an annular body constituted from a single piece of anisotropically-magnetized permanent magnet steel and having a plurality of separate spaced pole members extending radially inwardly therefrom, each of said pole members being adjacent a pole member of the opposite polarity on either side and having a preferential direction of magnetization in the direction of its length and being magnetized along said preferential direction whereby the mean path of lines of force between the ends of said pole members is substantially U-shaped, said pole members being separated by a portion of the body having a given distance, said pole members having a combined length which is substantially larger than the distance separating the pole members, said body having a preferential direction of magnetization which is substantially parallel to the preferential direction of magnetization of said pole members.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
204,141	Eaton	May 28, 1878
1,566,693	Pletscher	Dec. 22, 1925
2,189,524	Randolph et al.	Feb. 6, 1940
2,295,082	Jonas	Sept. 8, 1942
2,401,328	Black, Jr.	June 4, 1946
2,549,135	Sherman	Apr. 17, 1951