

Monopole Field Electric Motor Generator

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Background

Related Applications

- [1] This application claims international priority from a prior filed U.S. Utility Patent
10 Application having serial number 11200920 filed on August 9, 2005.

Field of the Present Disclosure

- [2] This disclosure relates generally to electric motors and electric generators and
15 more particularly to such rotating electromagnetic machines having monopole fields.

Description of Related Art

- [3] The following art defines the present state of the field of the apparatus described
20 and claimed herein:

- [4] Tu et al, US 2004/0135452, discloses a flat rotary electric generator that includes
at least one toroidal coil structure for cutting magnetic lines to induce a current and at
least one disc-shaped magnetic pole structure oriented parallel to the helical coil
25 structure. If multiple toroidal coil structures and disc-shaped magnetic coil structures
are included, the toroidal coil structures and disc-shaped magnetic coil structures are
arranged in alternating manner. The toroidal coil structure and disc-shaped magnetic
pole structure are not provided with a permeable material. When either the toroidal
coil structures or the at least one disc-shaped magnetic pole structure is rotated by an
30 external force, the toroidal coil structure cuts the magnetic lines passing therethrough

to generate an induced current. Neal, US 2002/0135263, discloses a plurality of stator arc segments that form a toroidal core for a stator assembly used to make a motor. In a preferred embodiment, a plurality of magnetic fields is created when electrical current is conducted through wire wound around poles on the toroidal core.

5 A monolithic body of phase change material substantially encapsulates the conductors and holds the stator arc segments in contact with each other in the toroidal core. Hard disc drives using the motor, and methods of constructing the motor and hard disc drives are also disclosed. Rose, US 6803691, discloses an electrical machine that comprises a magnetically permeable ring-shaped core centered on an

10 axis of rotation and having two axially-opposite sides. Coils are wound toroidally about the core and disposed sequentially along the circumferential direction. Each coil includes two side legs extending radially alongside respectively sides of the core. Coil-free spaces exist between adjacent side legs. A bracket has first and second side flanges that are connected by a bridging structure and respectively abut the first and

15 second sides of the coil. Mohler, US 6507257, discloses a bi-directional latching actuator that is comprised of an output shaft with one or more rotors fixedly mounted thereon. The shaft and rotor are mounted for rotation in a magnetically conductive housing having a cylindrical coil mounted therein and is closed by conductive end caps. The end caps have stator pole pieces mounted thereon. In one embodiment, the

20 rotor has at least two oppositely magnetized permanent magnets which are asymmetrically mounted, i.e., they are adjacent at one side and separated by a non-magnetic void on the other side. The stator pole piece has asymmetric flux conductivity and in one embodiment is axially thicker than the remaining portion of the pole piece. An abutment prevents the rotor from swinging to the neutral position

25 (where the rotor magnets are axially aligned with the higher conductivity portion of the pole piece). Thus, the rotor is magnetically latched in one of two positions being drawn towards the neutral position. Energization of the coil with an opposite polarity current causes the rotor to rotate towards its opposite latching position whereupon it is magnetically latched in that position. Mohler, US 5337030, discloses a permanent

30 magnet brushless torque actuator that is comprised of an electromagnetic core capable of generating an elongated toroidally shaped magnet flux field when energized. Outside the generally cylindrical coil is an outer housing with upper and

lower end plates at each end. Mounted to the end plates and extending towards each other are stator pole pieces separated from its opposing pole piece by an air gap. A permanent magnet rotor is disposed in the air gap and mounted on a shaft which in turn is rotatably mounted in each of the end plates. The permanent magnet rotor
5 comprises at least two permanent magnets, each covering an arcuate portion of the rotor and having opposite polarities. Energization of the coil with current in one direction magnetizes the pole pieces such that each of the two pole pieces attracts one of the magnets of the rotor and repels the other magnet of the rotor resulting in a torque generated by the output shaft. Reversal of the current flow results in a reversal
10 of the torque and rotation of the rotor in the opposite direction. Preferred embodiments are disclosed having multiple cells, i.e. a plurality of stator rotor stator combinations and/or cells in which there are a plurality of pole pieces at each stator pole plane. Kloosterhouse et al, US 5191255, discloses an electromagnetic motor that includes a rotor having a plurality of magnets mounted along a perimeter of the rotor. Preferably, adjacent magnets have opposite poles facing outward. One or more
15 electromagnets are disposed adjacent to the perimeter of the rotor so that as the rotor rotates, the magnets mounted on the rotor are carried near the poles of the electromagnets. Current is supplied to the electromagnets by a drive circuit in a predetermined phase relationship with the rotation of the rotor such that, for substantially all angular positions of the rotor, magnetic attraction and repulsion
20 between the poles of the electromagnets and the magnets mounted on the rotor urge the rotor to rotate in a desired direction. Reflective material is mounted on the rotor in predetermined angular positions. The drive circuit includes a photosensitive device which produces a signal whose value varies according to whether the device is receiving light reflected from the reflective material. The signal is amplified to
25 produce drive current for the electromagnets. Westley, 4623809, discloses a stepper motor housing a pole structure in which a pair of identical stator plates, each having a plurality of poles, are positioned back to back with the poles projecting in opposite directions, the stator plates being positioned between a pair of substantially identical stator cups, each stator cup having a plurality of poles projecting inwardly from a
30 back wall with a peripheral side wall terminating in an outwardly extending flange. A major surface of each flange is in contact with a face on one of the stator plates so as

to assure a low reluctance magnetic path. Fawzy, 4565938, discloses an electromechanical device which can be used as a motor or as a generator. The device has a housing, including bearing means to support a rotatable shaft. Disc magnet means are provided, and poled to have alternating polarity and are mounted on the shaft to define a rotor. The device includes at least one first pole shoe in contact with the magnet means, having a portion extending radially therefrom to define a virtual pole chamber, of a first polarity. Also included is at least one second pole shoe in contact with the magnet and having a portion extending radially therefrom to define a virtual pole chamber of the other polarity. A toroid stator is mounted on the housing and has windings thereon. The stator is positioned annularly around the disc magnets such that the virtual pole chambers of the first and second pole shoes surround portions of said windings with circumferentially alternating fields of alternating polarity. Means are provided for electrical contact with the stator to draw off current when the device is operated as a generator, or provide current to operate the device as a motor. Fawzy, 4459501, discloses an electromechanical device which can be used as a motor or as a generator that has a housing, including bearing means to support a rotatable shaft. A pair of disc magnets are poled to have opposite polarity on the two faces of each. The magnets are mounted face to face together on the shaft to define a rotor. The device includes at least one first pole shoe in contact with one face of each magnet, and having a portion extending radially therefrom to define, in its preferred form, a pair of virtual pole chambers, of the same polarity as said one face. Also included is at least one second pole shoe in contact with the other face of each magnet and having a portion extending radially therefrom to define in its preferred form a pair of virtual pole chambers of the same polarity as the other face. A toroid stator is mounted on the housing and has windings thereon. The stator is positioned annularly around the disc magnets such that the virtual pole chambers of the first and second pole shoes surround portions of said windings with circumferentially alternating fields of alternating polarity. Means for electrical contact with the stator draw off current when the device is operated as a generator, or provide current to operate the device as a motor.

[5] Our prior art search with abstracts described above teaches rotating electromagnet machines; in both motor and generator forms. Thus, the prior art shows in Neal, a toroidal core with radial arc segments, in Fawzy, we see a N-N and S-S pole face adjacency, in Tu et al, a N-S and S-N pole adjacency with radial coil windings, in
5 Rose, we find radially wound coils in sequence around a toroidal core and with permanent magnet segments with N-N and S-S adjacency. However, the prior art fails to teach a rotating electromagnetic machine that provides electromagnetic fields immersed in monopole permanent magnet fields of opposite polarities as is shown in the present apparatus.

[6] The present disclosure distinguishes over the prior art providing heretofore unknown advantages as described in the following summary.

Summary

[7] This disclosure teaches certain benefits in construction and use which give rise to the objectives described below.

[8] A rotating electromagnetic apparatus has a stator including a stator frame
20 supporting parallel spaced apart, disc-shaped permanent magnet sets. Each of the magnet sets is formed as plural, spaced apart, co-planar magnet segments. The segments are arranged with permanent magnet poles of opposite polarity in an alternating sequence. A rotor provides a magnetically permeable rotating rotor frame mounted on an axle and supported by the stator frame. The rotor frame provides a
25 plurality of radially oriented, toroidally wound coils. Like poles of the magnet sets are set in opposing, face-to-face positions with the rotor between them. A current supplying commutator engages the rotor such that each of the coils provides electromagnet poles positioned alternately for attraction and repulsion of the electromagnet poles with respect to the permanent magnet poles thereby causing rotor
30 rotation.

- [9] A primary objective inherent in the above described apparatus and method of use is to provide advantages not taught by the prior art.
- [10] Another objective is to provide an electromagnetic rotating machine with superior torque relative to conventional machines.
- [11] A further objective is to provide such a machine useful as an electric motor.
- [12] A further objective is to provide such a machine useful as an electric generator.
- [13] A further objective is to provide such a machine that is able to be operated as a DC or as an AC device.
- [14] A still further objective is to provide such a machine that is useful as a power converter.
- [15] Other features and advantages of the described apparatus and method of use will become apparent from the following more detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the presently described apparatus and method of its use.

Brief Description of the Drawings

- [16] The accompanying drawings illustrate at least one of the best mode embodiments of the present apparatus and method of its use. In such drawings:
- [17] Figure 1 is an elevational view of a rotor of the apparatus showing a commutator and brushes;
- [18] Figure 2 is a vertical cross-sectional view thereof taken along line 2-2 in Fig. 1;

- [19] Figure 3 is a perspective view thereof conceptually showing the stator as two pair of semicircular magnet sets, with the rotor positioned medially;
- [20] Figure 4 is a perspective view thereof conceptually showing the stator as rings of four magnet sets, with the rotor positioned medially;
- [21] Figure 5 is a perspective view thereof conceptually showing the stator as rings of eight magnet sets, with the rotor positioned medially;
- [22] Figure 6 is a perspective view thereof conceptually showing the stator as rings of twelve magnet sets, with the rotor positioned medially;
- [23] Figure 7 is a perspective view thereof showing construction details of the rotor;
- [24] Figure 8 is a cross-sectional view thereof showing the commutator and brushes of the apparatus;
- [25] Figure 9 is a side elevational view thereof showing the commutator and brushes;
- [26] Figure 10 is an electrical schematic diagram thereof configured for DC operation with high torque and moderate speed;
- [27] Figure 11 is an electrical schematic diagram thereof configured for DC operation with high speed and high torque;
- [28] Figure 12 is an electrical schematic diagram thereof configured for AC operation;
- [29] Figure 13 is an electrical schematic diagram thereof configured for DC operation with low current and high speed; and
- [30] Figure 14 is an electrical schematic diagram thereof configured for AC operation with high voltage.

Detailed Description

[31] The above described drawing figures illustrate the described apparatus and its method of use in at least one of its preferred, best mode embodiments, which is further defined in detail in the following description. Those having ordinary skill in the art may be able to make alterations and modifications to what is described herein without departing from its spirit and scope. Therefore, it must be understood that what is illustrated is set forth only for the purposes of example and that it should not be taken as a limitation in the scope of the present apparatus and method of use.

[32] A rotating electromagnetic apparatus comprises a stator including a stator frame 152 supporting parallel spaced apart, disc-shaped permanent magnet sets, wherein each of the magnet sets comprises plural, spaced apart, co-planar magnet segments 146. The segments 146 are arranged with pairs of opposing N-N and S-S permanent magnet poles, as shown by the letters "S" for south pole and "N" for north pole, of opposite polarity in alternating circumferential sequence as is shown in Figs. 3-6 depicting four separate possible configurations of the magnet sets. A rotor provides a magnetically permeable rotating rotor frame 140 mounted on, and rotating with, an axle 144 which is supported by the stator frame 152 as shown in Fig. 2. Rotor frame 140 includes central structural element 156 fixed to axle 144. The rotor frame 140 provides a plurality of radially oriented, toroidally wound coils 148 as shown in Figs. 1, 2 and 10. Like poles of the magnet segments 146 are in opposing, face-to-face positions with the rotor positioned therebetween. A current supplying commutator 158 engages the rotor such that each of the coils 148 provide, on each side of its plane, an electromagnet active monopole 168 as shown in Fig. 1, which are positioned for attraction or repulsion of the adjacent permanent magnet poles in a manner causing rotation of the rotor. The permanent magnets induce magnetic monopole fields in the ferromagnetic core. Axle 144 rotates within a bearing in frame 152 and the frame 152 includes structural elements 150 for supporting the stator.

[33] The magnet segments 146 may comprise two semicircular segments as shown in Fig. 3, four segments in quadrature, as shown in Fig. 4, eight segments, as shown in Fig. 5, twelve segments, as shown in Fig. 6, or may comprise any number of such segments 148. The segments 146 are mounted on discs 142 made of ferromagnetic material. When more than two segments are used, the commutator is also segmented accordingly. In the following description, we shall discuss the configuration shown in Fig. 3, however, the basic principals of the present apparatus and theory of operation apply as well to Figs. 4-6, and apply as well to a linear embodiment of the present rotating toroidal machine as would be able to be enabled by one of skill in the art.

[34] The rotor frame 140 may be made up of layers of ferromagnetic sheet material 164 as shown in Fig. 1, or it may be a monolithic sintered ferrite part as shown in Fig. 7 which eliminates hysteresis. Electrical conductors in the form of insulated wires are wound into coils 148 within radial slots 130 formed in the rotor frame 140 (Fig. 7). These coils 148 are interconnected as shown in Fig. 10, i.e., all of the coils 148 are wired so as to have an electrically common point 183 in Figs. 2 and 10 at one end of the coils 148. The other end of each of the coils 148 is connected to a wiper 158 which slides on commutator 159 as best shown in Fig. 8.

[35] In Fig. 8 we see that the wipers 158 are preferably set at an angle to the axis of axel 144 to obtain improved contact surface area with commutators 159, which are spring loaded for continuous contact with the wipers 158. In Fig. 9 we see that the wipers 158 are set very close together, but it is noted that they do not touch each other.

[36] In operation, the apparatus is set into rotational motion, the rotor rotating between and in close adjacency on both of its sides to the stator. Referring now to Fig. 10, it is seen that, in the preferred embodiment of the current apparatus, a pair of permanent magnet north poles N of semicircular segment 146 configuration are in close proximity to one half of the coils 148 at each instant, while a pair of permanent magnet south pole S semicircular segments 146 are in close proximity to the other

half of the coils 148. The coils sandwiched between the N pole magnets are polarized by current flow through the commutator 159 to produce magnetic field alignments that result in rotational forces. To understand this, it is important to recognize that the ferromagnetic rotor body 140 that is instantaneously positioned between the N pole permanent magnet segments 146 is induced as a south pole S. Each of the coils 148 mounted in the rotor body 140 that are also between the N pole permanent magnet segments 146 have a current sense producing a magnetic field that causes attraction to the rotor body 140 to product an electromotive fore in the direction of rotation, see the description in the incorporated Provisional Patent Application on page 20 and associated Fig. 9. Likewise, the same effect with opposite polarities occurs for those coils 148 that are between the S pole magnet segments 146.

[37] Generally, the present apparatus is a rotating electromagnetic machine having a stator which provides at least one permanent monopole magnetic field within its interior space. A ferromagnetic toroidal rotor body 140 has an outer circumference 140', and inner circumference 140'' as shown in Fig. 7. The body 140 also includes two opposing side walls 140'''. The rotor body 140 is immersed in the permanent magnetic field and thereby has induced into it, a monopole magnetic field of opposite polarity. At least one, and preferably a plurality of current carrying electrical coils 148 are wound around the rotor body within radially directed slots 130 on both of the side walls 140''' of the rotor body 140. The electrical coils 148 produce a electromagnetic field directed along a sense of rotation of the rotor body within the stator thereby producing an electromotive force.

[38] Assuming electron current flow from the positive terminal (+) to the negative terminal (-), the flow is therefore through all of the coils 148 associated with the permanent S pole first, and then through all of the coils 148 associated with the permanent N pole. As coils 148 transfer across the gap between the positive and negative commutator (brushes) 159 current flow reverses and then so does the force exerted on the coils 148, and since the permanent magnetic field also reverses its polarity at the same time, the rotor develops a constant rotational force. It is the fact

that the coils 148 find themselves immersed within a monopole, i.e., either a N pole field or a S pole field, that they develop an electromotive force significantly larger than alternative electromagnetic rotating machines.

5 [39] The enablements described in detail above are considered novel over the prior art of record and are considered critical to the operation of at least one aspect of the apparatus and its method of use and to the achievement of the above described objectives. The words used in this specification to describe the instant embodiments are to be understood not only in the sense of their commonly defined meanings, but to include by special
10 definition in this specification: structure, material or acts beyond the scope of the commonly defined meanings. Thus if an element can be understood in the context of this specification as including more than one meaning, then its use must be understood as being generic to all possible meanings supported by the specification and by the word or words describing the element.

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[40] The present invention apparatus is further and more particularly defined in this paragraph and the immediately following paragraph [41]. A rotating electromagnetic apparatus comprises a stator frame 152 supporting two pairs of a plurality of spaced apart co-planar magnet segments 146 with each plurality of co-planar magnet segments 146
20 arranged with permanent magnet poles of the magnet segments 146 in opposite polarity circumferentially arranged alternating sequence. A magnetically permeable, toroidally shaped rotor frame 140 has an outer circumference 140', an inner circumference 140'' and a pair of side walls 140''', the rotor frame 140 mounted on an axle 144 supported by the stator frame 152 for rotation of the rotor frame 140. The rotor frame 140 provides a
25 plurality of radially directed slots 130 extending between the outer 140' and the inner 140'' circumferences of the rotor frame 140, the slots 130 positioned in laterally spaced apart pairs around the rotor frame 140. Each of the slots 130 has an aperture 130' open to one of the side walls 140'''. The apertures 130' are circumferentially more narrow than the slots 130. A toroidally wound coil 148 is wound within each of the pairs of slots 130.
30 Like permanent magnet poles of the magnet sets 146 are positioned in opposing, face-to-face positions with the rotor frame 140 between them.

[41] The apparatus further comprises plural wipers 158, where each said wiper 158 has an approximately trapezoidal shape in cross-section and is electrically engaged with one of the toroidally wound coils 148. The wipers 158 are in surface-to-surface contact with a ring-shaped commutator 159, the commutator 159 having an approximately triangular shape in cross section.

[42] The definitions of the words or drawing elements described herein are meant to include not only the combination of elements which are literally set forth, but all equivalent structure, material or acts for performing substantially the same function in substantially the same way to obtain substantially the same result. In this sense it is therefore contemplated that an equivalent substitution of two or more elements may be made for any one of the elements described and its various embodiments or that a single element may be substituted for two or more elements in a claim.

[43] Changes from the claimed subject matter as viewed by a person with ordinary skill in the art, now known or later devised, are expressly contemplated as being equivalents within the scope intended and its various embodiments. Therefore, obvious substitutions now or later known to one with ordinary skill in the art are defined to be within the scope of the defined elements. This disclosure is thus meant to be understood to include what is specifically illustrated and described above, what is conceptually equivalent, what can be obviously substituted, and also what incorporates the essential ideas.

[44] The scope of this description is to be interpreted only in conjunction with the appended claims and it is made clear, here, that each named inventor believes that the claimed subject matter is what is intended to be patented.

Claims

What is claimed is:

- 5 1. A rotating electromagnetic apparatus comprising: a stator frame supporting two pairs of a plurality of spaced apart co-planar magnet segments with each plurality of co-planar magnet segments arranged with permanent magnet poles of the magnet segments in opposite polarity circumferentially arranged alternating sequence; a magnetically permeable, toroidally shaped rotor frame having an
10 outer circumference, an inner circumference and a pair of side walls, the rotor frame mounted on an axle supported by the stator frame for rotation of the rotor frame; the rotor frame providing a plurality of radially directed slots extending between the outer and the inner circumferences of the rotor frame, the slots positioned in laterally spaced apart pairs around the rotor frame, each of the slots
15 having an aperture open to one of the side walls, the apertures being circumferentially more narrow than the slots; a toroidally wound coil wound within each of the pairs of slots; and like permanent magnet poles of the magnet sets positioned in opposing, face-to-face positions with the rotor frame therebetween.
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2. The apparatus of claim 1 further comprising plural wipers, each said wiper having an approximately trapezoidal shape in cross-section and electrically engaged with one of the toroidally wound coils, the wipers in surface-to-surface contact with a ring-shaped commutator, the commutator having an approximately triangular
25 shape in cross section.