magnetic core includes a first magnetic path, around which the first input and output coils extend, and a second magnetic path, around which the second input and output coils extend, between opposite ends of the permanent magnet. The switching circuit drives electrical current alternately through the first and second input coils. The electrical current driven through the first input oil causes the first input coil to produce a magnetic field opposing a concentration of magnetic flux from the permanent magnet within the first magnetic path. The electrical current driven through the second input coil causes the second input coil to produce a magnetic field opposing a concentration of magnetic flux from the permanent magnet within the second magnetic path.

According to another aspect of the present invention, an electromagnetic generator is provided, including a magnetic core, a plurality of permanent magnets, first and second pluralities of input coils, a plurality of output coils, and a switching circuit. The magnetic core includes a pair of spaced-apart plates, each of which has a central aperture, and first and second pluralities of posts extending between the spaced-apart plates. The permanent magnets each extend between the pair of spaced apart plates. Each permanent magnet has magnetic poles at opposite ends, with the magnetic fields of all the permanent magnets being aligned to extend in a common direction. Each input coil extends around a portion of a plate within the spaced-apart plates, between a post and a permanent magnet. An output coil extends around each post. The switching circuit drives electrical current alternately through the first and second pluralities of input coils. Electrical current driven through each input coil in the first plurality of input coils causes an increase in magnetic flux within each post within the first plurality of posts from permanent magnets on each side of the post and a decrease in magnetic flux within each post within the second plurality of posts from permanent magnets on each side of the post. Electrical current driven through each input coil in the second plurality of input coils causes a decrease in magnetic flux within each post within the first plurality of posts from permanent magnets on each side of the post and an increase in magnetic flux within each post within the second plurality of posts from permanent magnets on each side of the post.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partly schematic front elevation of a magnetic generator and associated electrical circuits built in accordance with a first version of the first embodiment of the present invention;

FIG. **2** is a schematic view of a first version of a switching and control circuit within the associated electrical circuits of FIG. **1**;

FIG. **3** is a graphical view of drive signals produced within the circuit of FIG. **2**;

FIG. **4** is a schematic view of a second version of a switching and control circuit within the associated electrical circuits of FIG. **1**;

FIG. **5** is a graphical view of drive signals produced within the circuit of FIG. **3**;

FIG. **6**A is a graphical view of a first drive signal within the apparatus of FIG. **1**;

FIG. **6**B is a graphical view of a second drive signal within the apparatus of FIG. **1**;

FIG. **6**C is a graphical view of an input voltage signal within the apparatus of FIG. **1**;

FIG. **6**D is a graphical view of an input current signal within the apparatus of FIG. **1**;

FIG. **6**E is a graphical view of a first output voltage signal within the apparatus of FIG. **1**;

FIG. **6**F is a graphical view of a second output voltage signal within the apparatus of FIG. **1**;

FIG. **6**G is a graphical view of a first output current signal within the apparatus of FIG. **1**;

FIG. **6**H is a graphical view of a second output current signal within the apparatus of FIG. **1**;

FIG. **7** is a graphical view of output power measured within the apparatus of FIG. **1**, as a function of input voltage;

FIG. **8** is a graphical view of a coefficient of performance, calculated from measurements within the apparatus of FIG. **1**, as a function of input voltage;

FIG. **9** is a cross-sectional elevation of a second version of the first embodiment of the present invention;

FIG. **10** is a top view of a magnetic generator built in accordance with a first version of a second embodiment of the present invention;

FIG. **11** is a front elevation of the magnetic generator of FIG. **10**; and

FIG. **12** is a top view of a magnetic generator built in accordance with a second version of the second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** is a partly schematic front elevation of an electromagnetic generator **10**, built in accordance with a first embodiment of the present invention to include a permanent magnet **12** to supply input lines of magnetic flux moving from the north pole **14** of the magnet **12** outward into magnetic flux path core material **16**. The flux path core material **16** is configured to form a right magnetic path **18** and a left magnetic path **20**, both of which extend externally between the north pole **14** and the south pole **22** of the magnet **12**. The electromagnetic generator **10** is driven by means of a switching and control circuit **24**, which alternately drives electrical current through a right input coil **26** and a left input coil **28**. These input coils **26**, **28** each extend around a portion of the core material **16**, with the right input coil **26** surrounding a portion of the right magnetic path **18** and with the left input coil **28** surrounding a portion of the left magnetic path **20**. A right output coil **29** also surrounds a portion of the right magnetic path **18**, while a left output coil **30** surrounds a portion of the left magnetic path **20**.

In accordance with a preferred version of the present invention, the switching and control circuit **24** and the input coils **26**, **28** are arranged so that, when the right input coil **26** is energized, a north magnetic pole is present at its left end **31**, the end closest to the north pole **14** of the permanent magnet **12**, and so that, when the left input coil **28** is energized, a north magnetic pole is present at its right end **32**, which is also the end closest to the north pole **14** of the permanent magnet **12**. Thus, when the right input coil **26** is magnetized, magnetic flux from the permanent magnet **12** is repelled from extending through the right input coil **26**. Similarly, when the left input coil **28** is magnetized, magnetic flux from the permanent magnet **12** is repelled from extending through the left input coil **28**.

Thus, it is seen that driving electrical current through the right input coil **26** opposes a concentration of flux from the permanent magnet **12** within the right magnetic path **18**, causing at least some of this flux to be transferred to the left magnetic path **20**. On the other hand, driving electrical current through the left input coil **28** opposes a concentration of flux from the permanent magnet **12** within the left magnetic path **20**, causing at least some of this flux to be transferred to the right magnetic path **18**.

While in the example of FIG. **1**, the input coils **26**, **28** are placed on either side of the north pole of the permanent magnet **12**, being arranged along a portion of the core **16** extending from the north pole of the permanent magnet **12**, it is understood that the input coils **26**, **28** could as easily be alternately placed on either side of the south pole of the permanent magnet **12**, being arranged along a portion of the core **16** extending from the south pole of the permanent magnet **12**, with the input coils **26**, **28** being wired to form, when energized, magnetic fields having south poles directed toward the south pole of the permanent magnet **12**. In general, the input coils **26**, **28** are arranged along the magnetic core on either side of an end of the permanent magnet forming a first pole, such as a north pole, with the input coils being arranged to produce magnetic fields of the polarity of the first pole directed toward the first pole of the permanent magnet.

Further in accordance with a preferred version of the present invention, the input coils **26**, **28** are never driven with so much current that the core material **16** becomes saturated. Driving the core material **16** to saturation means that subsequent increases in input current can occur without effecting corresponding changes in magnetic flux, and therefore that input power can be wasted. In this way, the apparatus of the present invention is provided with an advantage in terms of the efficient use of input power over the apparatus of U.S. Pat. No. 4,000,401, in which a portion both ends of each magnetic path is driven to saturation to block flux flow. In the electromagnetic generator **10**, the switching of current flow within the input coils **26**, **28** does not need to be sufficient to stop the flow of flux in one of the magnetic paths **18**, **20** while promoting the flow of magnetic flux in the other magnetic path. The electromagnetic generator **10** works by changing the flux pattern; it does not need to be completely switched from one side to another.

Experiments have determined that this configuration is superior, in terms of the efficiency of using power within the input coils **26**, **28** to generate electrical power within the output coils **29**, **30**, to the alternative of arranging input coils and the circuits driving them so that flux from the permanent magnet is driven through the input coils as they are energized. This arrangement of the present invention provides a significant advantage over the prior-art methods shown, for example, in U.S. Pat. No. 4,077,001, in which the magnetic flux is driven through the energized coils.

The configuration of the present invention also has an advantage over the prior-art configurations of U.S. Pat. Nos. 3,368,141 and 4,077,001 in that the magnetic flux is switched between two alternate magnetic paths **18**, **20** with only a single input coil **26**, **28** surrounding each of the alternate magnetic paths. The configurations of U.S. Pat. Nos. 3,368,141 and 4,077,001 each require two input coils on each of the magnetic paths. This advantage of the present invention is significant both in the simplification of hardware and in increasing the efficiency of power conversion.

The right output coil **29** is electrically connected to a rectifier and filter **33**, having an output driven through a regulator **34**, which provides an output voltage adjustable through the use of a potentiometer **35**. The output of the linear regulator **34** is in turn provided as an input to a sensing and switching circuit **36**. Under start up conditions, the sensing and switching circuit **36** connects the switching and control circuit **24** to an external power source **38**, which is, for example, a starting battery. After the electromagnetic generator **10** is properly started, the sensing and switching circuit **36** senses that the voltage available from regulator **34** has reached a predetermined level, so that the power input to the switching and control circuit **24** is switched from the external power source **38** to the output of regulator **34**. After this switching occurs, the electromagnetic generator **10** continues to operate without an application of external power.

The left output coil **30** is electrically connected to a rectifier and filter **40**, the output of which is connected to a regulator **42**, the output voltage of which is adjusted by means of a potentiometer **43**. The output of the regulator **42** is in turn connected to an external load **44**.

FIG. **2** is a schematic view of a first version of the switching and control circuit **24**. An oscillator **50** drives the clock input of a flip-flop **54**, with the Q and Q' outputs of the flip-flop **54** being connected through driver circuits **56**, **58** to power FETS **60**, **62** so that the input coils **26**, **28** are alternately driven. In accordance with a preferred version of the present invention, the voltage V applied to the coils **26**, **28** through the FETS **60**, **62** is derived from the output of the sensing and switching circuit **36**.

FIG. **3** is a graphical view of the signals driving the gates of FETS **60**, **62** of FIG. **2**, with the voltage of the signal driving the gate of FET **60** being represented by line **64**, and with the voltage of the signal driving FET **62** being represented by line **66**. Both of the coils **26**, **28** are driven with positive voltages.

FIG. **4** is a schematic view of a second version of the switching and control circuit **24**. In this version, an oscillator **70** drives the clock input of a flip-flop **72**, with the Q and Q' outputs of the flip-flop **72** being connected to serve as triggers for one-shots **74**, **76**. The outputs of the one-shots **74**, **76** are in turn connected through driver circuits **78**, **80** to drive FETS **82**, **84**, so that the input coils **26**, **28** are alternately driven with pulses shorter in duration than the Q and Q' outputs of the flip flop **72**.

FIG. **5** is a graphical view of the signals driving the gates of FETS **82**, **84** of FIG. **4**, with the voltage of the signal driving the gate of FET **82** being represented by line **86**, and with the voltage of the signal driving the gate of FET **84** being represented by line **88**.

Referring again to FIG. **1**, power is generated in the right output coil **29** only when the level of magnetic flux is changing in the right magnetic path **18**, and in the left output coil **30** only when the level of magnetic flux is changing in the left magnetic path **20**. It is therefore desirable to determine, for a specific magnetic generator configuration, the width of a pulse providing the most rapid practical change in magnetic flux, and then to provide this pulse width either by varying the frequency of the oscillator **50** of the apparatus of FIG. **2**, so that this pulse width is provided with the signals shown in FIG. **3**, or by varying the time constant of the one-shots **74**, **76** of FIG. **4**, so that this pulse width is provided by the signals of FIG. **5** at a lower oscillator frequency. In this way, the input coils are not left on longer than necessary. When either of the input coils is left on for a period of time longer than that necessary to produce the change in flux direction, power is being wasted through heating within the input coil without additional generation of power in the corresponding output coil.

A number of experiments have been conducted to determine the adequacy of an electromagnetic generator built as the generator **10** in FIG. **1** to produce power both to drive the switching and control logic, providing power to the input coils **26**, **28**, and to drive an external load **44**. In the configuration used in this experiment, the input coils **26**, **28** had 40 turns of 18-gauge copper wire, and the output coils **29**, **30** had 450 turns of 18-gauge copper wire. The permanent magnet **12** had a height of 40 mm (1.575 in. between its north and south poles, in the direction of arrow **89**, a width of 25.4 mm (1.00 in.), in the direction of arrow **90**, and in the other direction, a depth of 38.1 mm (1.50 in.). The core **16** had a height, in the direction of arrow **89**, of 90 mm (3.542 in.), a width, in the direction of arrow **90**, of 135 mm (5.315 in.) and a depth of 70 mm (2.756 in.). The core **16** had a central hole with a height, in the direction of arrow **89**, of 40 mm (1.575 mm) to accommodate the magnet **12**, and a width, in the direction of arrow **90**, of 85 mm (3.346 in.). The core **16** was fabricated of two "C"-shaped halves, joined at lines **92**, to accommodate the winding of output coils **29**, **30** and input coils **26**, **28** over the core material.

The core material was a laminated iron-based magnetic alloy sold by Honeywell as METGLAS Magnetic Alloy 2605SA1. The magnet material was a combination of iron, neodymium, and boron.

The input coils **26**, **28** were driven at an oscillator frequency of 87.5 KHz, which was determined to produce optimum efficiency using a switching control circuit configured as shown in FIG. **2**. This frequency has a period of 11.45 microseconds. The flip flop **54** is arranged, for example, to be set and reset on rising edges of the clock signal input from the oscillator, so that each pulse driving one of the FETS **60**, **62** has a duration of 11.45 microseconds, and so that sequential pulses are also separated to each FET are also separated by 11.45 microseconds.

FIGS. **6A–6H** are graphical views of signals which simultaneously occurred within the apparatus of FIGS. **1** and **2** during operation with an applied input voltage of 75 volts. FIG. **6A** shows a first drive signal **100** driving FET **60**, which conducts to drive the right input coil **26**. FIG. **6B** is shows a second drive signal **102** driving FET **62**, which conducts to drive the left input coil **28**.

FIGS. **6C** and **6D** show voltage and current signals associated with current driving both the FETS **60**, **62** from a battery source. FIG. **6C** shows the level **104** of voltage V. While the nominal voltage of the battery was 75 volts, a decaying transient signal **106** is superimposed on this voltage each time one of the FETS **60**, **62** is switched on to conduct. The specific pattern of this transient signal depends on the internal resistance of the battery, as well as on a number of characteristics of the magnetic generator **10**. Similarly, FIG. **6D** shows the current **106** flowing into both FETS **60**, **62** from the battery source. Since the signals **104**, **106** show the effects of current flowing into both FETS **60**, **62** the transient spikes are 11.45 microseconds apart.

FIGS. **6E–6H** show voltage and current levels measured at the output coils **29**, **30**. FIG. **6E** shows a voltage output signal **108** of the right output coil **29**, while FIG. **6F** shows a voltage output signal **110** of the left output coil **30**. For example, the output current signal **116** of the right output coil **29** includes a first transient spike **112** caused when the a current pulse in the left input coil **28** is turned on to direct magnetic flux through the right magnetic path **18**, and a second transient spike **114** caused when the left input coil **28** is turned off with the right input coil **26** being turned on. FIG. **6G** shows a current output signal **116** of the right output coil **29**, while FIG. **6H** shows a current output signal **118** of the left output coil **30**.

FIG. **7** is a graphical view of output power measured using the electromagnetic generator **10** and eight levels of input voltage, varying from 10v to 75v. The oscillator frequency was retained at 87.5 KHz. The measurement points are represented by indicia **120**, while the curve **122** is generated by polynomial regression analysis using a least squares fit.

FIG. **8** is a graphical view of a coefficient of performance, defined as the ratio of the output power to the input power, for each of the measurement points shown in FIG. **7**. At each measurement point, the output power was substantially higher than the input power. Real power measurements were computed at each data point using measured voltage and current levels, with the results being averaged over the period of the signal. These measurements agree with RMS power measured using a Textronic THS730 digital oscilloscope.

While the electromagnetic generator **10** was capable of operation at much higher voltages and currents without saturation, the input voltage was limited to 75 volts because of voltage limitations of the switching circuits being used. Those skilled in the relevant art will understand that components for switching circuits capable of handling higher voltages in this application are readily available. The experimentally-measured data was extrapolated to describe operation at an input voltage of 100 volts, with the input current being 140 ma, the input power being 14 watts, and with a resulting output power being 48 watts for each of the two output coils **29**, **30**, at an average output current of 12 ma and an average output voltage of 4000 volts. This means that for each of the output coils **29**, **30**, the coefficient of performance would be 3.44.

While an output voltage of 4000 volts may be needed for some applications, the output voltage can also be varied through a simple change in the configuration of the electromagnetic generator **10**. The output voltage is readily reduced by reducing the number of turns in the output windings. If this number of turns is decreased from 450 to 12, the output voltage is dropped to 106.7, with a resulting increase in output current to 0.5 amps for each output coil **29**, **30**. In this way, the output current and voltage of the electromagnetic generator can be varied by varying the number of turns of the output coils **29**, **30**, without making a substantial change in the output power, which is instead determined by the input current, which determines the amount of magnetic flux shuttled during the switching process.

The coefficients of performance, all of which were significantly greater than 1, plotted in FIG. **8** indicate that the output power levels measured in each of the output coils **29**, **30** were substantially greater than the corresponding input power levels driving both of the input coils **26**, **28**. Therefore, it is apparent that the electromagnetic generator **10** can be built in a self-actuating form, as discussed above in reference to FIG. **1**. In the example of FIG. **1**, except for a brief application of power from the external power source **38**, to start the process of power generation, the power required to drive the input coils **26**, **28** is derived entirely from power developed within the right output coil **29**. If the power generated in a single output coil **29**, **30** is more than sufficient to drive the input coils **26**, **28**, an additional load **126** may be added to be driven with power generated in the output coil **29** used to generate power to drive the input coils **26**, **28**. On the other hand, each of the output coils **29**, **30** may be used to drive a portion of the input coil power requirements, for example with one of the output coils **26**, **28** providing the voltage V for the FET **60** (shown in FIG. **2**), while the other output coil provides this voltage for the FET **62**.

Regarding thermodynamic considerations, it is noted that, when the electromagnetic generator **10** is operating, it is an open system not in thermodynamic equilibrium. The system receives static energy from the magnetic flux of the permanent magnet. Because the electromagnetic generator **10** is self-switched without an additional energy input, the thermodynamic operation of the system is an open dissipative system, receiving, collecting, and dissipating energy from its environment; in this case, from the magnetic flux stored within the permanent magnet. Continued operation of the electromagnetic generator **10** causes demagnetization of the permanent magnet. The use of a magnetic material including rare earth elements, such as a samarium cobalt material or a material including iron, neodymium, and boron is preferable within the present invention, since such a magnetic material has a relatively long life in this application.

Thus, an electromagnetic generator operating in accordance with the present invention should be considered not as a perpetual motion machine, but rather as a system in which flux radiated from a permanent magnet is converted into electricity, which is used both to power the apparatus and to power an external load. This is analogous to a system including a nuclear reactor, in which a number of fuel rods radiate energy which is used to keep the chain reaction going and to heat water for the generation of electricity to drive external loads.

FIG. **9** is a cross-sectional elevation of an electromagnetic generator **130** built in accordance with a second version of the first embodiment of the present invention. This electromagnetic generator **130** is generally similar in construction and operation to the electromagnetic generator **10** built in accordance with the first version of this embodiment, except that the magnetic core **132** of the electromagnetic generator **10** is built in two halves joined along lines **134**, allowing each of the output coils **135** to be wound on a plastic bobbin **136** before the bobbin **136** is placed over the legs **137** of the core **132**. FIG. **9** also shows an alternate placement of an input coil **138**. In the example of FIG. **1**, both input coils **26**, **28** were placed on the upper portion of the magnetic core **16**, with these coils **26**, **28** being configured to establish magnetic fields having north magnetic poles at the inner ends **31**, **32** of the coils **26**, **28**, with these north magnetic poles thus being closest to the end **14** of the permanent magnet **12** having its north magnetic pole. In the example of FIG. **9**, a first input coil **26** is as described above in reference to FIG. **1**, but the second input coil **138** is placed adjacent the south pole **140** of the permanent magnet **12**. This input coil **138** is configured to establish a south magnetic pole at its inner end **142**, so that, when input coil **138** is turned on, flux from the permanent magnet **12** is directed away from the left magnetic path **20** into the right magnetic path **18**.

FIGS. **10** and **11** show an electromagnetic generator **150** built in accordance with a first version of a second embodiment of the present invention, with FIG. **10** being a top view thereof, and with FIG. **11** being a front elevation thereof. This electromagnetic generator **150** includes an output coil **152**, **153** at each corner, and a permanent magnet **154** extending along each side between output coils. The magnetic core **156** includes an upper plate **158**, a lower plate **160**, and a square post **162** extending within each output coil **152**, **153**. Both the upper plate **158** and the lower plate **160** include central apertures **164**.

Each of the permanent magnets **154** is oriented with a like pole, such as a north pole, against the upper plate **158**. Eight input coils **166**, **168** are placed in positions around the upper plate **158** between an output coil **152**, **153** and a permanent magnet **154**. Each input coil **166**, **168** is arranged to form a magnetic pole at its end nearest to the adjacent permanent magnet **154** of a like polarity to the magnetic poles of the magnets **154** adjacent the upper plate **158**. Thus, the input coils **166** are switched on to divert magnetic flux of the permanent magnets **154** from the adjacent output coils **152**, with this flux being diverted into magnetic paths through the output coils **153**. Then, the input coils **168** are switched on to divert magnetic flux of the permanent magnets **154** from the adjacent output coils **153**, with this flux being diverted into magnetic paths through the output coils **152**. Thus, the input coils form a first group of input coils **166** and a second group of input coils **168**, with these first and second groups of input coils being alternately energized in the manner described above in reference to FIG. **1** for the single input coils **26**, **28**. The output coils produce current in a first train of pulses occurring simultaneously within coils **152** and in a second train of pulses occurring simultaneously within coils **153**.

Thus, driving current through input coils **166** causes an increase in flux from the permanent magnets **154** within the posts **162** extending through output coils **153** and a decrease in flux from the permanent magnets **154** within the posts **162** extending through output coils **152**. On the other hand, driving current through input coils **168** causes a decrease in flux from the permanent magnets **154** within the posts **162** extending through output coils **153** and an increase in flux from the permanent magnets **154** within the posts **162** extending through output coils **152**.

While the example of FIGS. **10** and **11** shows all of the input coils **166**,**168** deployed along the upper plate **158**, it is understood that certain of these input coils **166**, **168** could alternately be deployed around the lower plate **160**, in the manner generally shown in FIG. **9**, with one input coil **166**, **168** being within each magnetic circuit between a permanent magnet **154** and an adjacent post **162** extending within an output coil **152**, **153**, and with each input coil **166**, **168** being arranged to produce a magnetic field having a magnetic pole like the closest pole of the adjacent permanent magnet **154**.

FIG. **12** is a top view of a second version **170** of the second embodiment of the present invention, which is similar to the first version thereof, which has been discussed in reference to FIGS. **10** and **11**, except that an upper plate **172** and a similar lower plate (not shown) are annular in shape, while the permanent magnets **174** and posts **176** extending through the output coils **178** are cylindrical. The input coils **180** are oriented and switched as described above in reference to FIGS. **9** and **10**.

While the example of FIG. **12** shows four permanent magnets, four output coils and eight input coils it is understood that the principles described above can be applied to electromagnetic generators having different numbers of elements. For example, such a device can be built to have two permanent magnets, two output coils, and four input coils, or to have six permanent magnets, six output coils, and twelve input coils.

In accordance with the present invention, material used for magnetic cores is preferably a nanocrystalline alloy, and alternately an amorphous alloy. The material is preferably in a laminated form. For example, the core material is a cobalt-niobium-boron alloy or an iron based magnetic alloy.

Also in accordance with the present invention, the permanent magnet material preferably includes a rare earth element. For example, the permanent magnet material is a samarium cobalt material or a combination of iron, neodymium, and boron.

While the invention has been described in its preferred versions and embodiments with some degree of particularity, it is understood that this description has been given only by way of example and that numerous changes in the details of construction, fabrication, and use, including the combination and arrangement of parts, may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. An electromagnetic generator comprising:

a permanent magnet having magnetic poles at opposite ends;

a magnetic core including first and second magnetic paths between said opposite ends of said permanent magnet, wherein

said magnetic core comprises a closed loop,

said permanent magnet extends within said closed loop, and

said opposite ends of said permanent magnet are disposed adjacent opposite sides of said closed loop and against internal surfaces of said magnetic core comprising said closed loop;

a first input coil extending around a portion of said first magnetic path,

a second input coil extending around a portion of said second magnetic path,

a first output coil extending around a portion of said first magnetic path for providing a first electrical output;

a second output coil extending around a portion of said second magnetic path for providing a second electrical output; and

a switching circuit driving electrical current alternately through said first and second input coils, wherein

said electrical current driven through said first input coil causes said first input coil to produce a magnetic field opposing a concentration of magnetic flux from said permanent magnet within said first magnetic path, and

said electrical current driven through said second input coil causes said second input coil to produce a magnetic field opposing a concentration of magnetic flux from said permanent magnet within said second magnetic path.

2. An electromagnetic generator comprising:

a permanent magnet having magnetic poles at opposite ends;

a magnetic core including first and second magnetic paths between said opposite ends of said permanent magnet, wherein

said magnetic core comprises a closed loop,

said permanent magnet extends within said closed loop,

said opposite ends of said permanent magnet are disposed adjacent opposite sides of said closed loop, and

a first type of pole of said permanent magnet is disposed adjacent a first side of said closed loop;

a first input coil, disposed along said first side of said closed loop, extending around a portion of said first magnetic path,

a second input coil, disposed along said first side of said closed loop, extending around a portion of said second magnetic path,

a first output coil extending around a portion of said first magnetic path for providing a first electrical output;

a second output coil extending around a portion of said second magnetic path for providing a second electrical output; and

a switching circuit driving electrical current alternately through said first and second input coils, wherein

said electrical current driven through said first input coil causes said first input coil to produce a magnetic field opposing a concentration of magnetic flux from said permanent magnet within said first magnetic path, and additionally causes said first input coil to produce a magnetic field having said first type of pole at an end of said first input coil adjacent said permanent magnet, and

said electrical current driven through said second input coil causes said second input coil to produce a magnetic field opposing a concentration of magnetic flux from said permanent magnet within said second magnetic path, and additionally causes said second input coil to produce a magnetic field having said first type of pole at an end of said of said second input coil adjacent said permanent magnet.

3. An electromagnetic generator comprising:

a permanent magnet having magnetic poles at opposite ends;

a magnetic core including first and second magnetic paths between said opposite ends of said permanent magnet, wherein

said magnetic core comprises a closed loop,

said permanent magnet extends within said closed loop, and

said opposite ends of said permanent magnet are disposed adjacent opposite sides of said closed loop,

a first type of pole of said permanent magnet is disposed adjacent a first side of said closed loop, and

a second type of pole, opposite said first type of pole, of said permanent magnet is disposed adjacent a second side of said closed loop;

a first input coil extending around a portion of said first magnetic path, wherein said first input coil is disposed along said first side of said closed loop;

a second input coil extending around a portion of said second magnetic path wherein said second input coil is disposed along said second side of said closed loop;

a first output coil extending around a portion of said first magnetic path for providing a first electrical output;

a second output coil extending around a portion of said second magnetic path for providing a second electrical output; and

a switching circuit driving electrical current alternately through said first and second input coils, wherein

said electrical current driven through said first input coil causes said first input coil to produce a magnetic field opposing a concentration of magnetic flux from said permanent magnet within said first magnetic path, and additionally causes said first input coil to produce a magnetic field having said first type of pole at an end of said first input coil adjacent said permanent magnet, and

said electrical current driven through said second input coil causes said second input coil to produce a magnetic field opposing a concentration of magnetic flux from said permanent magnet within said second magnetic path, and additionally causes said second input coil to produce a magnetic field having said second type of pole at an end of said of said second input coil adjacent said permanent magnet.

4. An electromagnetic generator comprising:

a permanent magnet having magnetic poles at opposite ends;

a magnetic core including first and second magnetic paths between said opposite ends of said permanent magnet;

a first input coil extending around a portion of said first magnetic path,

a second input coil extending around a portion of said second magnetic path,

a first output coil extending around a portion of said first magnetic path for providing a first electrical output;

a second output coil extending around a portion of said second magnetic path for providing a second electrical output; and

a switching circuit driving electrical current alternately through said first and second input coils, wherein said electrical current driven through said first input coil causes said first input coil to produce a magnetic field opposing a concentration of magnetic flux from said permanent magnet within said first magnetic path, and wherein said electrical current driven through said second input coil causes said second input coil to produce a magnetic field opposing a concentration of magnetic flux from said permanent magnet within said second magnetic path, wherein a portion of electrical power induced in said first output coil provides power to drive said switching circuit.

5. The electromagnetic generator of claim **4**, wherein said switching circuit is driven by an external power source during a starting process and by power induced in said first output coil during operation after said starting process.

6. The electromagnetic generator of claim **2**, wherein said magnetic core is composed of a nanocrystalline magnetic alloy.

7. The electromagnetic generator of claim **6**, wherein said nanocrystalline magnetic alloy is a cobalt-niobium-boron alloy.

8. The electromagnetic generator of claim **6**, wherein said nanocrystalline magnetic alloy is an iron-based alloy.

9. The electromagnetic generator of claim **2**, wherein said changes in flux density within said magnetic core occur without driving said magnetic core to magnetic saturation.

10. The electromagnetic generator of claim **2**, wherein

said switching circuit drives said electrical current through said first input coil in response to a first train of pulses,

said switching circuit drives said electrical current through said second input coil in response to a second train of pulses, alternating with pulses within said first train of pulses, and

said pulses in said first and second trains of pulses are approximately 11.5 milliseconds in duration.

11. The electromagnetic generator of claim **2**, wherein said permanent magnet is composed of a material including a rare earth element.

12. The electromagnetic generator of claim **11**, wherein said permanent magnet is composed essentially of samarium cobalt.

13. The electromagnetic generator of claim **11**, wherein said permanent magnet is composed essentially of iron, neodymium, and boron.

14. An electromagnetic generator comprising:

a magnetic core including a pair of spaced-apart plates, wherein each of said spaced-apart plates includes a central aperture, and first and second pluralities of posts extending between said spaced-apart plates;

a plurality of permanent magnets extending individually between said pair of spaced-apart plates and between adjacent posts within said plurality of posts, wherein each permanent magnet within said plurality of permanent magnets has magnetic poles at opposite ends, wherein all magnets within said plurality of magnets are oriented to produce magnetic fields having a common direction;

first and second pluralities of input coils, wherein each input coil within said first and second pluralities of input coils extends around a portion of a plate within said spaced-apart plates between a post in said plurality of posts and a permanent magnet in said plurality of permanent magnets;

an output coil extending around each post in said first and second pluralities of posts for providing an electrical output;

a switching circuit driving electrical current alternatively through said first and second pluralities of input coils, wherein said electrical current driven through each input coil in said first plurality of input coils causes an increase in magnetic flux within each post within said first plurality of posts from permanent magnets on each side of said post and a decrease in magnetic flux within each post within said second plurality of posts from permanent magnets on each side of said post, and wherein said electrical current driven through input coil in said second plurality of input coils causes a decrease in magnetic flux within each post within said first plurality of posts from permanent magnets on each side of said post and an increase in magnetic flux within each post within said second plurality of posts from permanent magnets on each side of said post.

15. The electromagnetic generator of claim **14**, wherein

each input coil extends around a portion of a magnetic path through said magnetic core between said opposite ends a permanent magnet adjacent said input coil,

said magnetic path extends through a post within said magnetic core adjacent said input coil, and

driving electrical current through said input coil causes said input coil to produce a magnetic field opposing a concentration of magnetic flux within said magnetic path.

16. The electromagnetic generator of claim **14**, wherein said switching circuit is driven by an external power source during a starting process and by power induced in said output coils during operation after said starting process.

17. The electromagnetic generator of claim **14**, wherein said magnetic core is composed of a nanocrystalline magnetic alloy.

18. The electromagnetic generator of claim **2**, wherein a portion of electrical power induced in said first output coil provides power to drive said switching circuit.

19. The electromagnetic generator of claim **18**, wherein said switching circuit is driven by an external power source during a starting process and by power induced in said first output coil during operation after said starting process.

20. The electromagnetic generator of claim **3**, wherein a portion of electrical power induced in said first output coil provides power to drive said switching circuit.

21. The electromagnetic generator of claim **20**, wherein said switching circuit is driven by an external power source during a starting process and by power induced in said first output coil during operation after said starting process.

22. The electromagnetic generator of claim **3**, wherein said magnetic core is composed of a nanocrystalline magnetic alloy.

23. The electromagnetic generator of claim **22**, wherein said nanocrystalline magnetic alloy is a cobalt-niobium-boron alloy.

24. The electromagnetic generator of claim **22**, wherein said nanocrystalline magnetic alloy is an iron-based alloy.

25. The electromagnetic generator of claim **3**, wherein said changes in flux density within said magnetic core occur without driving said magnetic core to magnetic saturation.

26. The electromagnetic generator of claim **3**, wherein

said switching circuit drives said electrical current through said first input coil in response to a first train of pulses,

said switching circuit drives said electrical current through said second input coil in response to a second train of pulses, alternating with pulses within said first train of pulses, and

said pulses in said first and second trains of pulses are approximately 11.5 milliseconds in duration.

27. The electromagnetic generator of claim **3**, wherein said permanent magnet is composed of a material including a rare earth element.

28. The electromagnetic generator of claim **27**, wherein said permanent magnet is composed essentially of samarium cobalt.

29. The electromagnetic generator of claim **27**, wherein said permanent magnet is composed essentially of iron, neodymium, and boron.

* * * * *