Realistic Inspired Vital Appropriate Solutions

THE THETA DEVICE

AND OTHER

FREE ENERGY PATENTS

by

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INTRODUCTION
TO
THE THETA DEVICE AND OTHER FREE ENERGY PATENTS

Those of us who "believe" are always looking for the holy grail of power generation, the wonderful free energy device that will power our homes, automobiles, trains, airplanes and all the other motorized systems on the planet. I have personally seen four free energy devices that really worked and which I ran sufficient tests on to convince me of their validity. I did not know enough about their internal mechanisms to reproduce them, however.

To me, it is patently obvious that there is some means whereby we can "hook our machinery up to the wheel work of nature (Tesla)". The electrons go serenely zipping around the nucleus, the whole atom literally pulsates with abundant energy, all of which is "forever". This is one of nature's free devices and if you look around there are others. We have only to tap into the universal energy source that the atom is locked into and we can use this same power source. Such a small word "only", but oh what a trek nature takes us on if we follow the search.

The following patents are of supposed free energy inventions, including the Richardson patent, the "Theta" device, which I mentioned in my lecture at the 1990 International Tesla symposium. I named it the Theta device because of its resemblance to the greek "theta" symbol. I built a scaled down version of the Theta device and could not get it to work. I also located another version which another experimenter sent to me to try to get running and I was unsuccessful in that attempt. Later, I found out that I was not pulsing the core with a high enough power pulse to flip the magnetic domains in the outer core. This, of course, would make the Theta unit non-functional.

Also included is the original text of the write up on the Theta device which prompted me to attempt to build it. The original text has been retained except where references to the figures were needed. The original drawings were in such poor condition that new CAD copies have been included. The Theta plans were given to Jerry Decker of Vangard Sciences (P.O. Box 1031, Mesquite, TX 75150) by a friend of his, who supposedly got the plans from the inventor. According to the information I received, the original inventor decided to remain anonymous. As the story goes, the inventor had been trying for the last 15 years to get patent coverage for the device but had been harassed by the patent office as well as certain power companies. Subsequent information proved this story a fabrication, as is obvious from the Richardson patent; but I had already built the device. It may turn out that the new derivative of the Theta device, the Pasichinskyj patent, offers a greater potential as a free energy unit and is much easier to build.

Rumors are that both the Hyde and the Pasichinskyj units actually produce useable free energy and the Hyde patent actually claims such. The Hyde patent has been extolled by Moray King (in a recent article) as having great potential as a possible free energy motor. The Hyde electrostatic generator looks to me like an advanced version of a free energy device that is supposedly running in Europe.

We offer these patents to you for your reading enjoyment and hope they will stimulate your interest in free energy and possibly in building one of the devices and experimenting with it. At the present time, we do not know if they do in fact produce free energy. Additionally, I make no claims as to the truth of the plans and description of the Theta device.

I would encourage you to experiment, experiment, experiment--your learning curve will go up exponentially when you do! All those who really built running devices were experimenters and tinkerers. ENJOY!

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A BRIEF, SIMPLIFIED EXPLANATION OF THE SOLID STATE (THETA) RESONATING GENERATOR

(Received May 1990)

Anonymous

An observed and practiced fact of science is applied in a conventional electric generator. That is: when a metal object is passed through a magnetic field, electric current is produced and the efficiency is always less than 100%. The mechanical design of a modern generator requires a proportionately higher amount of energy consumption to produce a given amount of electrical energy Consequently, an electric motor cannot be used to run a generator which in turn feeds fuel back to the motor, leaving an excess for other uses.

In the case of the solid state generator, it has been discovered that a mechanical force is <u>not</u> required to alter the magnetic field; therefore, it is vastly more efficient. So much more efficient that it produces 100 times as much energy as is required to operate it at peak load. The perpetual motion machine is finally here!

The desired result is obtained by using transistors to rapidly alternate low voltage through the mass of an "X" shaped core (see Figure A). The rapidly changing pulse (excitation current) generates electrical current which develops in the central coil.

The generator then quickly achieves an optimum state of operational balance called the <u>resonant frequency</u> at which point it produces electricity at a ratio of 1:100 between the excitation current and the produced current. One percent of the produced current is then used to re-charge the battery fuel source and 99% is available to do the work of mankind.

No other fuel is involved. There are no moving parts to maintain, no pollutants created, and the operation is silent! Actually the barium core is eventually consumed in about 200 to 300 years of operation and is technically a source of energy (fuel).

A unit measuring 2 feet in diameter by 4 feet long and weighing 500 lbs. at a cost of $5,000 could produce more than enough electricity to serve a fully electric modern home, or operate a 40 h.p. electric vehicle for a lifetime plus.

All other known fuels and energy systems are now obsolete. Today's energy transmission methods (power lines, pipe lines) and generating processes (fossil atomic fired) are pointless. Millions of small generating units can now be placed at points of use instead, right at the grass roots, where the power belongs. Power to/for the people. "Right on!" (sic).

Figure A depicts the four piece X shaped barium ferrite core surrounded by an "elongated octagon" core making the total core look similar to the theta symbol; hence, the name. Four excitation coils are placed on the legs of the X core (see Figure B). The central body of the X core has 10 nested coils that are for the output power. A schematic of the coil layout is shown in Figure C. The excitation coils are pulsed using a flip-flop circuit. The coils are pulsed A-A′ then B-B′ then A-A′ again etc.

Figure D shows a detail design of the barium ferrite cores. The X is in two pieces to facilitate placement of the central core area.

The complete core with the coils attached is shown in Figure E. A steel band around the outer core holds the entire core/coil arrangement together.

The circuits shown in Figure F are for the excitation pulse circuitry only. The wiring for the central coil, to pick up the produced current, is simply a collection of the ends of the coil wires hooked in series as required to produce the voltage wanted. The excitation circuits shown are complex in fact, but simple in purpose, and are available "off the shelf" items of transistorized electronic gear.

The upper circuit is a frequency modulator (variable oscillator) allowing the pulse rate of excitation to be adjusted to the optimum "resonant frequency".

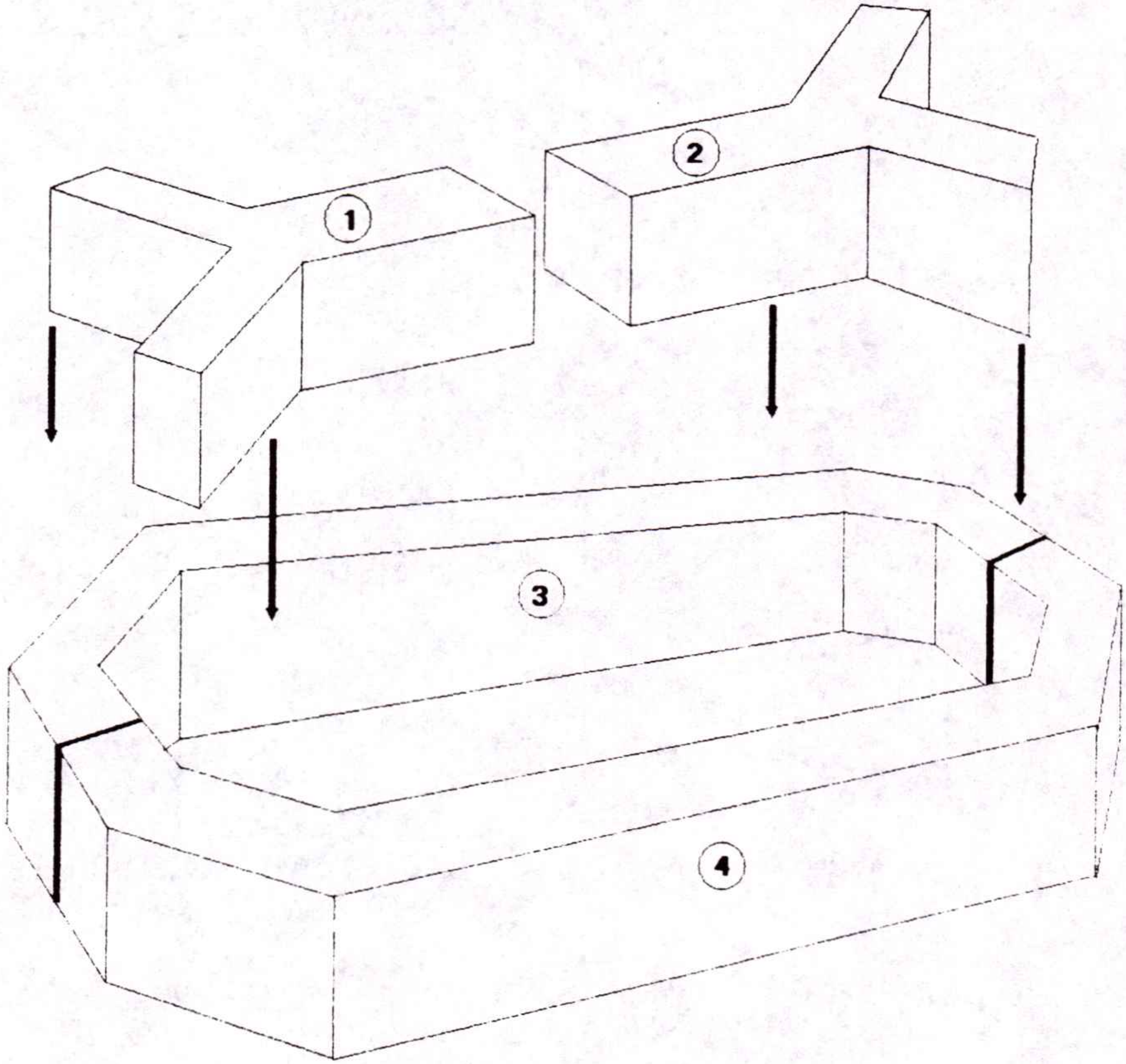
The lower circuit is a "flip-flop" system to permit the rapid changing of current from one electromagnetic circuit to another, within the core.

A 12-volt battery is the source of the excitation current, and can be kept re-charged by the functioning generator or a feed-back circuit could be used to take its place during operation.

That is all there is to the circuitry. The barium core and magnetic fields do the rest.

The entire Theta device (core, coils and electronics) is housed in a cylindrical steel casing that is 22" in diameter by 42" in length. The ends are covered with steel plates (to form a closed tube. The total unit weighs about 550 pounds. An access hole is cut into the top of the casing and a cover installed to facilitate servicing. Steel legs are welded to the bottom for support.

FIGURE A. FOUR PIECE - BARRUIM FERRITE CORE



CORE WEIGHT IS 200 POUNDS. BARIUM FERRITE MATERIAL HAS THE CHARACTERISTIC OF PRODUCING AN ELECTRICAL CURRENT WHEN USED IN THIS WAY. NO OTHER HAS YET BEEN FOUND TO DO THIS. THE MASS OF THE MATERIAL DICTATES THE POTENTIAL ELECTRICAL YIELD OF THE UNIT.

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DATE: MAY 1990

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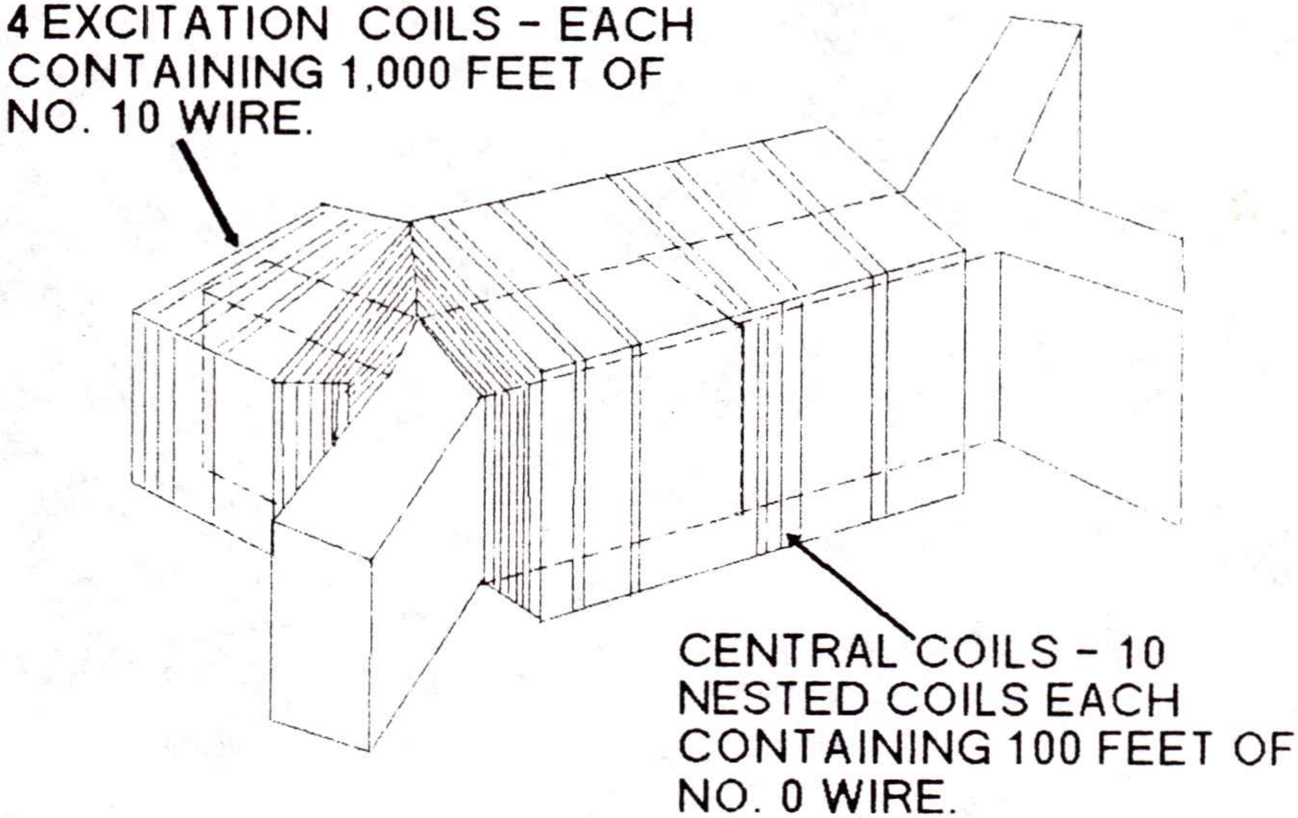
FIGURE B. COPPER COIL WIRES ON CORE



COILS ARE INSTALLED ON CORE. 14 TOTAL.

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FIGURE C DETAIL ON ENERGY/COIL

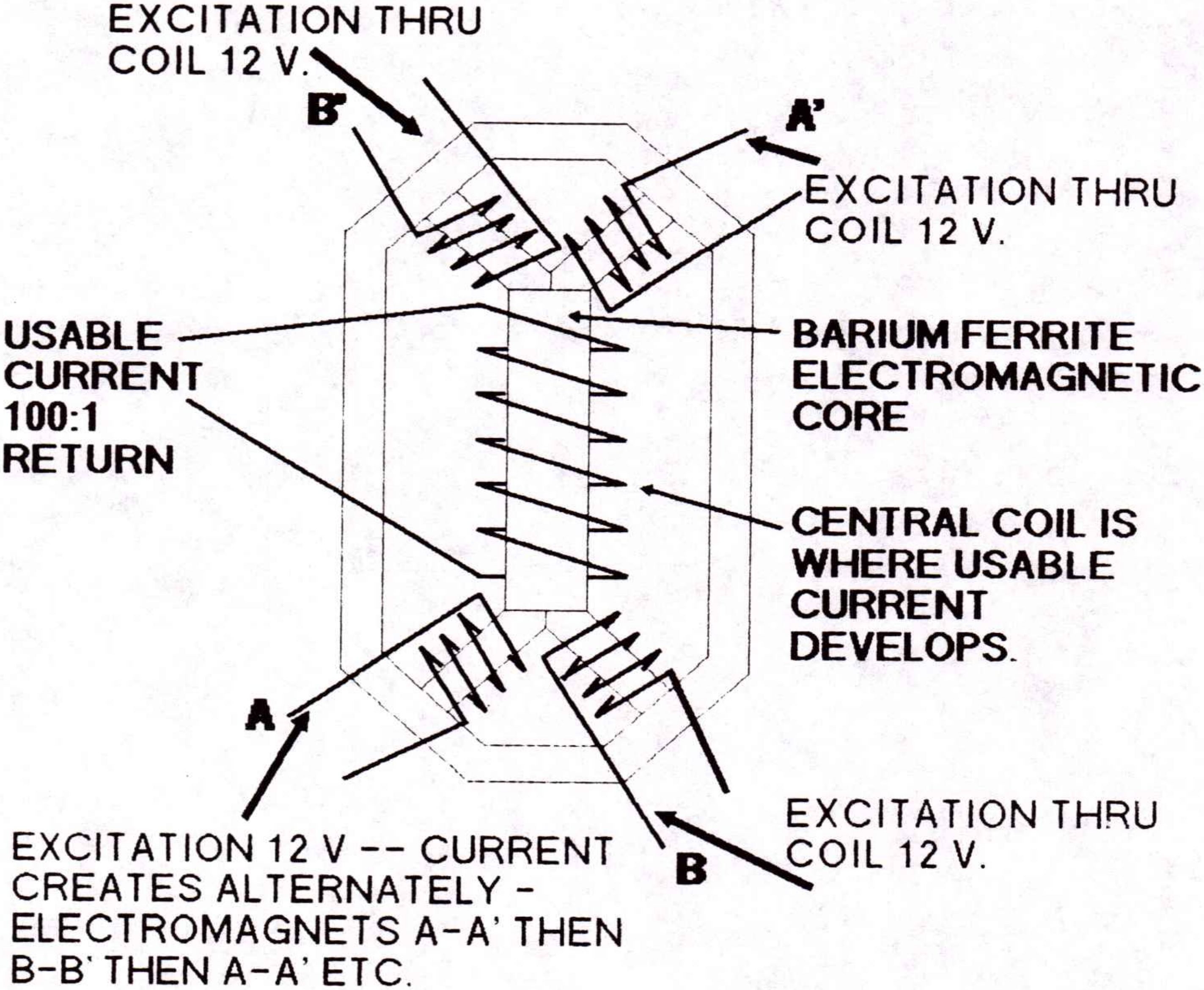

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FIGURE D BARIUM FERRITE CORE DESIGN DETAIL

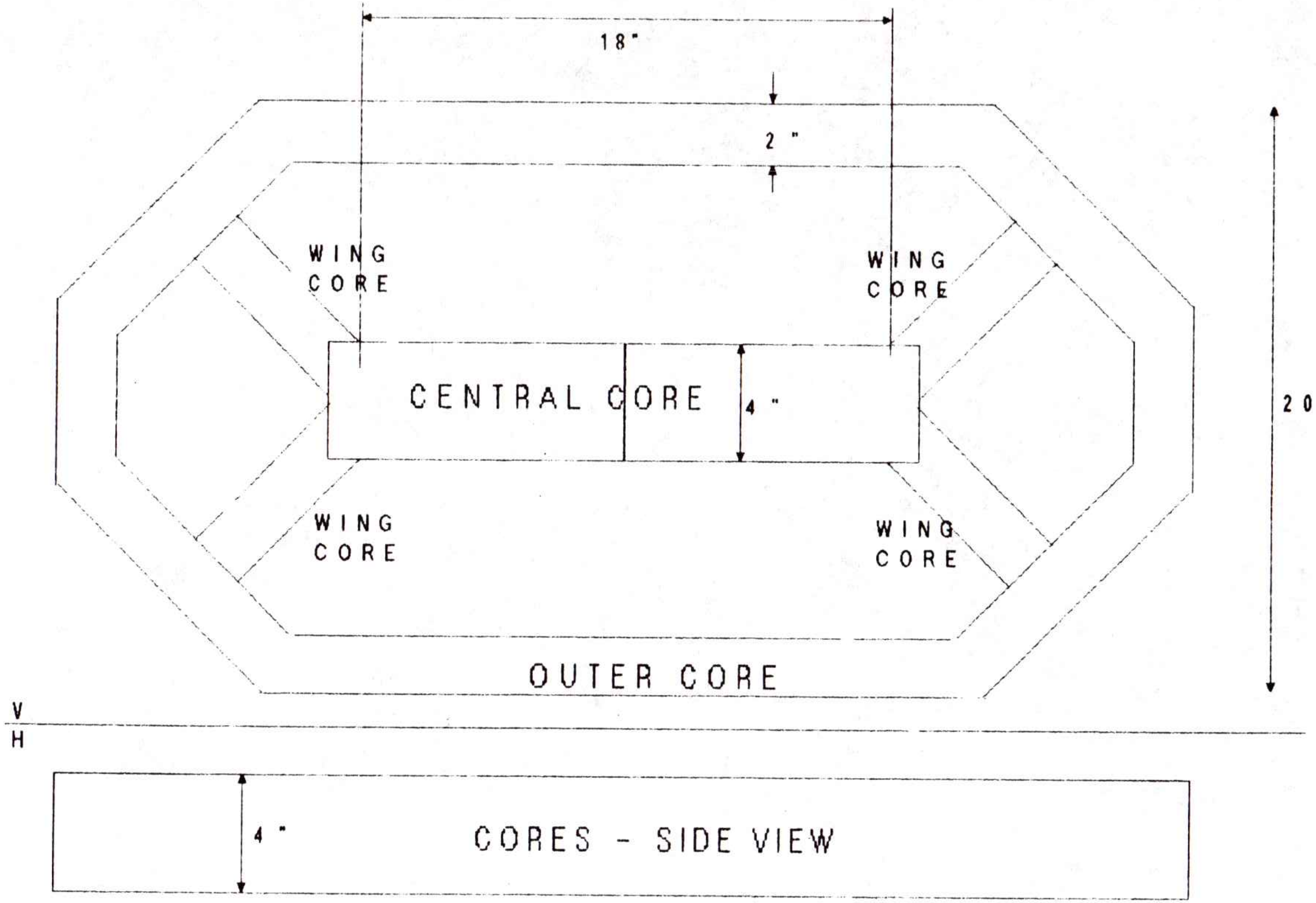

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FIGURE E COMPLETE THETA FREE ENERGY UNIT

COMPLETE UNIT CONTAINS:
- 4 WING COILS
- 10 NESTED COIL ON CENTRAL CORE
- CENTRAL CORE
- OUTER CORE
- STEEL BAND AROUND OUTSIDE
  HOLDS UNIT TOGETHER

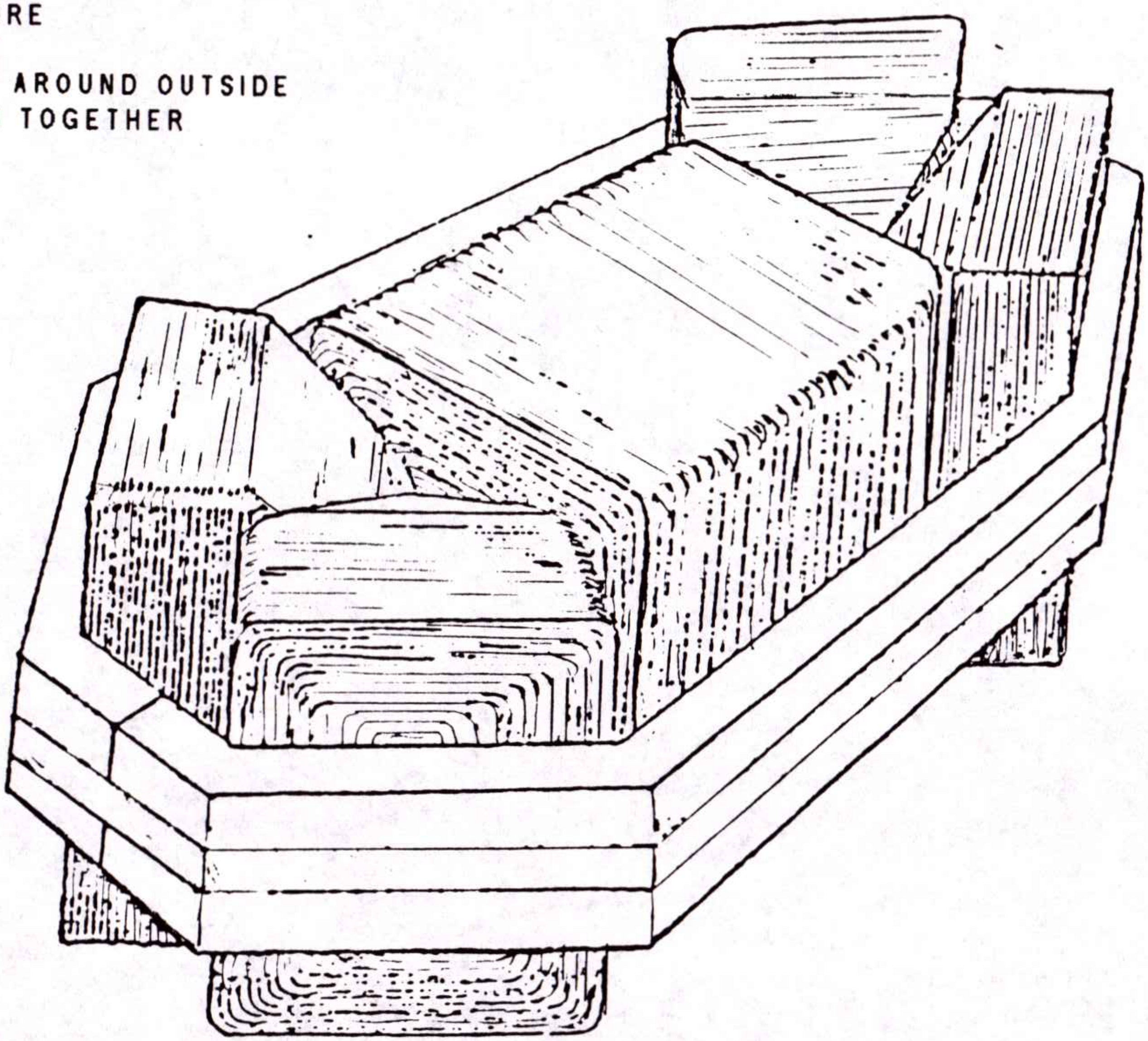

FIGURE F CIRCUIT DIAGRAM FOR EXCITATION COILS

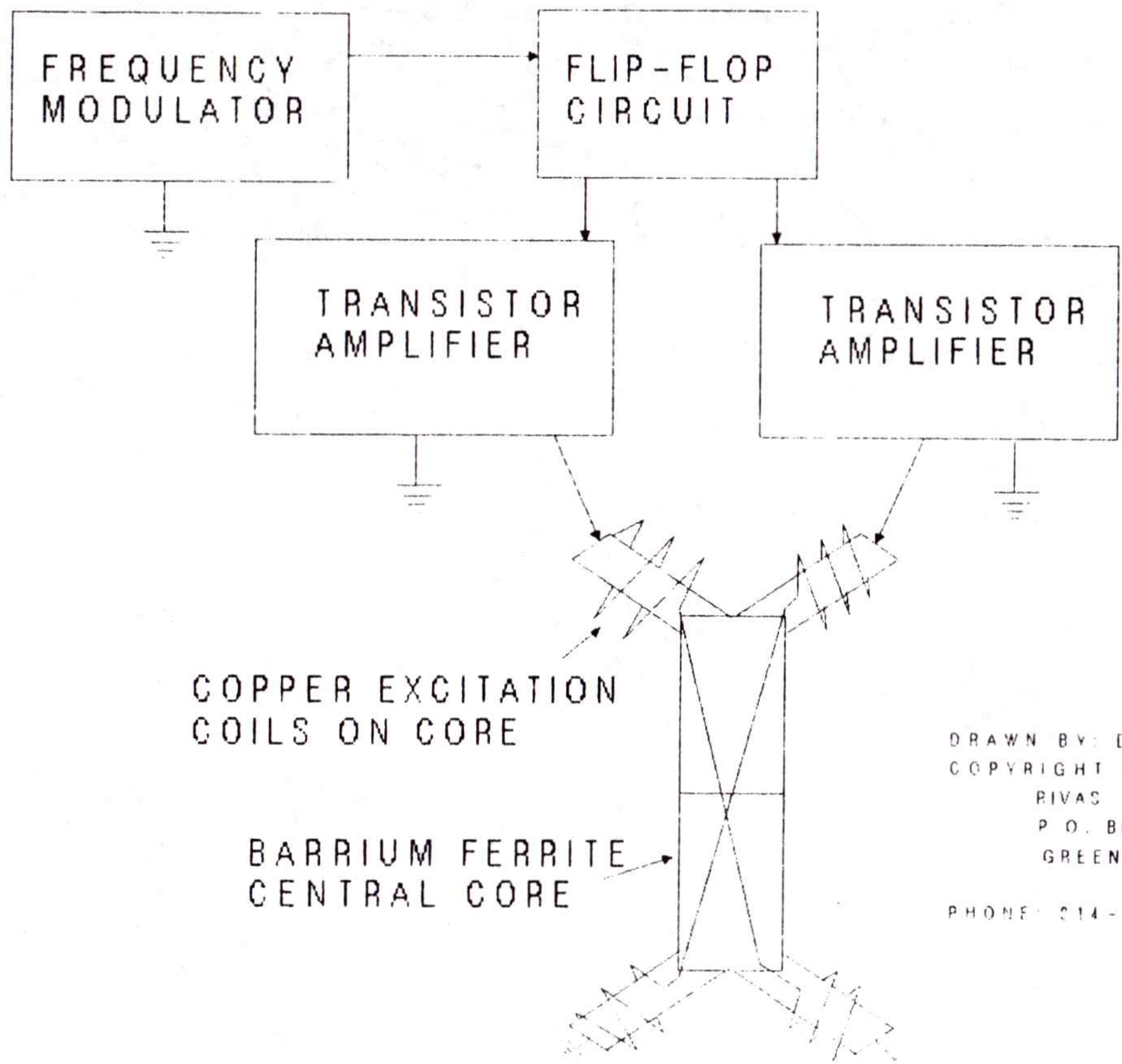

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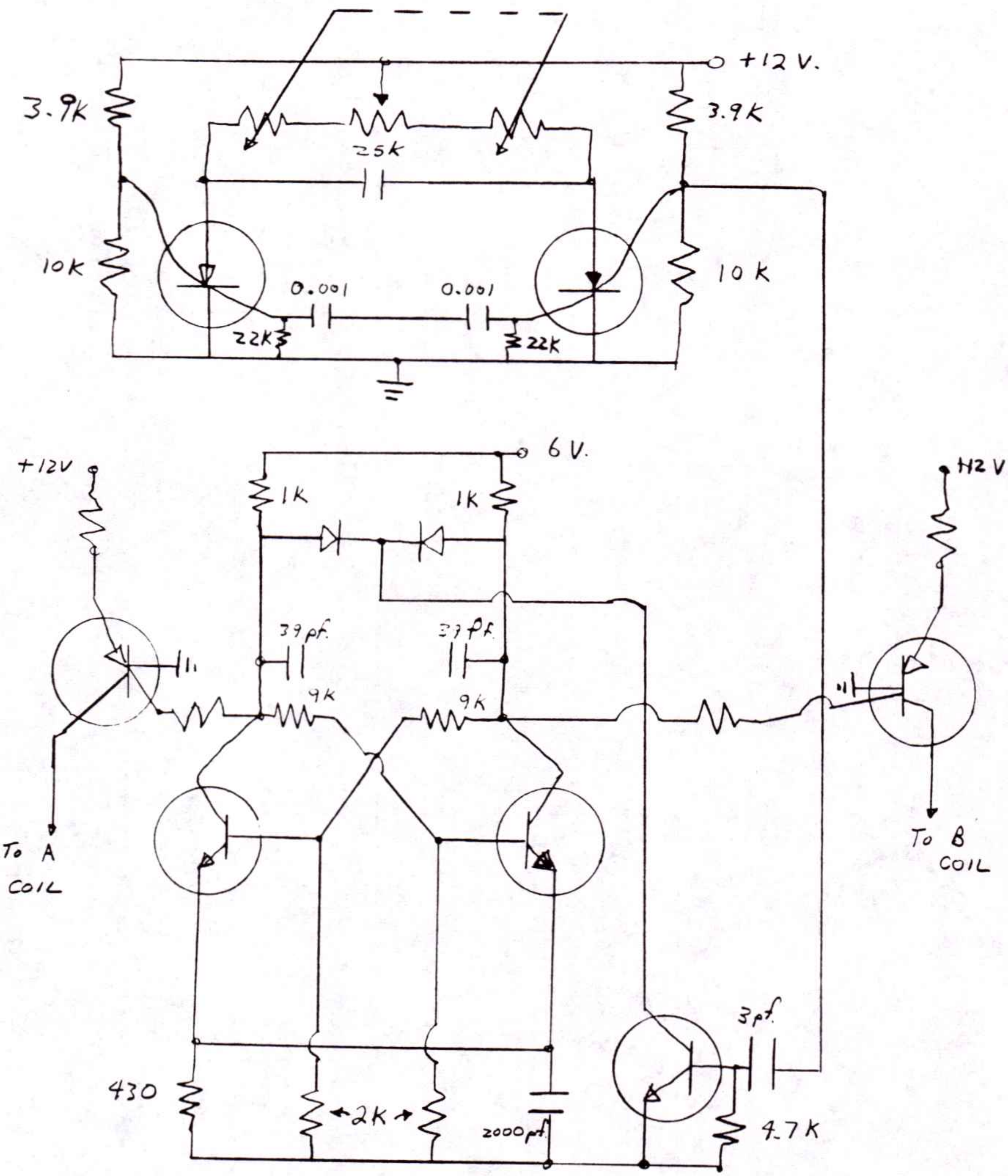
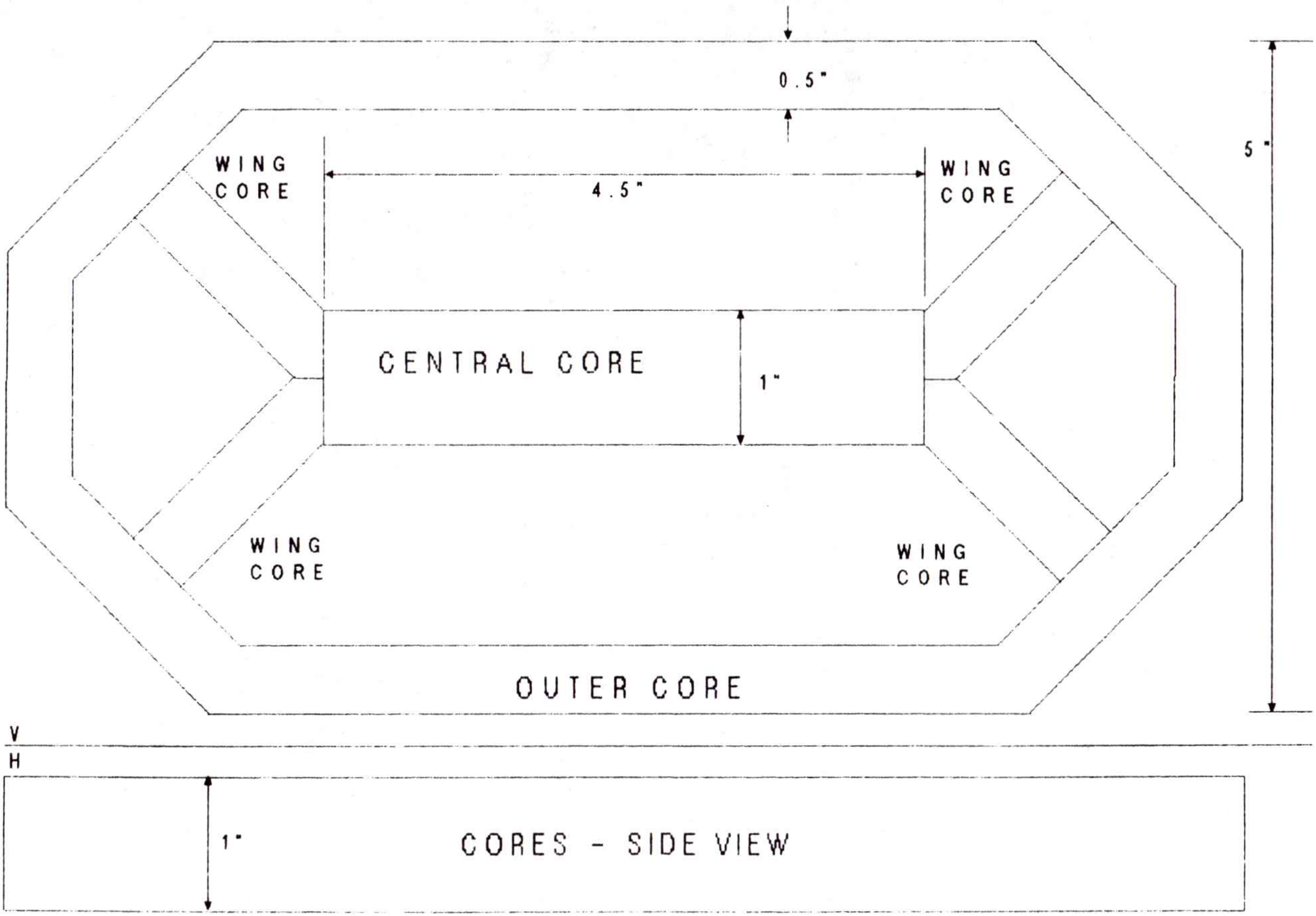
FIGURE 6. ORIGINAL THETA DRIVER CIRCUIT



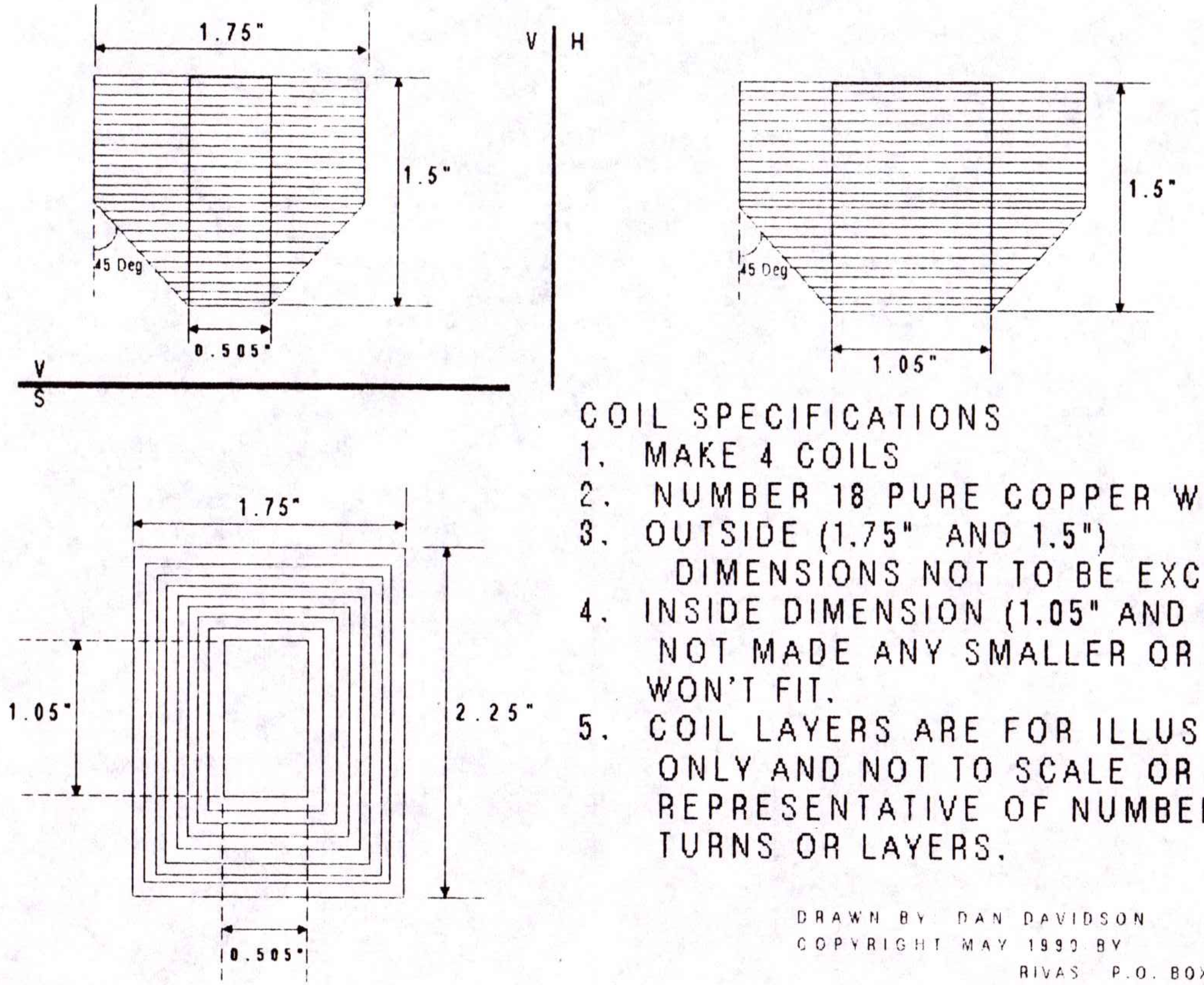
Dual flip-flop oscillator with dual amplifiers drive the θ coils. This was circuit from anonymous. Can be greatly simplified.

FIGURE H REDUCED SIZE TEST CORE DESIGN DETAIL



SCALE: 1 : 1

FIGURE I WING COIL DESIGN (SCALE VERSION)



COIL SPECIFICATIONS

1. MAKE 4 COILS
2. NUMBER 18 PURE COPPER WIRE
3. OUTSIDE (1.75" AND 1.5")
   DIMENSIONS NOT TO BE EXCEEDED.
4. INSIDE DIMENSION (1.05" AND 0.55")
   NOT MADE ANY SMALLER OR CORE
   WON'T FIT.
5. COIL LAYERS ARE FOR ILLUSTRATION
   ONLY AND NOT TO SCALE OR
   REPRESENTATIVE OF NUMBER OF
   TURNS OR LAYERS.

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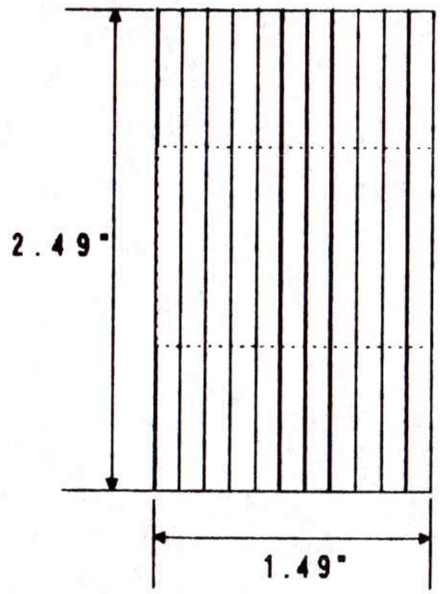
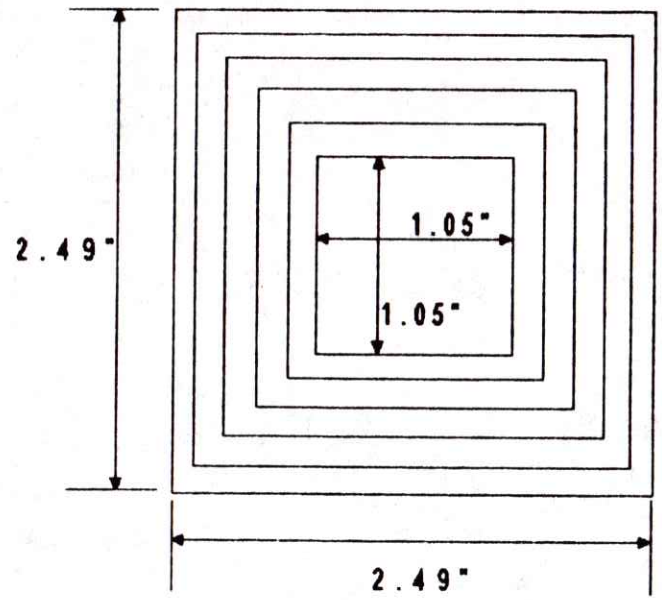
FIGURE J INNER CORE COIL DESIGN (SCALE VERSION)





COIL SPECIFICATIONS

1. MAKE 3 OF THESE COILS.
2. NUMBER 8 PURE COPPER WIRE.
3. COIL LAYERS ARE NOT TO SCALE AND ARE FOR ILLUSTRATION OF THE RELATIVE COIL RELATIONSHIPS.
4. INSIDE COIL DIMENSIONS (1.05") ARE CRITICAL AND ARE NOT TO BE MADE SMALLER.
5. WIDTH DIMENSION CANNOT EXCEED 1.5 (3 SIDE BY SIDE CANNOT BE › 4.5).
6. HORIZONTAL(2.49") AND VERTICAL(2.49") DIMENSIONS HAVE A LITTLE SLACK EITHER WAY. IF ANOTHER LAYER CAN BE ADDED WITHOUT INCREASING THESE COIL DIMENSION MORE THAN 0.05".

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United States Patent [19]

Hyde

[11] Patent Number: 4,897,592

[45] Date of Patent: Jan. 30, 1990

[54] ELECTROSTATIC ENERGY FIELD POWER GENERATING SYSTEM

[76] Inventor: William W. Hyde, 1685 Whitney, Idaho Falls, Id. 83402

[21] Appl. No.: 211,704

[22] Filed: Jun. 27, 1988

[51] Int. Cl.⁴ H02N 1/08

[52] U.S. Cl. .... 322/2 A; 310/309

[58] Field of Search .... 322/2 A; 310/309

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Primary Examiner—R. J. Hickey

Attorney, Agent, or Firm—Fleit, Jacobson, Cohn, Price, Holman & Stern

[57] ABSTRACT

Externally charged electrodes of an electrostatic generator induce charges of opposite polarity on segments of a pair of confronting stators by means of electric fields within which a pair of rotors are confined during rotation to vary the charge binding field linkages between confronting rotors and stators by a shielding action of the rotors in a plane perpendicular to the field flux. A high electric potential difference induced between the stators resulting from such rotation of the rotors, is transformed by an output circuit into a reduced DC voltage applied to a load with a correspondingly increase current conducted therethrough.

19 Claims, 3 Drawing Sheets

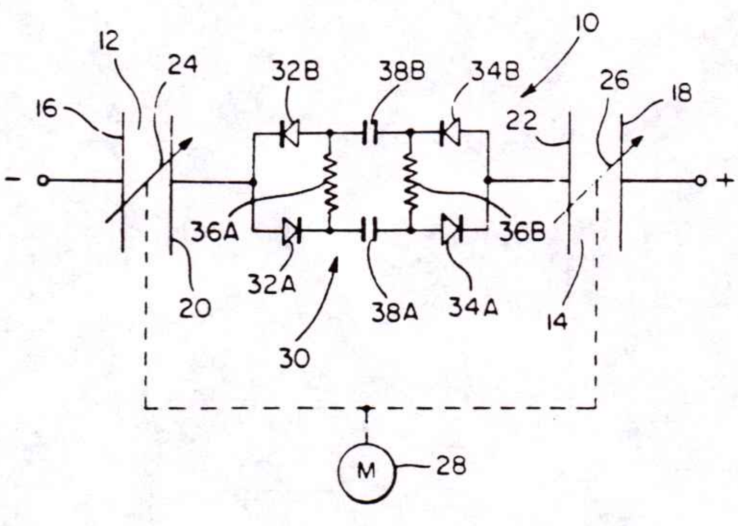


FIG. 1

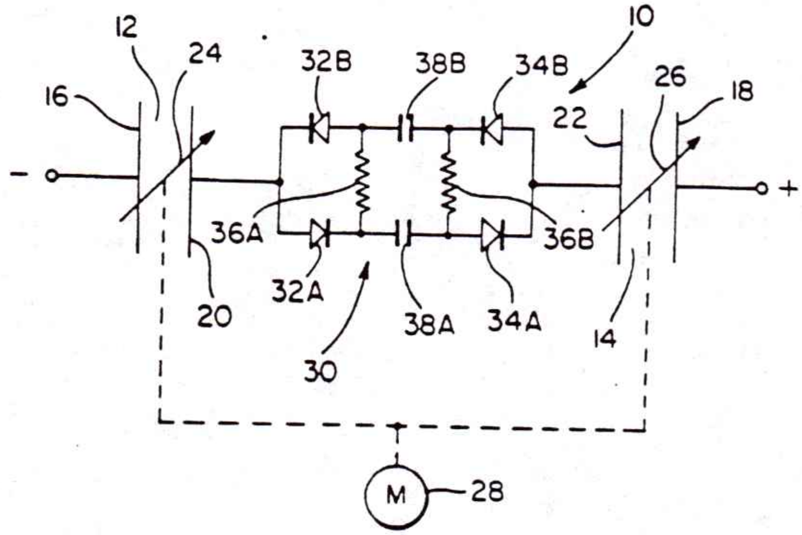
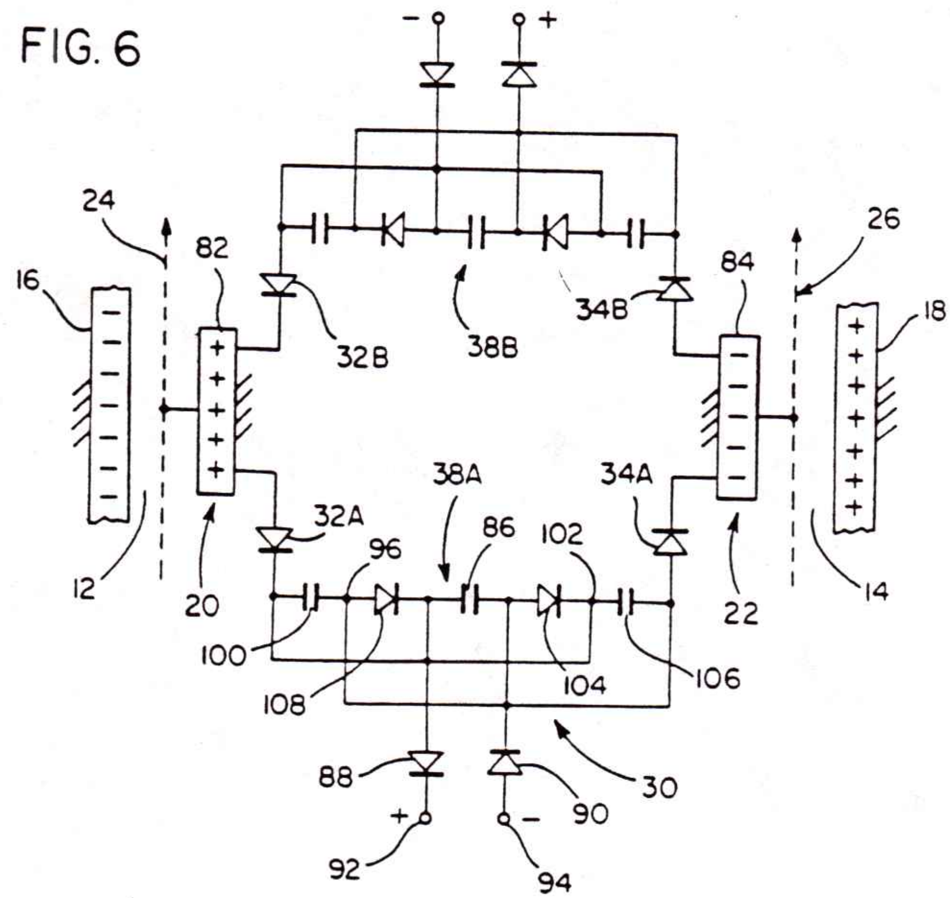

12
24
16
32B
38B
34B
10
26
18
22
36A
36B
32A
20
38A
34A
14
30
M
28

FIG. 6


24
26
82
84
16
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32B
38B
34B
38A
34A
32A
86
102
96
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20
22
14
100
108
104
106
30
88
90
92
94

FIG. 2

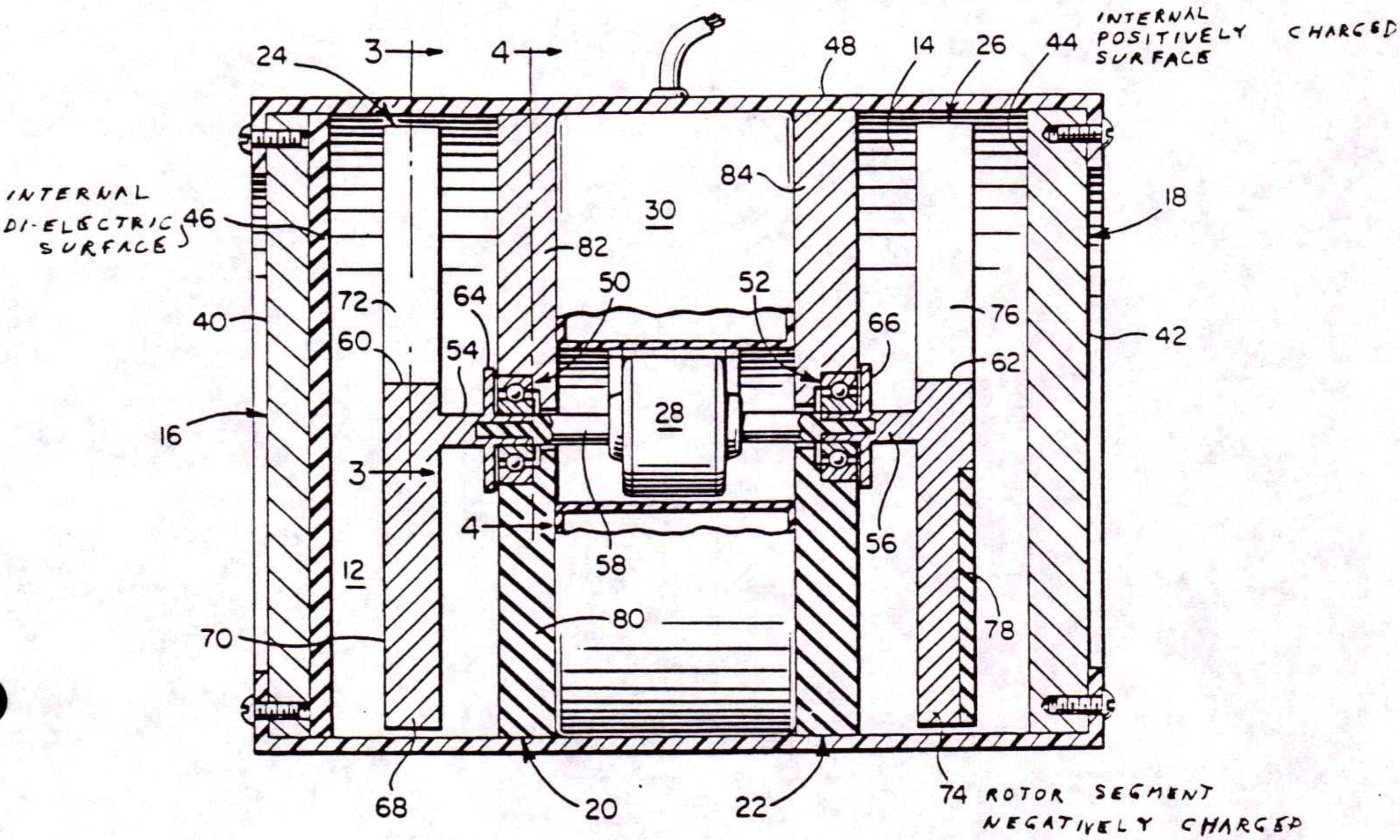


FIG. 3

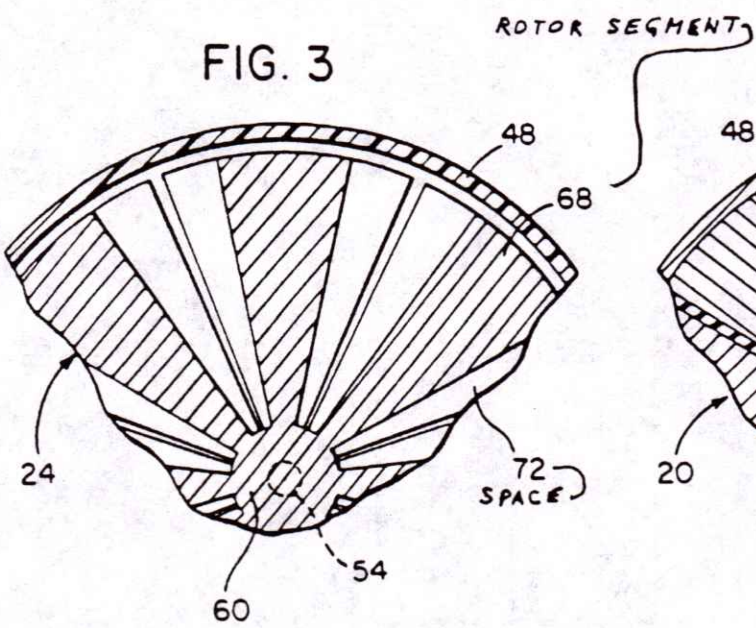


FIG. 4

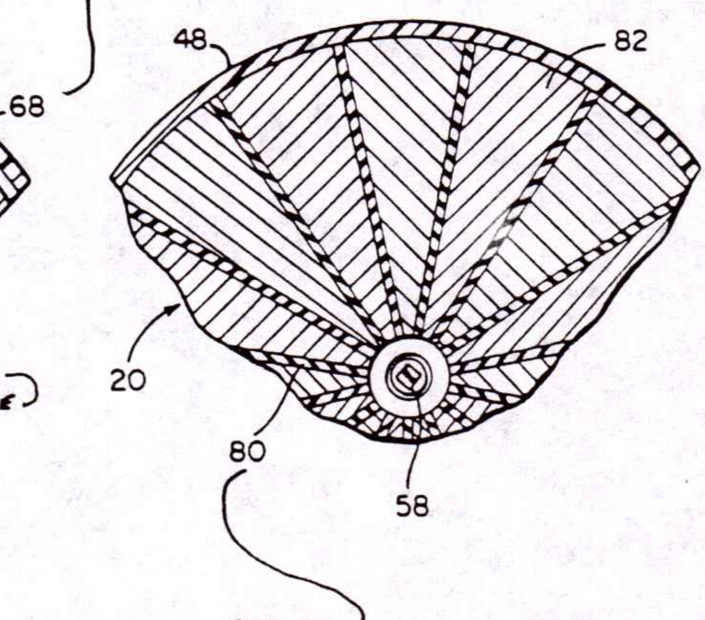
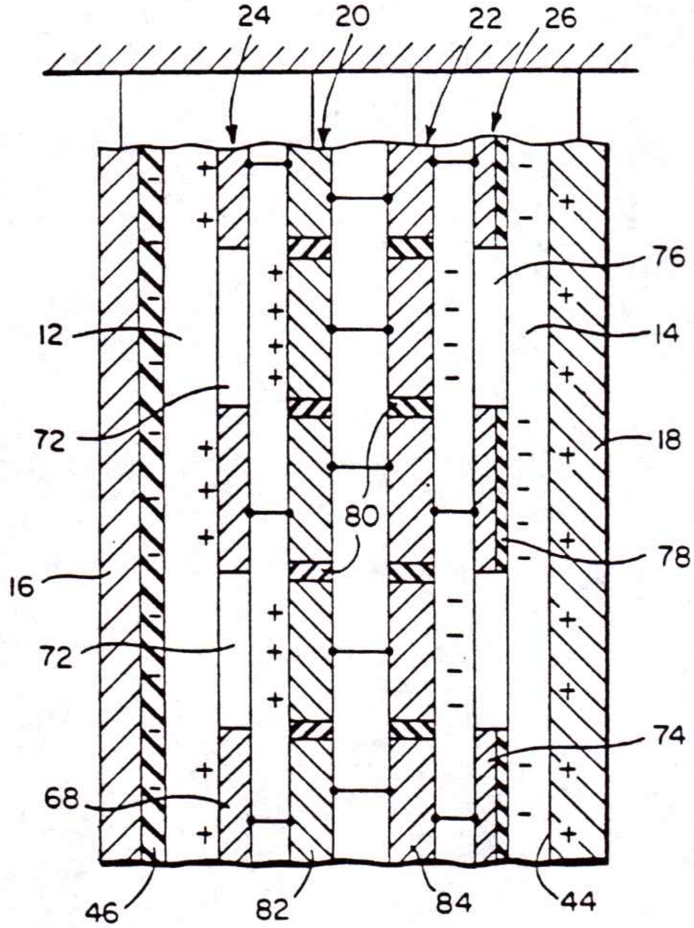


FIG. 5A


24
20
22
26
76
12
14
72
18
80
78
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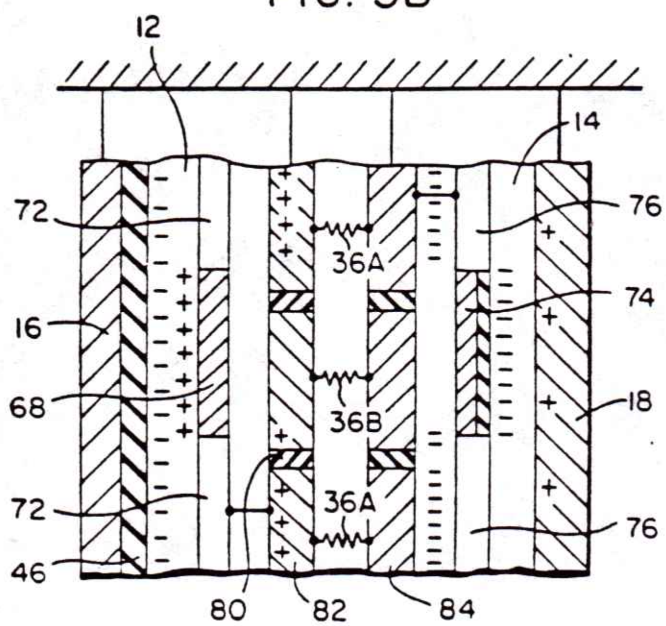
72
74
68
46
82
84
44

FIG. 5B


12
14
72
76
36A
74
16
18
68
36B
36A
72
76
46
80
82
84

ELECTROSTATIC ENERGY FIELD POWER GENERATING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to the generation of electrical power by conversion of energy from an electrostatic field.

The conversion of energy from a static electric field into useful electrical energy by means of an electrostatic generator is already well known in the art as exemplified by the disclosures in U.S. Pat. Nos. 2,522,106, 3,013,201, 4,127,804, 4,151,409 and 4,595,852. Generally, the energy conversion process associated with such prior art electrostatic generators involves the input of mechanical energy to separate charges so that a considerable portion of the output is derived from the conversion of mechanical energy.

It is therefore an important object of the present invention to provide an electrostatic generator in which electrical power is derived from the energy of static electric fields with a minimized input of mechanical power.

SUMMARY OF THE INVENTION

In accordance with the present invention, static electric fields are established between electrodes externally maintained at charge levels of opposite polarity and a pair of internal stator discs having segmental surfaces that are dielectrically spaced to confine thereon charges induced by the electric fields. A pair of rotor discs are rotated within continuous electric fields in planes perpendicular to the field flux to locationally vary the charge linkage established by the electric fields between the electrodes and stator discs. Such changes in charge linkage are effected by rotation of electrically conductive segments of the rotor angularly spaced from each other to partially shield the stator discs from the electric fields. The segments of each rotor disc have charged faces confronting the electrodes in its field to shield the stator disc over a total face area that is one-half the total area of the confronting segment surfaces on the stator disc to which the induced charges are confined. Charges on the rotors and stators are equalized by electrical interconnections established through the rotor shafts. The stator discs are electrically interconnected with an electrical load through an output circuit transforming a high potential between the stator discs into a reduced dc voltage to conduct a correspondingly multiplied current through the load.

BRIEF DESCRIPTION OF DRAWING FIGURES

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings in which like parts or elements are denoted by like reference numerals throughout the several views of the drawings and wherein:

FIG. 1 is a simplified electrical circuit diagram corresponding to the energy conversion system of the present invention.

FIG. 2 is a side section view of an electrostatic generator embodying the system of FIG. 1 in accordance with one embodiment of the invention.

FIGS. 3 and 4 are partial section views taken substantially through planes indicated by section lines 3—3 and 4—4 in FIG. 2.

FIGS. 5A and 5B are schematic partial laid out top views of the electrostatic generator of FIGS. 2-4, under static and dynamic charge distribution conditions, respectively.

FIG. 6 is an electrical circuit diagram of the output circuit of the generator shown in FIG. 2, in accordance with one embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Referring now to the drawings in detail, FIG. 1 diagrammatically depicts the energy conversion system of the present invention generally referred to by reference numeral 10. As diagrammed in FIG. 1, the system includes a pair of electrostatic fields 12 and 14 established by electrostatic charges of opposite polarity applied to electrode plates 16 and 18 from some external energy source. Thus, the electrostatic field 12 is established between electrode 16 and a stator disc 20 while the electrostatic field 14 is established between electrode 18 and a stator disc 22. In accordance with the present invention, electrostatic charge linkages established by the flux of the fields between the electrodes and stators are periodically varied by displacement within continuous energy fields 12 and 14 in response to rotation of rotors 24 and 26 aligned with planes perpendicular to their common rotational axis and the field flux as will be hereinafter described. The rotors are mechanically interconnected with an electric motor 28, as diagrammatically illustrated in FIG. 1, for rotation about the common rotational axis. Electrical energy may be extracted from the electric fields 12 and 14 during rotation of the rotors 24 and 26 by motor 28 through an output circuit generally referred to by reference numeral 30. The output circuit 30 as shown, in FIG. 1 in a simplified fashion, includes two pair of current conducting diodes 32A, 32B and 34A, 34B. The diodes of each pair are oppositely poled and each pair is connected in parallel to one of the stators 20 and 22. The diodes of each pair are also electrically connected across an electrical load represented by resistors 36A and 36B with capacitor networks 38A and 38B interconnected between each pair of diodes by means of which the voltage potential between the stators 20 and 22 is reduced in favor of an increased current through the electrical load.

Referring now to FIGS. 2, 3 and 4 in particular, a physical embodiment of the energy conversion system diagrammed in FIG. 1 is shown. The electrodes 16 and 18 are in the form of circular plates or discs made of an electrically conductive metal having external surfaces 40 and 42 adapted to be charged from the external source as aforementioned. The internal surface 44 of electrode 18 is thereby adapted to maintain a positive charge opposite in polarity to the negative charge of the electrode 16 which is maintained in a stable ion form within a dielectric surface portion 46 of the electrode 16. The energy conversion system may be enclosed within an outer housing 48 to which the electrodes 16 and 18 are secured.

With continued reference to FIG. 2, the stators 20 and 22 mounted by housing 48 in axially fixed spaced relation to the electrodes 16 and 18 are provided with bearings 50 and 52 establishing the aforementioned common rotational rotor axis journaling a powered shaft assembly having electrically conductive shaft sections 54 and 56 to which the rotors 24 and 26 are respectively connected. In the embodiment illustrated in FIG. 2, the drive motor 28 is mechanically interconnected with the shaft sections 54 and 56 through an electrically nonconductive shaft section 58 of the power shaft assembly for simultaneous rotation of both rotors 24 and 26 at the same speed and in the same direction about the common rotational axis perpendicular to parallel spaced planes with which the electrode and stator discs are aligned. The electrically conductive shaft sections 54 and 56 are respectively keyed or secured in any suitable fashion to hub portions 60 and 62 of the rotors and are provided with flange portions 64 and 66 forming electrical wipers in contact with confronting surfaces of the stators 20 and 22, which are inductively charged by the static electric fields 12 and 14 to equal levels of opposite polarity.

As more clearly seen in FIGS. 2 and 3, the rotor 24 has a plurality of angularly spaced, field linkage controlling segments 68 projecting radially outwardly from the hub portion 60. Each rotor segment 68 is made of an electrically conductive metal having a face 70 on one axial side confronting the adjacent electrode 16. The faces 70 confronting the electrode 16 are charged positively by the electric field 12 extending between the dielectric surface portion 46 of electrode 16 and the stator disc 20. While the electric field 12 projects through the spaces 72 between the rotor segments 68, the rotor segments 68 themselves shield portions of the stator disc 20 from the electric field.

The rotor 26 is similarly formed with rotor segments 74 angularly spaced from each other by spaces 76 through which the electric field 14 extends between the positively charged surface 44 of electrode 18 and the stator 22. The rotor segments 74 of rotor 26 as shown in FIG. 2, are provided with dielectric surface portions 78 confronting the internally charged surface 44 of electrode 18. While the rotor segments 74 are negatively charged by the electric field 14 within the surface portions 78, they also shield portions of the stator disc 22 from the electric field as in the case of the rotor segments 68 hereinbefore described. The internal dielectric surface portion 46 of electrode 16 and dielectric surface portions 78 of rotor 26 act as a stabilizer to prevent eddy currents and leakage of negative charge. Further, in view of the electrical connections established between the rotors and the stator discs, the charge on each stator is equalized with that of the charge on its associated rotor.

As shown in FIGS. 2 and 4, the stator disc 20 includes a plurality of segments 82 to which charges are confined, closely spaced from each other by dielectric spacers 80. The segments 82 are electrically interconnected with the rotor segments 68 through rotor shaft section 54. Similarly, the segments 84 of the stator 22 are electrically interconnected with the rotor segments 74 through rotor shaft section 56. The stator segments 82 and 84 are therefore also made of electrically conductive metal. Each of the segments 82 of stator 20 is electrically interconnected through the output circuit 30 with each of the segments 84 of the stator. The stator discs being fixedly mounted within the housing 48, centrally mount the bearings 50 and 52 through which the electrically nonconductive motor shaft section 58 is journaled as shown in the embodiment of the invention illustrated in FIG. 2. Further, the total area of the charged segment surfaces on each of the stator discs is greater than the total area of the faces 70 or 78 on the segments of each associated rotor disc 24 or 26. According to one embodiment, the total charged stator surface area is twice that of the rotor face area.

According to the embodiment of the invention illustrated in FIG. 6, the output circuit 30 includes the two oppositely poled capacitive circuit networks 38A and 38B connected across each aligned pair of stator segments 82 and 84 on the stators 20 and 22 by means of the oppositely poled diodes 32A and 34A. Each of such capacitive circuit networks includes a capacitor 86, the opposite sides of which are connected by oppositely poled diodes 88 and 90 to positive and negative load terminals 92 and 94 across which a suitable electrical voltage is established for operating an electrical load. The diode 88 is connected to the junction 102 between diode 104 and one side of capacitor 106. The diode 88 is also connected to the junction between one side of capacitor 100 and the diode 32A. The diode 90, on the other hand, is interconnected with the junction 96 between diode 108 and capacitor 100. Also, diode 90 is connected to the junction between the other side of capacitor 106 and the diode 34A. The foregoing circuit arrangement of capacitive network 38A is the same as that of network 38B by means of which aligned pairs of the stator segments 82 and 84 have the electrical potentials therebetween transformed into a lower voltage across the load terminals 92 and 94 to conduct a higher load current.

FIG. 5A illustrates the distribution of charges established in the electric fields 12 and 14 between the electrodes and stators under static conditions in which each of the rotor segments 68 and 74 is positioned in alignment with one of the stator segments 82 and 84 to thereby shield alternate stator segments from the electric fields. The charges established by the electric fields are therefore confined to the faces of alternate stator segments confronting the electrodes and are equalized with the charges established on and confined to the shielding faces of the rotor segments confronting the electrodes by virtue of the electrical interconnection between the rotors and stators as aforementioned. As depicted in FIG. 5B, when rotation is imparted to the rotors, the charge linkages established by the electric fields between the electrodes and alternate stator segments 82 or 84 are interrupted by the moving rotor segments 68 or 74 so that previously sielded stator segments become exposed to the fields to reestablish field energy linkages with the associated electrodes. Such action causes electrical potentials to be established between the stator segments 82 and 84.

It will be apparent from the foregoing description that the electrostatic energy fields 12 and 14 of opposite polarity are established maintained between the externally charged electrodes 16 and 18 and the internally charged stators 20 and 22 under static conditions as depicted in FIG. 5A. During rotation, the rotors 24 and 26 continuously disposed within such energy fields 12 and 14, exert forces in directions perpendicular to the field flux representing the energy linkages between electrodes and stators to cause interruptions and reestablishment of energy linkages with portions of different stator segments as depicted in FIG. 5B. Such energy linkage locational changes and the charge binding and unbinding actions between electrodes and stators creates an electrical potential and current to flow between stators through the output circuit 30. Thus, the output circuit when loaded extracts energy from the electric fields 12 and 14 as a result of the field linkage charge bindinbg and unbinding actions induced by rotation of the rotors. The stator segments 82 and 84 shielded from the electric fields by the moving rotor segments 68 and 74 as depicted in FIG. 5B, have electric potentials of polarity opposite to those of the external electrodes 16 and 18 because of the field linkage charge unbinding action. Previously shielded stator segments being exposed to the electric fields by the moving rotor segments, have the same electric potential polarity as those of the external electrodes because of field linkage binding action. Since the forces exerted on the respective rotors by the electric fields 12 and 14 of opposite polarity act on the common rotor shaft assembly perpendicular to said fields, such forces cancel each other. The energy input to the system may therefore be substantially limited to mechanical bearing losses and windage during conversion of electrostatic field energy to electrical energy as well as electrical resistance losses and other electrical losses encountered in the output circuit 30.

Based upon the foregoing operational characteristics, rotation of the rotors in accordance with the present invention does not perform any substantial work against the external electric fields 12 and 14 since there is no net change in capacitance thereby enabling the system to convert energy with a reduced input of mechanical energy and high efficiency, as evidenced by minimal loss of charge on the electrodes. It was therefore found that working embodiments of the present invention require less than ten percent of the electrical output energy for the mechanical input. Further, according to one prototype model of the invention, a relatively high output voltage of 300,000 volts was obtained across the stators. By reason of such high voltage, an output circuit 30 having a voltage reducing and current multiplying attribute as hereinbefore described was selected so as to render the system suitable for many practical applications.

The foregoing is considered as illustrative only of the principles of the invention. Further since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and, accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

What is claimed is:

1. An energy conversion system including a pair of electrodes maintained electrostatically charged at substantially equal potentials of opposite polarity, stator means mounted in operatively spaced relation to said electrodes for inducement therein of charges of opposite polarity through electric fields established by said equal potentials, power driven rotor means continuously disposed within said electric fields for receiving charged induced by said electric fields, means electrically connecting said rotor means to the stator means for equalizing of said induced charges therebetween, field linkage control means for movably shielding the stator means from the electric fields during rotation of the rotor means and output circuit means operatively connected to the stator means for extracting therefrom an operating voltage in response to movement of said shielding of the stator means.

2. The system as defined in claim 1 wherein said stator means includes a pair of axially spaced stator discs respectively linked electrostatically to the electrodes by said eletric fields, the rotor means including a pair of rotor discs respectively disposed axially between the electrodes and the stator discs.

3. The system as defined in claim 2 wherein said field linkage control means comprises angularly spaced segments on the rotor discs having charged faces shielding portions of the stator discs from the electrodes.

4. The system as defined in claim 3 wherein each of the stator discs includes angularly spaced surface portions confronting the angularly spaced rotor segments and dielectric means between said surface portions for confining the induced charges thereto, the surface portions of the stator discs and the charged faces of the rotor segments being unequal in area.

5. An energy conversion system including a pair of electrodes electrostatically charged to substantially equal potentials of opposite polarity, stator means mounted in operatively spaced relation to said electrodes for inducement therein of charges of opposite polarity through electric fields established by said equal potentials, said stator means including a pair of axially spaced stator discs respectively linked to the electrodes by said electric fields, power driven rotor means continuously disposed within said electric fields for receiving induced charges thereon, means electrically connecting said rotor means to the stator means for transfer of said induced charges therebetween, said rotor means including a pair of rotor discs respectively disposed axially between the electrodes and the stator discs and field linkage control means for variably shielding the stator means from the electric fields during rotation of the rotor means, said field linkage control means comprising angularly spaced segments on the rotor discs having charged faces shielding portions of the stator discs from the electrodes, each of the stator discs including angularly spaced surface portions confronting the angularly spaced rotor segments and dielectric means between said surface portions for confining the induced charges thereto, the surface portions of the stator disc having areas twice that of the areas of the charged faces of the rotor segments and output circuit means operatively connected to the stator means for establishing an operating voltage in response to said variation in the shielding of the stator means by the rotor means.

6. The system as defined in claim 5 including a power shaft assembly on which the rotors are mounted for simultaneous rotation, said electrical connecting means being formed by electrically conductive sections of said shaft assembly.

7. The system as defined in claim 6 wherein the charged faces of the rotor segments on one of the rotors is formed by dielectric material within which the induced charges of negative polarity are confined in stable ion form.

8. The system as defined in claim 7 wherein said output circuit means includes a pair of dc voltage terminals, a capacitive network, and current blocking diode means coupling the network to the terminals and to each of the surface portions of the stator discs for multiplying current conducted between the stator discs while reducing potentials therebetween to a value equal to the operating voltage across the dc voltage terminals.

9. The system as defined in claim 2 wherein each of the stator discs includes angularly spaced surface portions confronting the rotor and dielectric means between said surface portions for confining the induced charges thereto.

10. The system as defined in claim 9 wherein said output circuit means includes a pair of dc voltage termi-

nals, a capacitive network, and current blocking diode means coupling the network to the terminals and to each of the surface portions of the stator discs for multiplying current conducted between the stator discs while reducing potentials therebetween to the operating voltage across the terminals.

11. The system as defined in claim **1** including a power shaft assembly on which the rotors are mounted for simultaneous rotation, said electrical connecting means being formed by electrically conductive sections of said shaft assembly.

12. The system as defined in claim **3** wherein the charged faces of the rotor segments on one of the rotors is formed by dielectric material within which the induced charges of negative polarity are confined in stable ion form.

13. The system as defined in claim **1** wherein said stator means and said rotor means respectively have faces confronting each of the electrodes, and dielectric surface means coating those of the confronting faces on which the charges of negative polarity are induced and maintained in a stable ion form for preventing eddy currents and charge leakage.

14. The system as defined in claim **1** wherein the stator means and the rotor means have faces continuously exposed to said electric fields on which the charges of negative polarity are induced, and stabilizer means for preventing leakage of the induced charges through said faces.

15. The system as defined in claim **14** wherein said stabilizer means comprises dielectric material on said faces maintaining the negative charges therein in stable ion form.

16. In an energy conversion system having an electrode of one polarity maintained at an electrostatic potential, a stator and a rotor disposed within an electric field established between the electrode and the stator by said potential on the electrode, means mounting the rotor for rotation continuously within the electric field and means electrically interconnecting the rotor and the stator for equalizing electrostatic charges established thereon opposite in polarity to said one polarity, the rotor having charged surface means partially shielding the stator from the electric field for producing an electric potential on the stator in response to rotation of the rotor causing movement of the charges established by the unshielded electric field.

17. The system as defined in claim **16** wherein the stator includes means for confining electrostatic charges established to surfaces of greater total area than that of the charged surface means of the rotor.

18. The system as defined in claim **1** wherein said stator means is mounted in fixed parallel spaced relation to the electrodes and said rotor means is rotatable about a rotational axis perpendicular to said electrodes.

19. In an electrostatic generator having a pair of axially spaced electrodes with electric fields therebetween establishing corresponding capacitances, a power driven rotor and means for electrically interconnecting the rotor with one of the electrodes of said pair during rotation of the rotor, the improvement residing in means fixedly mounting both of the electrodes of said pair, said electric fields being established and maintained by means respectively applying charge producing potentials of substantially equal and opposite polarity to the other of the electrodes of said pair for cancellation of forces exerted by said electric fields on the rotor, means mounted by the rotor for partial shielding of said one of the electrodes from said electric fields and means responsive to rotation of the rotor for extracting an output voltage generated on said one of the electrodes by movement of said partial shielding thereof during maintenance of the corresponding capacitances established by the electric fields.

* * * * *

United States Patent [19]
Pasichinskyj

[11] Patent Number: 4,904,926
[45] Date of Patent: Feb. 27, 1990

[54] MAGNETIC MOTION ELECTRICAL GENERATOR

[76] Inventor: Mario Pasichinskyj, 10666 NE. 11th Ct., Miami Shores, Fla. 33138

[21] Appl. No.: 244,021

[22] Filed: Sep. 14, 1988

[51] Int. Cl.[4] G05F 7/00

[52] U.S. Cl. .... 323/362; 323/330; 336/110; 324/117 R; 505/879

[58] Field of Search .... 323/362, 330, 331; 307/101, 104, 106; 336/110, 160, 170, 155; 324/117 R, 253; 505/879

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Primary Examiner—Patrick R. Salce
Assistant Examiner—Kristine Peckman
Attorney, Agent, or Firm—M. K. Silverman

[57] ABSTRACT

A magnetic motion electrical generator includes an electrical winding defining a magnetically conductive zone having bases at each end, the winding including elements for the removing of an induced current therefrom. The generator further includes two pole magnets, each having a first and a second pole, each first pole in magnetic communication with one base of the magnetically conductive zone. The generator further includes a third pole magnet, the third pole magnet oriented intermediately of the first poles of the two pole electromagnets and in magnetic communication with the electromagnets, the third pole magnet having a magnetic axis substantially transverse to an axis of the magnetically conductive zone, the third magnet having a pole nearest to the conductive zone and in magnetic attractive relationship to the first poles of the two pole electromagnets, in which the first poles thereof are like poles. Yet further included in the generator are elements for cyclically reversing the magnetic polarities of the electromagnets. Said reversing means, through a cyclical change in the magnetic polarities of the electromagnets, will cause the magnetic flux lines associated with the magnetic attractive relationship between the first poles of the electromagnets and the nearest pole of the third magnet to correspondingly reverse, causing a wiping effect across the magnetically conductive zone, as lines of magnetic flux swing between respective first poles of the two electromagnets, thereby inducing electron movement within the windings and thusly generating a flow of current within the winding

11 Claims, 5 Drawing Sheets

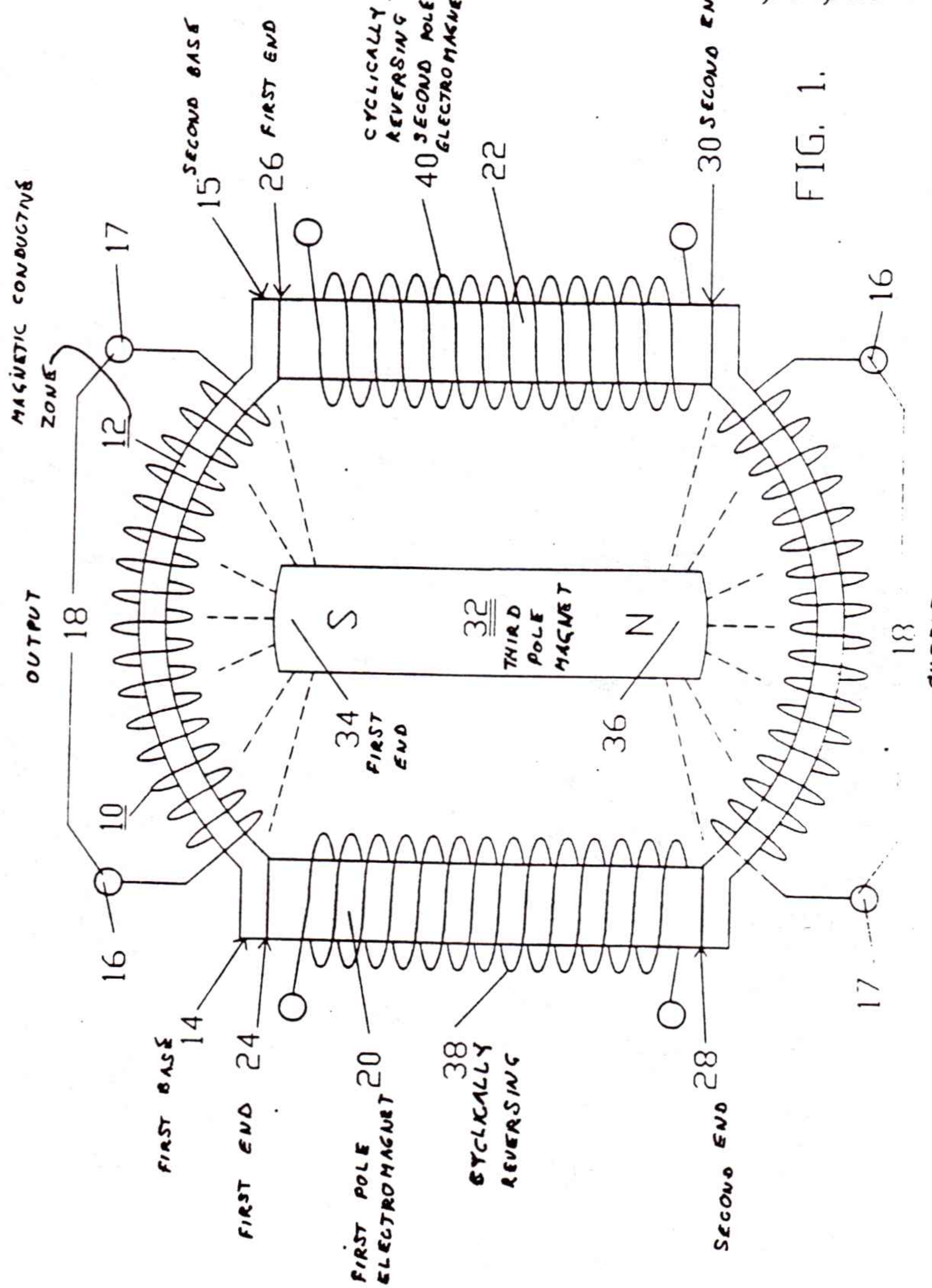

MAGNETIC CONDUCTING ZONE
12
17
15 SECOND BASE
26 FIRST END
40 CYCLICALLY REVERSING SECOND POLE ELECTROMAGNET
22
30 SECOND END
16
18 OUTPUT
S
32 THIRD POLE MAGNET
N
34 FIRST END
36
10
16
14 FIRST BASE
24 FIRST END
20 FIRST POLE ELECTROMAGNET
38 CYCLICALLY REVERSING
28 SECOND END
17

FIG. 1.

FIG. 3.

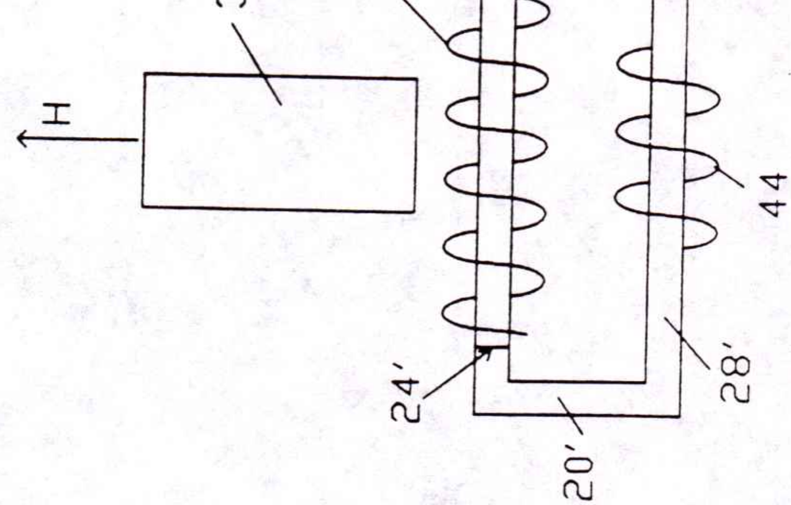
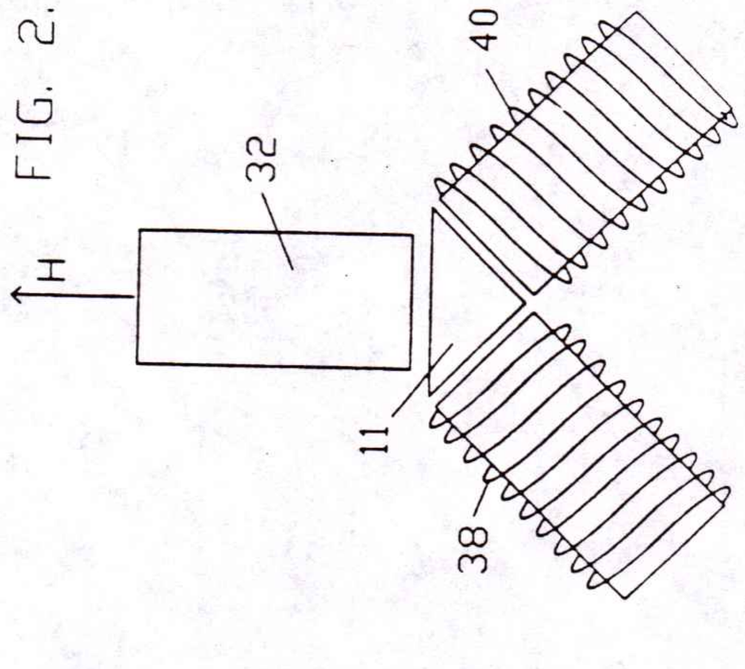


FIG. 2.



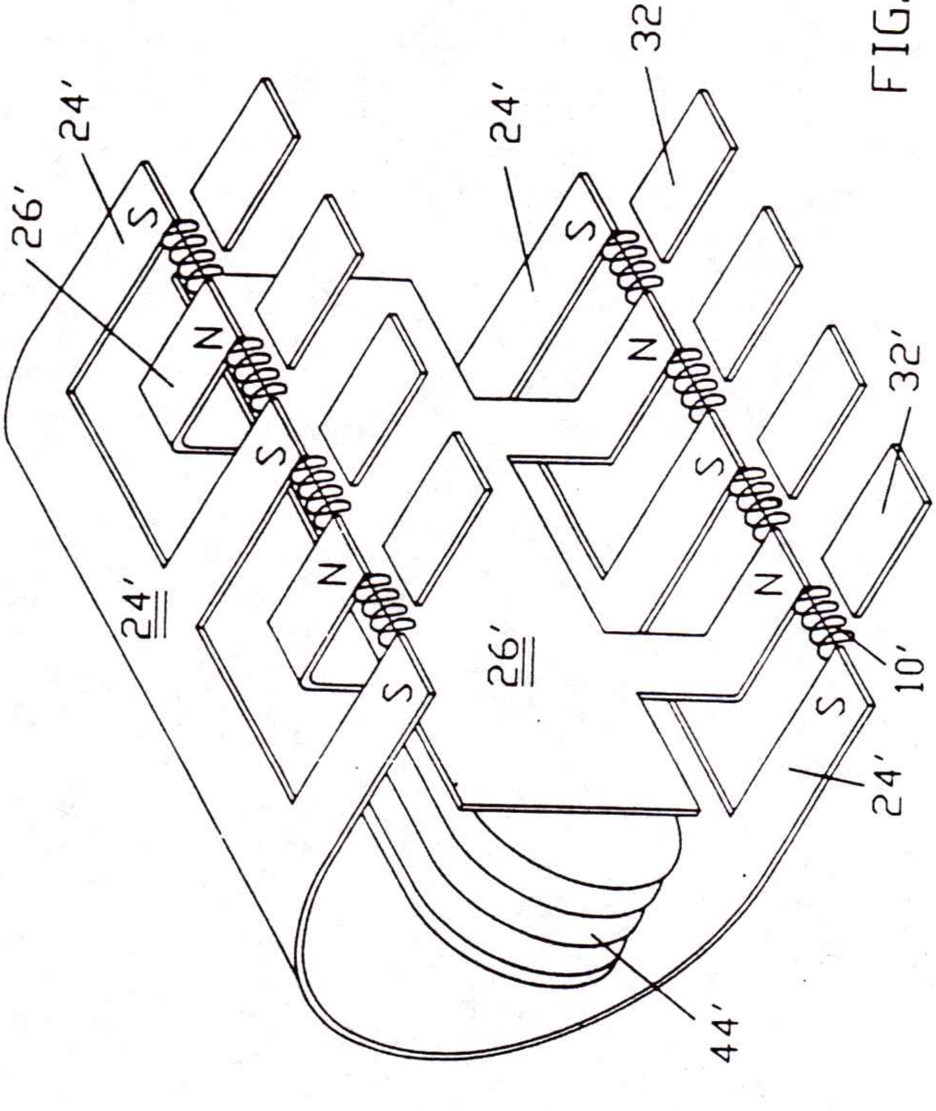
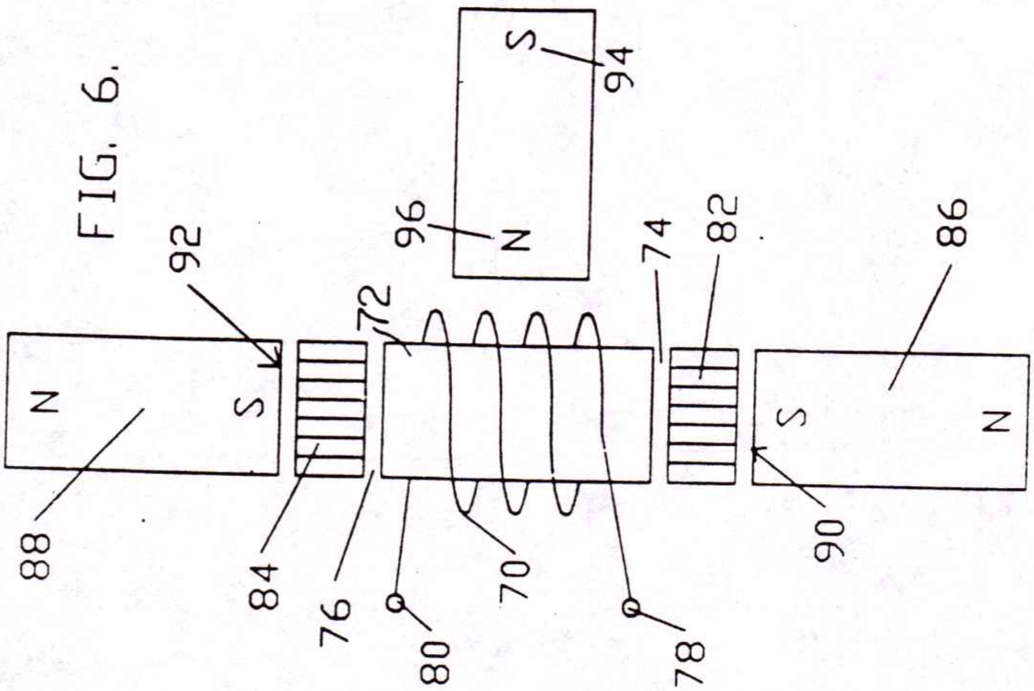


FIG. 4.

FIG. 6.


N
S
92
88
84
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72
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70
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74
82
86
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S
N
96
N
S
94

FIG. 5.

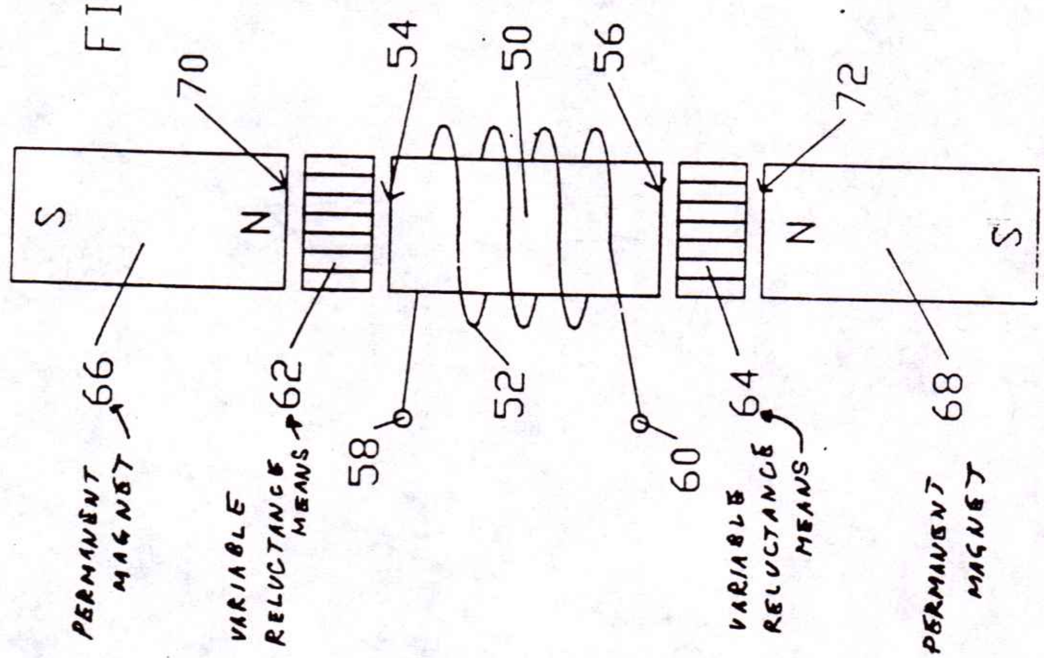
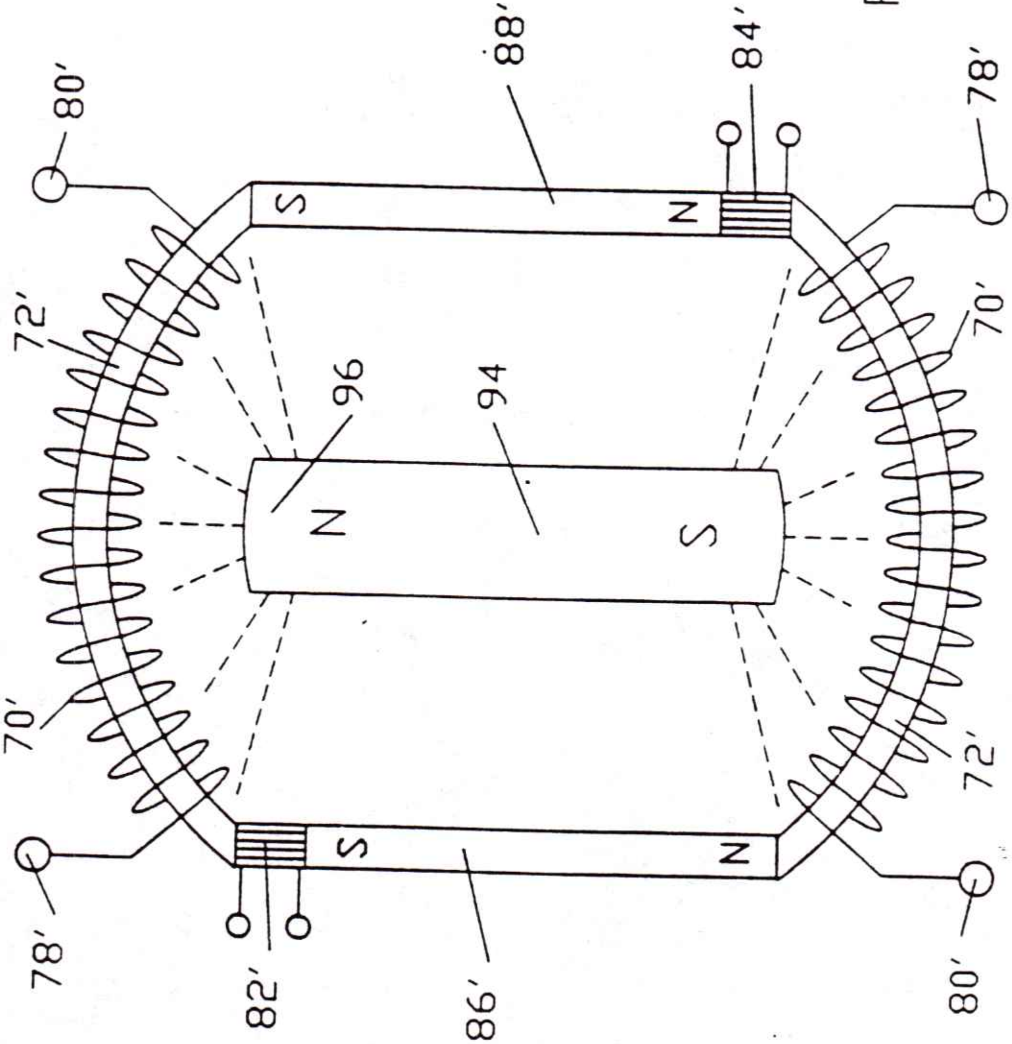

S
N
70
66
PERMANENT MAGNET
62
VARIABLE RELUCTANCE MEANS
54
58
50
52
56
60
64
VARIABLE RELUCTANCE MEANS
72
N
S
68
PERMANENT MAGNET

FIG. 7.



MAGNETIC MOTION ELECTRICAL GENERATOR

BACKGROUND OF THE INVENTION

The present invention relates to a solid-state electrical generator having no moving parts in its structure. More particularly, the instant invention makes use of a proposed extension of Faraday's Law, this extension constitutes a proposition to the effect that a changing magnetic field, relative to an electrical conductor, will induce an electric field therein, regardless of whether or not the source of the magnetic field undergoes physical movement. It is, through the present invention, suggested that to generate electric current, it is only necessary that a magnetic field move relative to a conductor and that, consequently, it is not necessary that the source magnet itself move to induce electric field or current into a conductor.

The most relevant prior art known to the inventor comprises U.S. Pat. No. 4,006,401 (1977) to De Rivas, entitled Electromagnetic Generator; and U.S. Pat. No. 4,077,001 (1978) to Richardson, entitled Electromagnetic Converter with Stationery Variable Reluctance Members.

The above reference to De Rivas discloses an electromagnetic generator which utilizes a permanent magnet and inductive means to "alternate by switching" the flux of the permanent magnet, thereby generating alternating current at the output thereof. Said reference, as well as Richardson, represent the only known direct attempts in the prior art to generate electricity by non-moving means through the manipulation of the magnetic field of a permanent magnet. In De Rivas, inductive means are used for the purpose of "magnetic switching". As such, inductive and related heat losses would produce a questionable level of performance.

The above reference to Richardson discloses an "energy conversion system" in which the flux of the permanent magnet is, as in De Rivas, "shifted" by inductive means. However, unlike De Rivas, Richardson makes use of a lamellar core which acts as a bi-stable magnetic valve placed in the proximity of the output windings to carry-off the induced power from the system.

Richardson accurately identifies many key concepts of power generation by non-moving systems and recognizes the need to optimize geometry, materials, control, timing and other factors which must be taken into consideration in the efficient generation of power through the shifting, oscillation and/or rotation of the magnetic field of a fixed permanent magnet. It is upon the teachings of Richardson and De Rivas that the invention set forth herein is most directly based.

SUMMARY OF THE INVENTION

The invention constitutes an electrical generator comprising an electrical winding defining a magnetically-conductive zone having bases at each end thereof, said winding including means for the removing of an induced current therefrom. The generator further includes two pole magnets, each having a first and second pole, each first pole thereof in magnetic communication with one base of said magnetically conductive zone. The generator further includes a third pole magnet, said third magnet oriented intermediately of said first poles of said two pole electromagnets and in magnetic communication with said electromagnets, said third pole magnet having a magnetic axis substantially transverse to an axis of said magnetically-conductive zone, said third magnet having a pole thereof nearest to said zone and in magnetic attractive relationship to said first poles of said two pole electromagnets, in which said first poles thereof are like poles. Yet further included in the generator are means for cyclically reversing the magnetic polarities of said electromagnets. Accordingly, said reversing means, through said cyclical change in said magnetic polarities of said electromagnets, will cause the magnetic flux lines associated with said magnetic attractive relationship between said first poles of said electromagnets and said nearest pole of said third magnet to correspondingly reverse, thereby causing a wiping effect across said magnetically conductive zone, as lines of magnetic flux swing between respective first poles of said two electromagnets, thereby inducing electron movement within said windings and thusly generating a flow of current within said winding.

It is accordingly an object of the present invention to provide an electric generator having no moving parts therein.

It is another object of the present invention to provide an electrical generator making use of both electromagnets and pole magnets in which electric current is induced through the oscillation or rotation of magnetic flux, while said magnets and electromagnets are kept stationery.

It is a further object to employ a permanent magnet in combination with an electromagnet to intensify current flow obtainable from said electromagnet.

It is a yet further object to provide an electromagnetic generator including a permanent magnet as a flux source in which the magnitude of the generated current of the generator increases as a function of the frequency of the signals applied to control the motion of the flux between the permanent magnet and the electromagnet.

The above and yet other objects and advantages of the present invention will become apparent from the hereinafter set forth Detailed Description of the Invention, the Drawings and Claims appended herewith.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic of a first embodiment of the present invention, employing one permanent magnet and two electromagnets.

FIG. 2 is a schematic illustration of a variation of the embodiment of FIG. 1.

FIG. 3 is a schematic view of a further variation of the embodiment of FIG. 1.

FIG. 4 is a schematic view of an embodiment of the structure shown in FIG. 3.

FIG. 5 is a schematic view of a second embodiment of the present invention.

FIG. 6 is a schematic view of a third embodiment of the present invention.

FIG. 7 is a schematic view of a variation of the embodiment of FIG. 6.

DETAILED DESCRIPTION OF THE INVENTION

With reference to the view of FIG. 1, there is shown an electrical winding 10 defining a magnetically conductive zone 12, said zone having bases 14 and 15 at each end thereof. Said winding 10 includes means 16 and 17 for removing an induced current from said winding means 10 and carrying said current to an output 18.

Further included in the embodiment of FIG. 1 is a first pole electromagnet 20 and a second pole electromagnet 22, each of said electromagnets having first ends 24 and 26 respectively and second ends 28 and 30 respectively. Each of said first poles 24 and 26 are in magnetic communication with respective first and second bases 14 and 15 of said magnetically conductive zones.

Further included in the present electrical generator is a third pole magnet 32, said third pole magnet comprising a permanent magnet. Said third magnet is oriented with a first end 34 intermediately of said first poles 24 and 26 of said two pole electromagnets 20 and 22, and is in magnetic communication with said electromagnets. A magnetic axis defined by the poles of said permanent magnet 32 is substantially transverse to an axis which is defined by the geometry of said magnetically conductive zone 12. The pole 34 of said third magnet 32 is in magnetic attractive relationship to said first pole 24 and 26 of said two pole electromagnets 20 and 22, in which said first poles 24 and 26 are like poles and said pole 34 of said permanent magnet 32 is an opposite pole to said poles 24 and 26.

Yet further provided are means 38 and 40 (shown in the form of windings) for cyclically reversing the magnetic polarities of said electromagnets 20 and 22. Said control means, through cyclical changing of the magnetic polarities of said electromagnets, will cause the magnetic flux lines associated with said attractive magnetic relationship between said first pole 24 and 26 of said electromagnets and said pole 34 of said third and permanent magnet 32 to correspondingly reverse. This will cause a wiping effect across said magnetically conductive zone 12, as lines of magnetic flux swing between respective first poles 24 and 26 of said electromagnets in a high-frequency reciprocating fashion. This movement of lines of flux will induce electron movement within said winding 10, thusly generating a flow of current within said winding. Accordingly, the power output from the system of FIG. 1 will be a function of the strength of said magnets 20, 22 and 32, the number of current loops within winding 10, and the rate of reversal of the magnetic polarities of said electromagnets 20 and 22 by said cyclical reversing means.

As may be appreciated, said electrical winding 10 may comprise a helical winding, and said magnetically conductive zone may comprise a magnet core or a magnetically conductive coating.

Either such core or said winding may commprise a super-conductive material.

Further, said control means 38 and 40 may comprise flat spirally-wound elements in which the plane of such flat spiral elements is transverse to the primary axis of said electromagnets 20 and 22.

Alternatively, said cyclical reversing means may comprise means for applying an alternating pulsating DC current at said bases 14 and 15 of said magnetically conductive surface.

There may be further provided means for magnetically concentrating lines of magnetic flux in said magnetically conductive zone. For example, such means may comprise a pole shoe of a magnet of like polarity to said pole 34 of said permanent 32, in which such pole shoe would symmetrically surround said winding 10.

With reference to FIG. 2, it is seen that there is shown the schematic thereof a variation of the embodiment of FIG. 1, the primary difference therebetween being the use of solid state means such as a liquid or semiconductor 11 in lieu of winding 10 and magnetically conductive surface 12. Therein, the lines of magnetic flux will oscillate between first poles of the electromagnets, through the liquid or semiconductive materials, thereby inducing electron movement within the liquid or semiconductor and, thusly, generating a flow of current therewithin.

With reference to the view of FIG. 3, there is seen a yet further variation of the embodiment of FIG. 1 in which said control means for cyclically reversing the magnetic polarity of said electromagnets comprise an electromagnetic path between said ends 28' and 30' of said electromagnets 20' and 22'. Thereby, it may be seen that the embodiment of FIG. 3 differs from the embodiment of FIG. 1 only in the provision of a single control means 44 in lieu of the separate control means 38 and 40 of the embodiment of FIGS. 1 and 2.

With reference to FIG. 4, there is shown, in schematic view, a further embodiment of the invention of FIG. 3 in which the basic structure thereof is simply repeated a multiplicity of times. Therein, permanent magnetic elements 32' appear to the right of the figure, and electromagnetic pole elements 24' and 26' appear and repeat in sequence, windings 10' and control means 44' are also shown therein.

With reference to the embodiment of FIG. 5, there is shown an electrical winding 50 disposed about a substantially cylindrical magnetically conductive axial surface 52 having bases 54 and 56 at each end thereof. The winding 50 includes means 58 and 60 for removing an output current therefrom.

Yet further provided in the embodiment of FIG. 5 are two variable reluctance means (VRMs) 62 and 64, one disposed in magnetic communication with each of said bases 54 and 56 of said magnetically conductive surface 52.

Yet further provided in the embodiment of FIG. 5 are means for controlling said VRM's 62 and 64 to cyclically and axially increase and decrease the reluctance thereof, such that the reluctance of one VRM is decreased while the reluctance of an opposite VRM is inversely increased, and vice versa.

Yet further provided in the embodiment of FIG. 5 are two permanent pole magnets 66 and 68, each having like poles 70 and 72 thereof in magnetic communication with a surface of said VRMs 62 and 64 other than that surface which is in magnetic communication with one of said bases 54 and 56 of said magnetically conductive surface 52. Thereby, the polarity of the magnetic axis of said magnetic surface of said winding will reverse in response to cyclical changes in the magntic reluctance of said VRMs 62 and 64, causing an expansion and compression of the magnetic axis of said surface 52, thereby causing magnetic flux to swing between respective like poles 70 and 72 of said two permanent magnets 66 and 68, this causing electron movement within said windings 50, and generating a flow of current therewithin.

Said VRMs 62 and 64 may be thought of as magnetic couplers and decouplers in that they selectively bring permanent magnet 60 and 68 into and out of the magnetic circuit of the embodiment of FIG. 5.

It is to be appreciated that said VRMs 62 and 64 may take many forms, these including electrical coil means surrounding a magnetic core in which excitation of said coil will effect a change in the magnetic reluctance of said core; wafers of superconductive material which, in a preferred embodiment, will be flat spirally-wound elements, the plane of such flat spiral elements being transverse to the axis of the magnetic path of travel therewithin; and means for cyclically applying a pulsating DC current at said bases 54 and 56 of said magnetically-conductive surface 52. Also, as in other embodiments, means for magnetically concentrating lines of magnetic flux about the region of said winding may be employed.

With reference to the embodiment of FIG. 6, the electrical generator thereof is seen to include an electrical winding 70 disposed about a substantially cylindrical magnetically conductive surface 72 having bases 74 and 76 at each end thereof, in which said winding means 70 includes means 78 and 80 for removing an induced current therefrom.

The embodiment of FIG. 6 further includes two variable reluctance means (VRMs) 82 and 84, one disposed in magnetic communication with each of said bases 74 and 76 of said magnetically conductive surface.

Yet further provided in the embodiment of FIG. 6 are means for controlling said VRMs 82 and 84 to cyclically increase and decrease the reluctance thereof such that the reluctance of one VRM is decreased while the reluctance of an opposite VRM is inversely increased, and vice versa.

Yet further provided in the embodiment of FIG. 6 are two permanent pole magnets 86 and 88, each having like poles thereof 90 and 92 in magnetic communication with one of said bases 74 and 76 respectively of said magnetically conductive surface 72. As may be noted, said VRM's 82 and 84 are interposed between said poles 90 and 92 of said first and second permanent magnets 86 88 respectively.

Yet further provided in the embodiment of FIG. 6 is a third pole magnet 94 which is oriented intermediately of said VRMs 82 and 84 and which is in magnetic communication therewith. Said third pole magnet 94 exhibits a magnetic axis which is substantially transverse to an axis connecting said VRMs. Further, said third magnet 94 possesses a pole 96 thereof which is disposed near to said windings 70 and which is in attractive magnetic relationship to said like poles 90 and 92 of said permanent magnets 86 and 88. Accordingly, said VRM control means, through cyclical changes in the magnetic reluctance of said VRM's at the bases 74 and 76 of said magnetically conductive surface, will cause the magnetic flux lines associated with the attractive magnetic relationship between said like poles of said permanent pole magnets and said nearest pole of said third magnet to correspondingly couple and decouple, this thereby causing a wiping effect across said winding as lines of magnetic flux swing between respective like poles 90 and 92 of said two permanent pole magnets 86 and 88 thereby causing electron movement within said winding and thusly generating a flow of current therewithin.

With reference to the embodiment of FIG. 7, this may be seen to comprise an elaboration of the embodiment of FIG. 6 in that the upper and lower hemisphere of FIG. 7 are seen to symetrically include the same elements above described with reference to FIG. 6. However, in the view of FIG. 7, the use of a magnetic concentrator 98 is also shown. Also, VRM's 82' and 84' are used.

It is to be appreciated that the magnetically conductive surface 72' of FIG. 7 may comprise many materials, these including such materials as an magneto hydro dynamic liquid, a super-conducting liquid, a magnetic coating and a paramagnetic coating.

Further it is to be appreciated that said VRMs may comprise many materials which, in addition to those above noted, may include a bi-metallic solid-state element, a curved junction solid-state element, or a field effect solid-state element.

While there has been shown and described the preferred embodiments of the present invention, it is to be understood that the invention may be embodied otherwise than is herein specifically illustrated and described and that, within such embodiments certain changes in the detail and construction, in the form and arrangements of the parts, may be made without departing from the underlying idea or principles of this invention within the scope of the appended claims.

Having thus described my invention, what I claim is new, useful and nonobvious and, accordingly, secured by Letters of Patent of the United States is:

1. An electrical generator, comprising:

(a) an electrical winding defining a magnetically conductive zone having bases at each end thereof, said winding including means for removing an induced current therefrom;

(b) two pole electromagnets, each having a first and a second pole, each first pole thereof in magnetic communication with one base of said magnetically conductive zone;

(c) a third pole magnet, said magnet comprising a permanent magnet, said third magnet oriented intermediately of said first poles of said two pole electromagnets and in magnetic communication with said electromagnets, said third pole magnet having a magnetic axis substantially transverse to an axis of said magnetically conductive zone, said third magnet having a pole thereof nearest to said zone and in magnetic attractive relationship to said first poles of said two pole electromagnets, in which said first poles thereof are like poles;

(d) control means for cyclically reversing the magnetic polarities of said electromagnets,

whereby said control means, through said cyclical change in said magnetic polarities of said electromagnets, will cause magnetic flux lines associated with said attractive magnetic relationship between said first poles of said electromagnets and said nearest pole of said third magnet to correspondingly reverse, thereby causing a wiping effect across said magnetically conductive zone, as lines of magnetic flux swing between respective first poles of said two electromagnets, thereby inducing electron movement within said winding and thusly generating a flow of current within said winding.

2. The electrical generators recited in claim 1 which said path of said wiping effect occurs along the same axis as a principal axis of said magnetically conductive zone.

3. The generator as recited in claim 2 in which said electrical winding about said magnetically conductive zone comprises a helical winding.

4. The generator as recited in claim 3 in which said magnetically conductive zone comprises a magnetic core.

5. The generator as recited in claim 4 in which said core and windings comprise a superconductive material.

6. The generator as recited in claim 2 in which said control means comprises flat spirally-wound elements, the plane of such flat spiral elements being transverse to said primary axis of said electromagnets.

7. The generator as recited in claim 1 in which said control means comprises an electromagnetic path be-

tween said second ends of said electromagnets in which a polarity control signal is applied across said path.

8. The electrical generator as recited in claim 7 in which said electrical winding about said magnetically conductive zone comprises a helical winding.

9. The generator as recited in claim 8 in which said magnetically conductive zone comprises a magnetic core.

10. The generator as recited in claim 8 in which said core and windings comprise a superconductive material.

11. The generator as recited in claim 1 in which said control means comprises flat spirally wound elements, the plan of said flat spiral elements being transverse to the primary axis of said magnetic path of travel.

* * * * *

United States Patent [19]
Richardson
[11] 4,077,001
[45] Feb. 28, 1978

[54] ELECTROMAGNETIC CONVERTOR WITH STATIONARY VARIABLE-RELUCTANCE MEMBERS

[76] Inventor: Frank B. Richardson, 2610 San Gorgoino, Las Vegas, Nev. 89110

[21] Appl. No.: 677,731

[22] Filed: Apr. 16, 1976

[51] Int. Cl.² G05F 7/00

[52] U.S. Cl. 323/92; 307/104; 363/170; 336/110

[58] Field of Search 336/110, 214, 215; 323/92; 322/46, 49; 321/68

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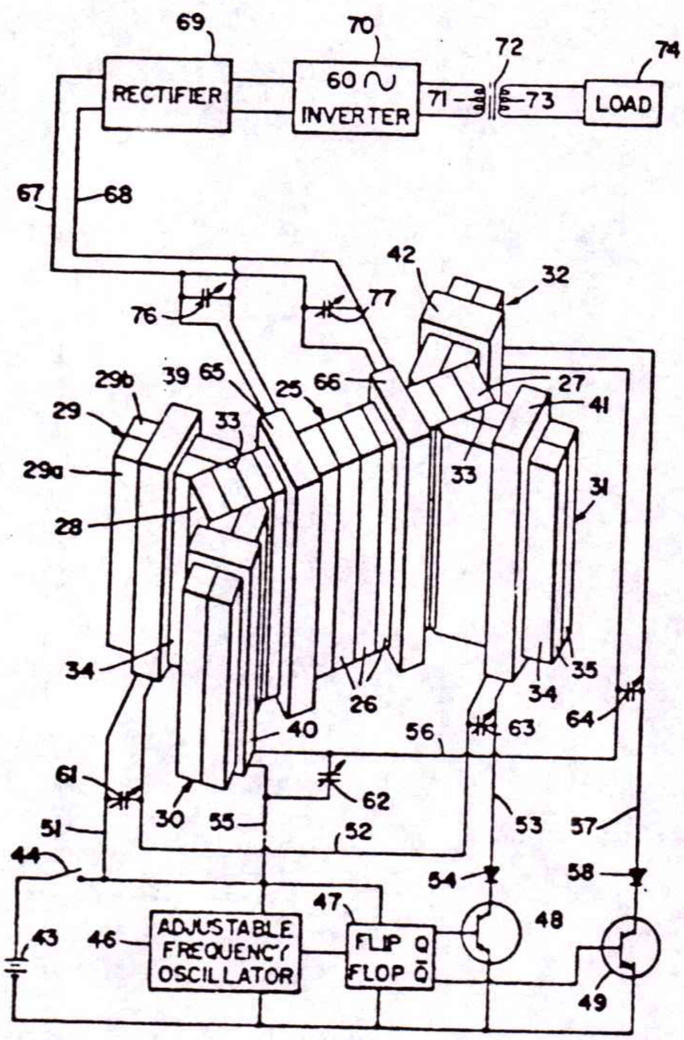
Primary Examiner—Robert J. Hickey
Attorney, Agent, or Firm—Phillips, Moore, Weissenberger, Lempio & Majestic

[57] ABSTRACT

A dc/dc converter comprising a permanent magnet having spaced-apart poles and a permanent magnetic field extending between the poles of the magnet. A variable-reluctance core is disposed in the field in fixed relation to the magnet and the reluctance of the core is varied to cause the pattern of the lines of force of the magnetic field to shift. An output conductor is disposed in the field in fixed relation to the magnet and is positioned to be cut by the shifting lines of permanent magnetic force so that a voltage is induced in the conductor.

53 Claims, 26 Drawing Figures



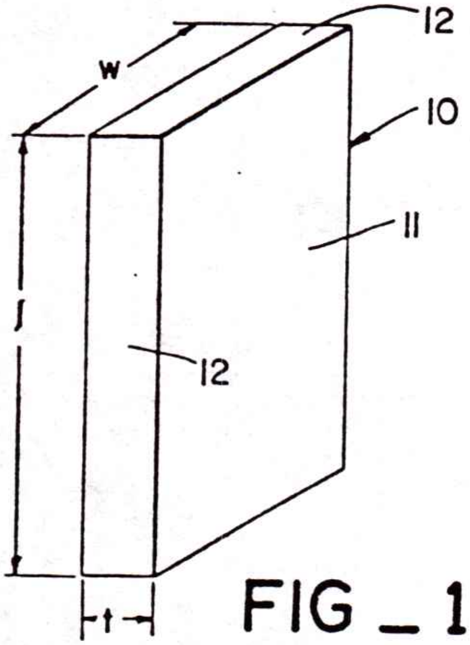


FIG_1

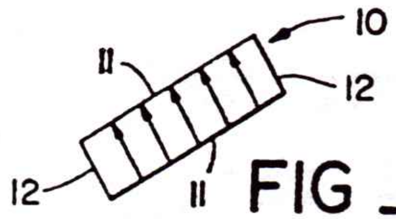


FIG_2

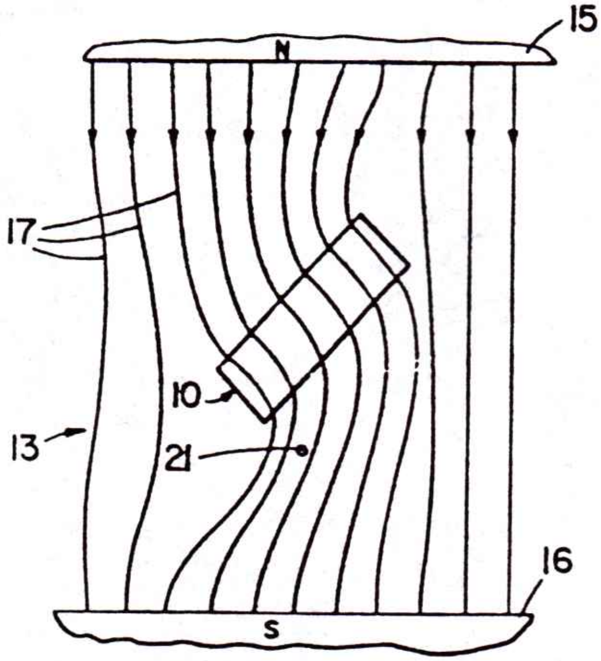


FIG_3

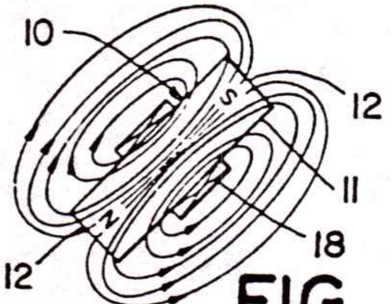


FIG_5

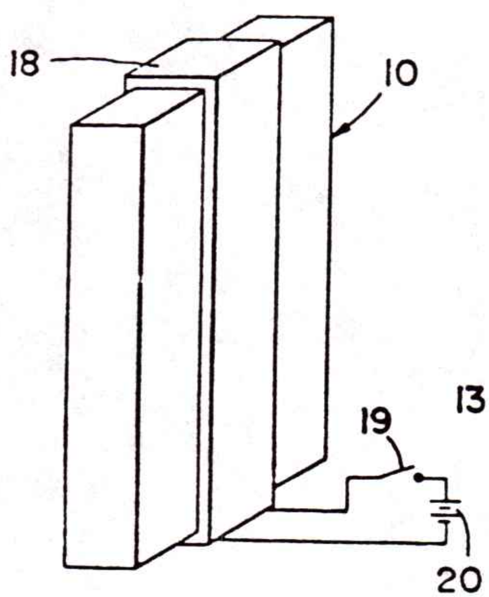


FIG_4

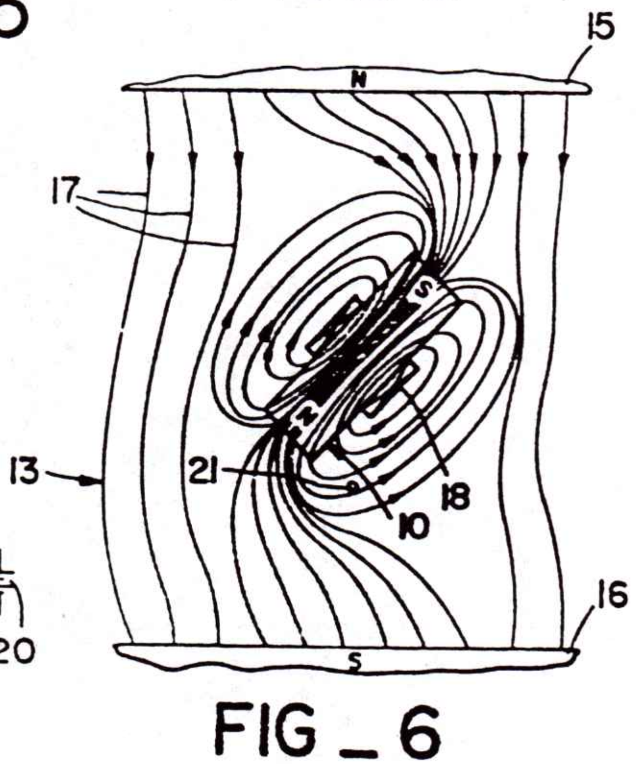
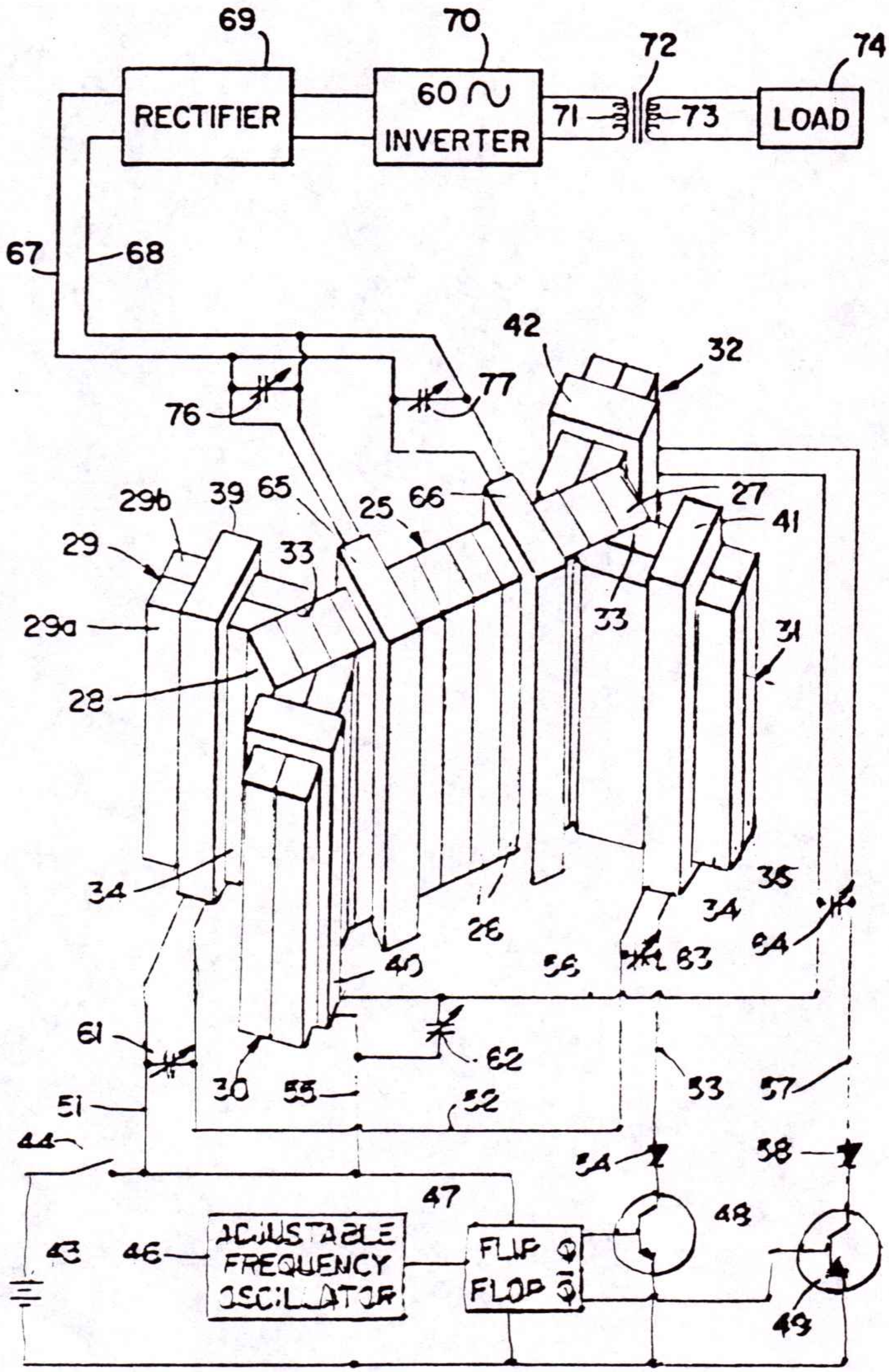


FIG_6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RECTIFIER
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ADJUSTABLE
FREQUENCY
OSCILLATOR
FLIP
FLOP
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FIG _ 7

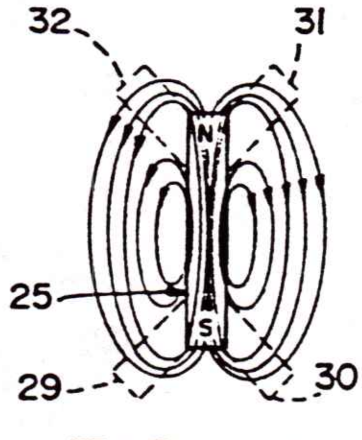

FIG _ 9

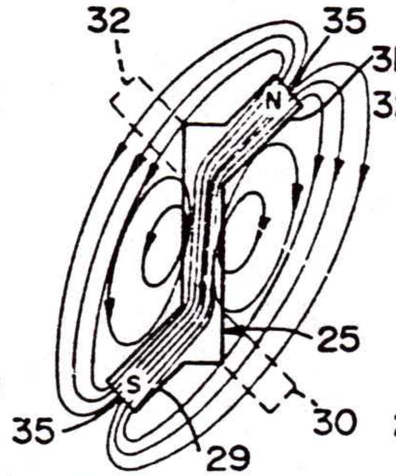

FIG _ 10

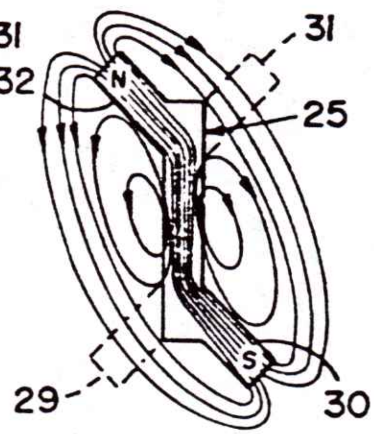

FIG _ 11

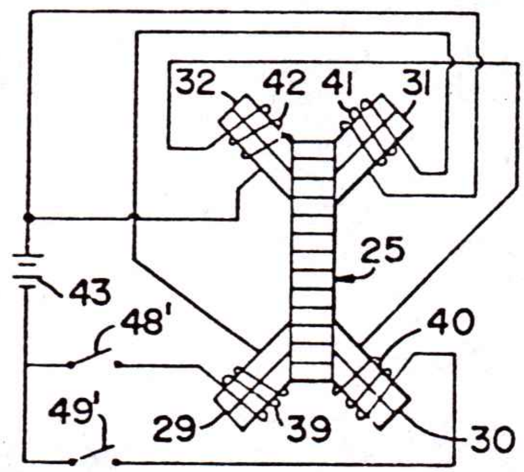

FIG _ 8

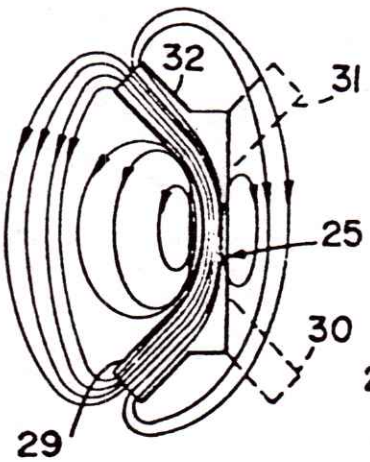

FIG _ 12

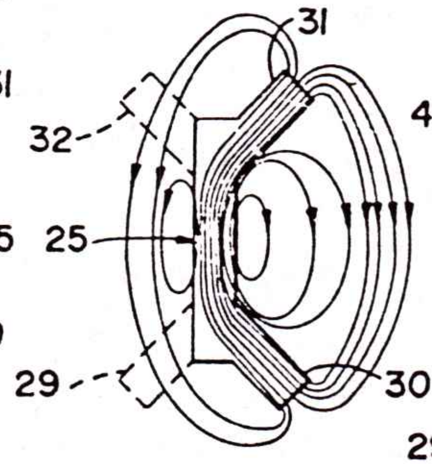

FIG _ 13

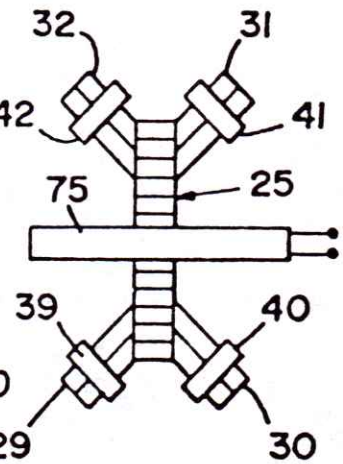

FIG _ 14

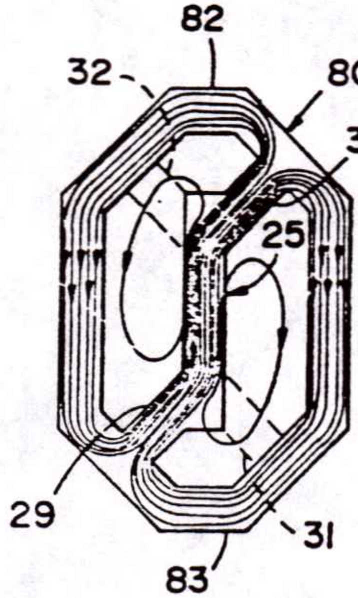

FIG_16

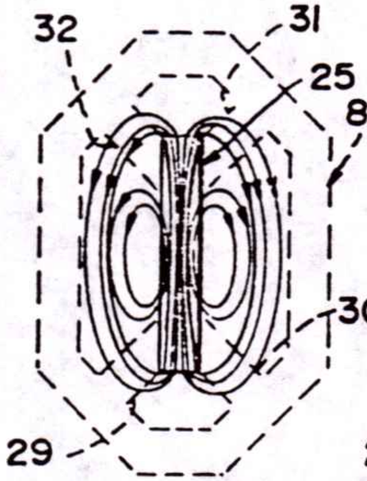

FIG_17

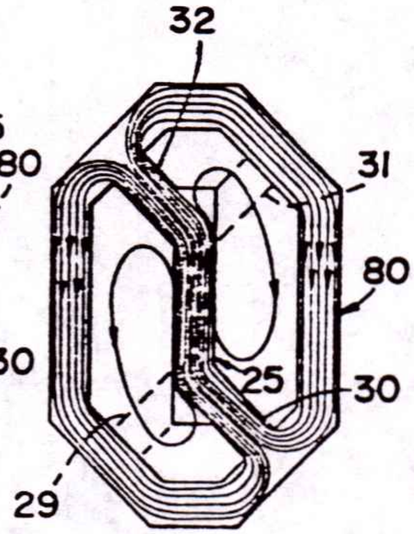

FIG_18

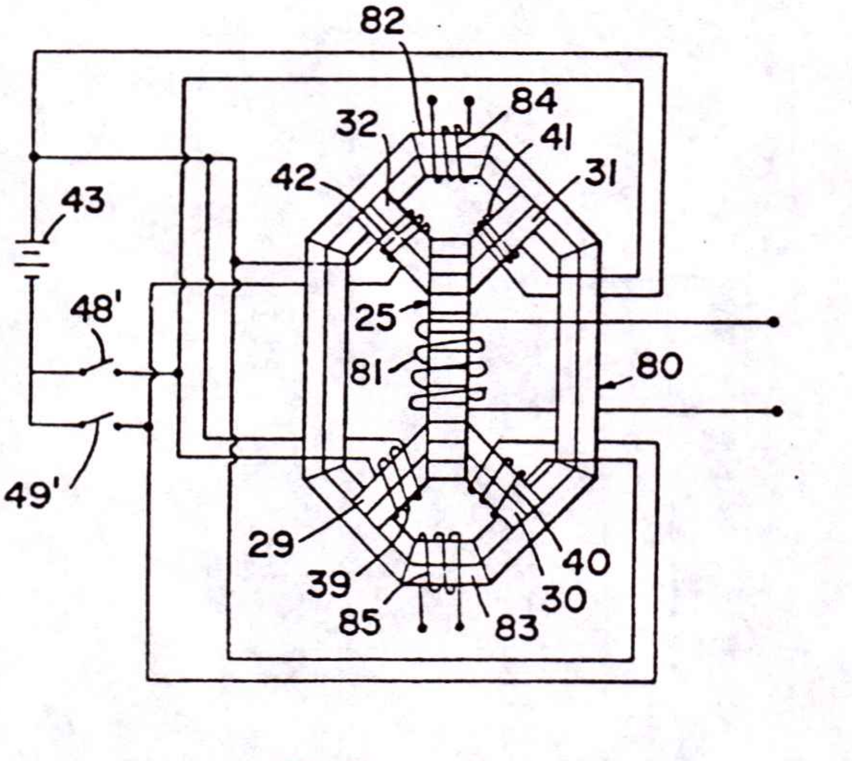

FIG_15

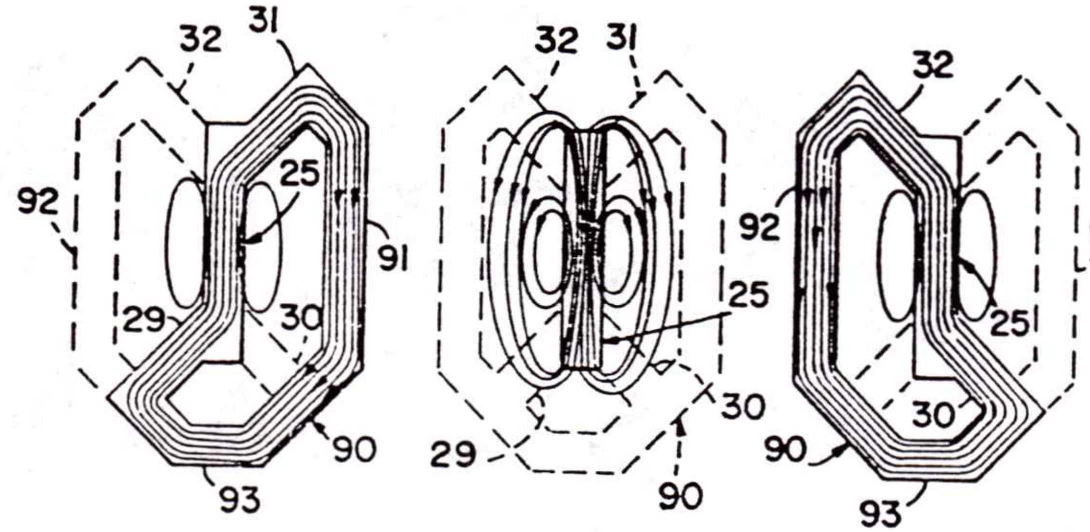

FIG _ 20 FIG _ 21 FIG _ 22

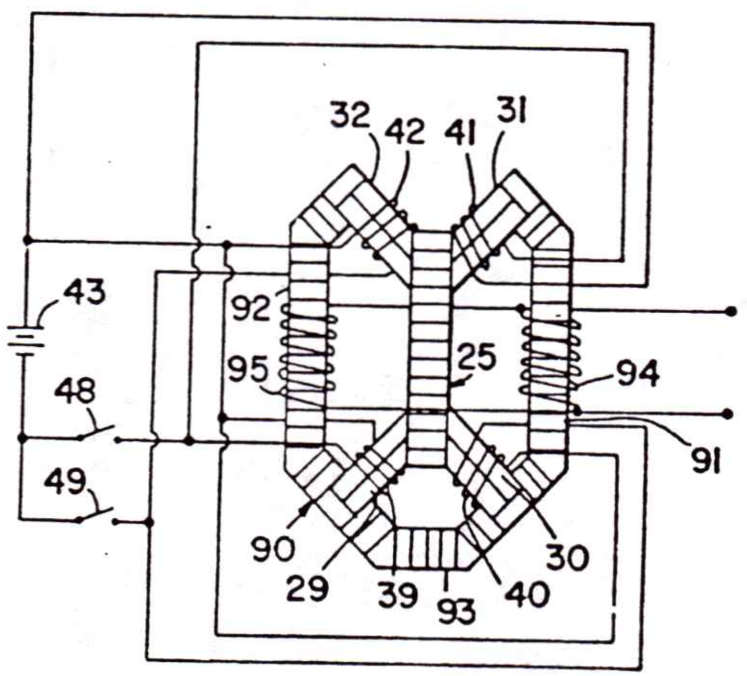

FIG _ 19

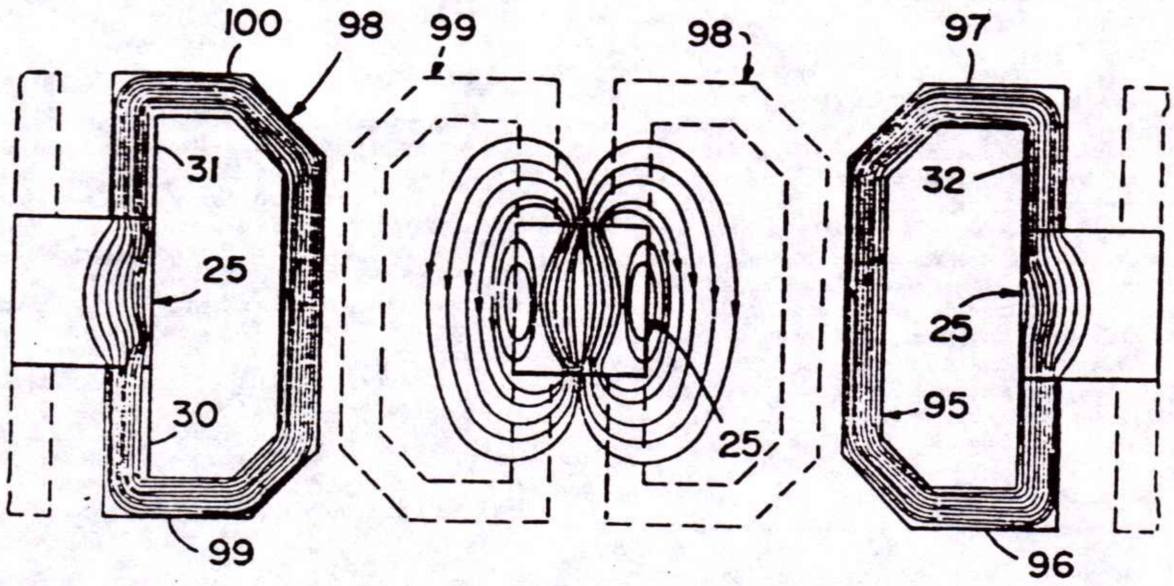

FIG _ 24 FIG _ 25 FIG _ 26

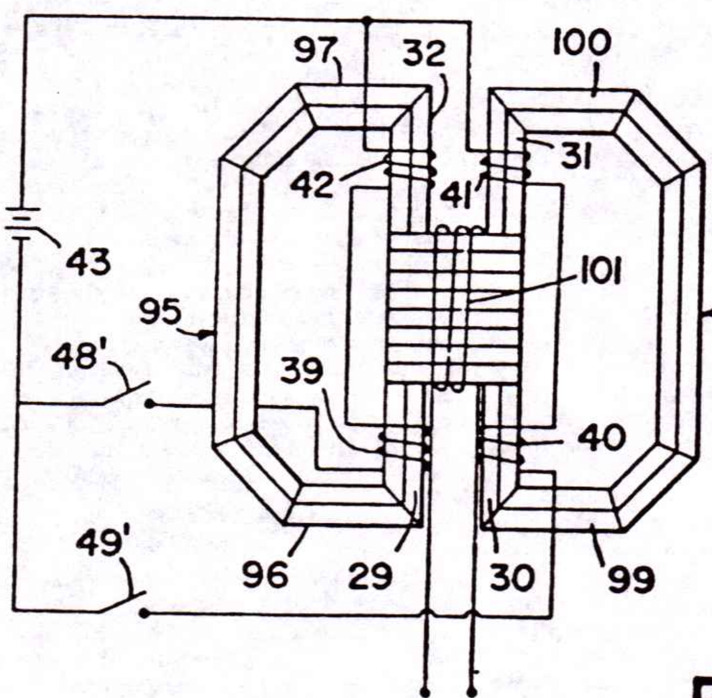

FIG _ 23

ELECTROMAGNETIC CONVERTOR WITH STATIONARY VARIABLE-RELUCTANCE MEMBERS

BACKGROUND OF THE INVENTION

This invention relates to an energy conversion system having a magnet with spaced-apart poles of opposite polarity, the magnet being permanently magnetized to create an external field having lines of permanent magnetic force extending between the poles of the magnet and there being an electrical conductor positioned in the permanent magnetic field. As is well known, if there is relative movement between the magnetic field and the conductor, such that the conductor is cut by the magnetic lines of force, an electrical voltage will be induced in the conductor. If the ends of the conductor are connected to an electrical load, an output current will flow through the conductor and load.

More specifically, the present invention relates to the manner in which the permanent magnetic field is shifted by the application of electrical power to the system and has for its principal object the provision of a new and novel manner by which dc energy is used to cause a shifting of the permanent magnetic field so as to induce an output voltage and current.

For a given system of such type, the output power will be a function of the number of times that there is a relative movement of the magnetic field and output conductor per unit time. The greater the number of cycles of relative movement per unit time, the greater will be the power output, up to the limit determined by the time constant of the system, i.e., the time required for the voltage to be induced in response to a sudden cutting of a conductor by a relatively moving magnetic field.

It is a further object of the invention to provde an energy conversion system capable of operating efficiently at high frequencies.

SUMMARY OF THE INVENTION

The primary object of the present invention is achieved by positioning a core member in the magnetic field of a permanent magnet, the core member being positioned in fixed relation to the magnet and by varying the magnetic reluctance of the core member at a controlled rate. The changes in magnetic reluctance of the core member will cause distortions in the permanent magnetic field so that the pattern of the lines of force will shift back and forth relative to the magnet. An electrical conductor is also positioned in fixed relation to the magnet and positioned in the field at a location therein so that the warpage and shifting of the permanent magnetic lines of force will cut across the conductor and induce a voltage therein as the reluctance of the core is varied.

More specifically, it has been realized that unmagnetized core members of barium- or strontium- and ferric-oxide material having a stable lamellar pattern of residual induced magnetic distribution and a path of least magnetic reluctance across the shortest, or face-to-face, direction, can be energized by a coil having windings across its faces so that the path of least reluctance extends in an edge-to-edge direction, the direction of least reluctance reverting to the stable direction when de-energized by the coil. It has been further realized that such variable reluctance property can be used to produce shifting of the pattern of a permanent magnetic field.

The utilization of barium- or strontium- and ferric-oxide material is also advantageous in that such material has excellent high-frequency characteristics, permitting operating frequencies at the optimum frequency determined by the time constant of the system.

Other objects and advantages will be set forth in the course of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, forming a part of this application, and in which like parts are designated by like reference numerals throughout the same,

FIG. 1 illustrates a magnetic core of a material having a lamellar distribution of magnetism;

FIG. 2 is a diagram of the stable magnetic distribution of the core of FIG. 1;

FIG. 3 is a diagrammatic representation of the effect of the core of FIGS. 1 and 2 when placed in a uniform magnetic field;

FIG. 4 illustrates the core of FIG. 1 with an excitation coil wound therearound;

FIG. 5 is a diagrammatic representation of the magnetic field of the core of FIG. 4 when the excitation coil is electrically energized;

FIG. 6 is a diagrammatic representation of the effect of the core of FIGS. 4 and 5 on a uniform magnetic field;

FIG. 7 is a perspective view of a magnetic generator constructed in accordance with the invention and with the excitation and output circuits being shown schematically;

FIG. 8 is a simplified illustration of the embodiment of FIG. 7;

FIGS. 9–13 are diagrammatic representations of the magnetic field of the permanent magnet of FIG. 8 for different energizations of the excitation coils;

FIG. 14 is a simplified illustration of the embodiment of FIG. 7, illustrating a modification of the output coil;

FIG. 15 is a simplified illustration of the magnetic generator of FIG. 7 with a keeper ring encircling the ends of the variable-reluctance members;

FIGS. 16–18 are diagrammatic representations of the magnetic field of the permanent magnet of FIG. 15 for different energizations of the excitation coils;

FIG. 19 illustrates, in simplified form, a further modification of the invention, similar to FIG. 15, but with a U-shaped keeper ring;

FIGS. 20–22 are diagrammatic representations of the pattern of the permanent magnetic field for different energizations of the excitation coils;

FIG. 23 illustrates, in simplified form, a further modification of the invention, with separate keeper members;

FIGS. 24–26 are diagrammatic representations of the pattern of the permanent magnetic field for different energizations of the excitation coils.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The ordinary stable distribution of magnetism along a bar is solenoidal, i.e., the molecules of the magnet are oriented so that the lines of magnetic force extend the length of the magnet with the lines of force passing through the surface of the magnet primarily at the poles located at the ends of the bar.

Magnetic materials are available, however, wherein the stable distribution of induced magnetism is lamellar, with the molecules having a stable orientation in a direction such that the lines of force extend through the shortest direction of the magnet, i.e., from face to face, so that opposed faces have opposite magnetic polarities.

The present invention utilizes the magnetic properties of materials having a lamellar distribution of magnetism.

As for example, permanent magnetic ceramic material comprised of barium-oxide and iron-oxide, or strontium-oxide and iron oxide may be used to make magnets having a lamellar magnetic distribution. For example, iron-oxide and barium-carbonate are blended, pelletized and calcined in a rotary gas furnace to form barium-iron oxide crystals by chemical reaction at high temperatures. The pellets are then pulverized and ball milled to permanent magnet particles approximately 0.00004 inch in diameter. After dewatering, the particles are pressed in slurry form, at very high pressure in the direction of the thickness of the desired shape and in a powerful magnetic field which causes the particles to magnetically orient themselves in the pressed direction. The pressed magnet is then dried and sintered at temperatures about 2000° F. for several days. The material may then be permanently magnetized, with a field of at least 10,000 oersteds or 20,000 ampere/turns per inch being required for saturation. The induced magnetism will have a stable lamellar distribution through the shortest polar direction, from face to face of the magnet.

Permanent magnetic material with a grain orientation as just described is commercially available, in magnetized or unmagnetized form, as for example, from Crucible Magnetics Division of Colt Industries, Elizabethtown, Kentucky.

The magnetic behavior of such material is illustrated in FIGS. 1–6, wherein a magnetic core 10, having a thickness *t*, width *w*, and length *l* is shown, the core 10 having been formed in a manner as described above. As shown in FIG. 2, the individual particles of which the core 10 is composed set up a field effect in the direction of the shortest polar direction of the core, i.e., between the opposed faces 11 and parallel to the side edges 12 of the core, as indicated by the arrows on FIG. 2.

FIG. 3 illustrates the effect if an unmagnetized core 10 is placed in a uniform magnetic field 13 created as by opposed polarity poles 15 and 16 of permanent magnets, the lines of force of field 13 being represented by lines 17. The magnetic reluctance of core 10 is less than that of air and the lines of force will pass through the core in the direction of stable magnetic orientation of the core imposed therein during manufacture.

If a coil 18 is placed around the core so that the axis of the coil is parallel to the faces 11 of the core and switch 19 is closed so that the coil is electrically energized from battery 20, as in FIG. 4, the current in the coil will set up a magnetic field which will induce magnetic lines of force in the core which extend generally parallel to the faces 11 so that opposed side edges 12 of the core become the magnetic poles, FIG. 5.

FIG. 6 illustrates the effect of the core 10 if it is positioned in magnetic field 13 as in FIG. 3 and the coil 15 is electrically energized. Again, a number of the lines of force 14 will extend through the core but primarily now in the lesser reluctance direction therethrough of the lines of force set up by coil 13.

If the coil 15 is now de-energized, by opening switch 16, the residual field pattern of the magnetism induced in the core by coil 15 will not remain in an edge-to-edge pattern, but will seek and revert to its normal stable orientation across the shortest polar direction of the core, i.e., as in FIG. 2, so that the magnetic lines 14 of field 13 again extend through the core, from face to face thereof as illustrated in FIG. 3.

Thus, the core 10 with its stable lamellar magnetic distribution comprises a variable-reluctance member in which the magnetic reluctance from face to face differs from the magnetic reluctance from edge to edge and, as compared thereto, is relatively high or low depending on whether the coil 15 is electrically energized or de-energized, respectively.

As is seen in FIGS. 3 and 5, the pattern of the lines of force 17 of the magnetic field 13 will shift back and forth as coil 18 is energized and de-energized. If an electrical conductor 21 is disposed in the field, as shown in FIGS. 3 and 6, in fixed relation to the poles 15 and 16 and core 10 and extending perpendicularly to the plane of these figures, and positioned to be cut by some of the lines of force 17 as the field pattern shifts, a voltage will be induced therein by the lines of force each time the coil is energized or de-energized.

The principle described above is utilized in one form of the present invention, as illustrated in FIG. 7. In this instance, a permanent magnet 25 is formed of a plurality of individual core pieces 26 each having a lamellar distribution of magnetism and stacked face to face with adjacent faces being of opposite polarity so that a composite bar magnet is formed having poles of opposite polarity at the ends 27 and 28 of the bar. The bar magnet is permanently magnetized and, if the core material is barium- and ferric-oxide, a residual permanent magnetism in the order of 2950 gauss (lines per square inch) may be induced therein. Merely by way of illustration, the magnet 25 may be made of core pieces 26 each being one inch thick, two inches wide and eight inches long, so that the magnet after magnetization will have a residual magnetism in the order of 63,000 gauss. Core pieces of barium- or strontium- and ferric-oxide are preferably used in the formation of the permanent magnet 25 because of the low hysteresis losses at very high frequencies, for the reasons set forth more fully below.

Variable-reluctance members 29, 30, 31 and 32 are disposed at the ends of the bar magnet 25. Each of these members may be made of two core pieces, e.g., 29*a* and 29*b*, each having a lamellar distribution of magnetism, placed face to face against each other. The side edges 33 of the core pieces are formed at an angle to the faces 34 of the core pieces so that the side edges 33 will be flush against the sides of the bar magnet, with no air gap therebetween, with the faces 34 of the core pieces being inclined at an angle to the longitudinal axis of the bar magnet. The side edges 35 of the core pieces opposite from the side edges 33 will thus be disposed away and outwardly from the bar magnet 25. The core pieces of these variable-reluctance members are unmagnetized. Although the members 29–32 are illustrated as made up of two core pieces, a single piece, or more than two may be used. Preferably the cross-sectional area of the cores, in a plane normal to faces 34 is the same as the cross-sectional area of the bar magnet 25.

Coil 39 is disposed around variable-reluctance member 29, with the axis of the coil being parallel to the planes of the faces 34 of member 29, the coil having a suitable number of turns to produce the desired amount of magnetic induction of the member 29 when supplied with electrical current. Coils 40, 41 and 42 are similarly associated with variable-reluctance members 30, 31 and 32, respectively.

A series of direct current, e.g., battery 43, is connected by switch 44 to a variable frequency oscillator 46 whose frequency may be adjusted as desired. The output of the oscillator is fed to flip-flop 47 so that the Q and Q outputs thereof will change at a rate dependent on the frequency of the oscillator. The Q and Q outputs are applied to the bases of power transistors 48 and 49 so that these transistors will conduct alternately. When switch 44 is closed and transistor 48 is conducting, current from battery 43 will flow through switch 44, line 51, coil 40, line 52, coil 41, line 53, diode 54 and transistor 48 back to the battery. If transistor 49 is conducting, current will flow through line 55, coil 30, line 56, coil 42, line 57, diode 58 and transistor 49 back to the battery. Diodes 54 and 58 are provided to protect transistors 54 and 58 from the inductive reactance of the coils when they are de-energized. Adjustment capacitor 61 is connected between lines 51 and 52, i.e., across the inductance of coil 40, so that the circuit can be tuned for resonance and maximum efficiency at the desired frequency of operation. Adjustment capacitors 62, 63 and 64 are similarly associated with coils 40, 41 and 42. The windings of coils 39–42 are wound in a direction so that the magnetic field created by energization thereof will aid the magnetic field of permanent magnet 25 to avoid degaussing of the magnet in operation.

Output coils, for example coils 65 and 66 connected in parallel with each other, will generate an alternating current at the frequency of oscillator 46, which is fed by lines 67 and 68 to rectifier 69 to convert the a.c. output to d.c., the output being fed to a fixed frequency inverter 70, which supplies pulsating d.c. current, e.g., at 60 cycles per second, to primary 71 of transformer 72. The secondary 73 will then deliver a.c. current at the desired voltage and frequency to load 74. Adjustable tuning capacitors 76 and 77 are connected across output coils 65 and 66.

The operation of the system of FIG. 7 is illustrated in FIGS. 8–11, FIG. 8 being a simplified diagram of the FIG. 7 system not including the output coils, and with transistors 48 and 49 being represented by switches 48' and 49' respectively.

With both switches 48' and 49' open, no energizing current will be supplied to any of the coils 39-42 and the only magnetic field present is the field produced by the residual magnetism of permanent magnet 25. The pattern of this field is illustrated in FIG. 9. Since the edge-to-edge magnetic reluctance of the members 29–32 is less than the face-to-face reluctance when the coils are de-energized, the lines of force in the field external to magnet 25 will extend primarily from and between the pole ends of magnet 25, and will extend through the members 29–33 generally perpendicular to the faces 34. Since the faces of members 29–33 are inclined to the longitudinal axis of magnet 25 so that the faces are substantially perpendicular to the lines of force, substantially the same pattern of the lines of force will exist whether the members 29–33 are present or not. Although the flux concentration will be greatest at the ends of magnet 25, considerable lines of force will pass through the surface of magnet 25 along the length thereof. The number of lines of force present in the external field will, of course, equal the number of lines of the residual magnetic force induced in the magnet by the magnetization thereof.

If switch 48' is now closed, coils 39 and 41 will be simultaneously energized, and the current in the coils will induce a magnetic field in members 29 and 31 sufficient to change the edge-to-edge magnetic reluctance so that it is less than the face-to-face reluctance. As a result, the lines of force in magnet 25 will extend through magnet 25 and edge-to-edge through members 29 and 31 so that the side edges 35 of members 29 and 35 become the main poles of the magnet. In a sense, it can be said that energization of coils 39 and 41 has changed the physical shape of the magnet to displace its ends so that the axis of the magnet is now a line drawn between the ends 35 of members 29 and 31. The shift of the magnet axis produces a consequent shift in the external field as illustrated in FIG. 10. As seen, the faces of de-energized variable-reluctance members 30 and 32 are still generally perpendicular to the external lines of force and thus produce little distortion of the shifted field pattern.

If switch 48' is reopened and switch 49' is left open, the de-energization of coils 39 and 41 will allow the residual magnetism in members 29 and 31 to restore to stable lamellar face-to-face distribution so that the permanent magnetic field of magnet 25 shifts back to the pattern of FIG. 9.

Closure of switch 49' will energize both coils 40 and 42, causing a shift of the permanent magnetic field in the opposite direction, as illustrated in FIG. 11. Reopening of switch 49' allows the field to restore to the pattern of FIG. 9.

Thus, as switches 48' and 49' are alternately closed and opened, the pattern of the magnetic field will shift back and forth relative to the center of magnet 25, in substantially the same manner as if magnet 25 were physically oscillated about its center.

The output coil or coils should be located relative to magnet 25 so that the maximum number of lines of force will cut the windings of the coil during the above-described shifting of the field. Although the sequential excitation of coils 29–33 will create additive magnetic lines of force and thereby generate some output current in the output coils by mutual inductance or transformer action, the primary generation of output current will be caused by the shift of the lines of force of the permanent magnetic field relative to the output coil windings.

The shift of the field will depend to some extent on the angle of inclination of the variable-reluctance members to the longitudinal axis of magnet 25. Results show that the optimum angle is at about 45°, but the inclination can be varied considerably therefrom and still produce a usable field shift.

The power output from the system will depend upon the number of lines of force cutting the output coil windings per unit time, and will increase as the rate of shifting of the field increases. For a given system, the power output has an upper limit determined by the time constant of the system, the time constant for magnetic circuits being conventionally defined as the time taken for the output to rise to 63% of its final value when a sudden magnetic excitation is applied. The time constant will depend on all of the parameters of the system involved. For systems as described herein, the maximum frequency of operation may range from 1000 Hertz to several million Hertz. In any event, for a given system, the theoretical power output can be increased by increasing the frequency of field shifting until the upper limit is reached. Increasing the frequency beyond that limit will result in a decreasing output since the system cannot respond that quickly.

An increase in frequency of operation will generally increase the power losses, primarily hysteresis losses. The use of barium- or strontium- and ferric-oxide material is particularly suitable in the present invention because of the very low power loss therein at high-frequency operation.

To optimize performance of the present invention, the oscillator 46 should be set to oscillate at a frequency related to the time constant of the system, and the adjustable capacitors 61–64 and 76 and 77 should be trimmed so that the coils will resonate at that frequency. Although direct current is applied to the excitation coils 39–41, the output voltage and current from coils 65 and 66 will be alternating since it is produced by the resultant back-and-forth shifts of the magnetic field. The frequency of alternation of the output will be the same as the frequency of the oscillator 46 and hence the use of rectifier 69 and inverter 70 to reduce the frequency to a standard value for operation of the load 74 which may be resistive, inductive or capacitive in nature.

It is apparent, from a consideration of FIGS. 8–11, that variable-reluctance members 30 and 32 could be eliminated. In such case alternate but simultaneous energization and deenergization of coils 39 and 41 would cause the permanent magnetic field to shift back and forth from the patterns illustrated in FIGS. 9 and 10. Similarly, if members 30 and 32 were eliminated, a shift of the permanent magnetic field could also be produced by energizing and de-energizing coil 39 and then coil 41. Further, if only one variable-reluctance member, e.g., member 29, were used, alternate energization and deenergization of its coil would create some shift of the permanent magnetic field. In each instance, however, the degree of field shift would decrease substantially as compared to a system wherein four variable-reluctance members are used.

In the four variable-reluctance members described above, excitation coils on opposite sides of the permanent magnet were simultaneously energized. If desired, however, coils 39 and 42 could be simultaneously energized, while leaving coils 40 and 41 de-energized. In such case the pattern of the lines of force in the permanent magnetic field would shift to a pattern as illustrated in FIG. 12. Deenergization of coils 39 and 42 would restore the field to the FIG. 9 position and subsequent energization of coils 40 and 41 would cause the field to shift to the pattern illustrated in FIG. 13. Again, the lateral shifting of the lines in the field can be utilized to cut the winding of the output coil and generate an output voltage as a result. For example, a toroidal output coil 75 having a plurality of windings wound around magnet 25 from close to the magnet to a considerable distance therefrom (FIG. 14) will intercept substantially all of the permanent magnetic lines of force as they shift back and forth.

A modification of the invention is illustrated in FIGS. 15–18. In this case, the permanent magnet 25 and variable-reluctance members 29–32 are arranged as in FIG. 7, each member 29–32 having one of the coils 39–42 associated therewith. A keeper ring 80 extends around and joins the ends of the variable-reluctance members 29–32, ring 80 being in physical contact with the ends of members 29–32 so that there is no air gap therebetween. Preferably the ring 80 is built up of bars or plates of unmagnetized material of the same composition and magnetic properties as those of the variable-reluctance members, the bars or plates being disposed in edge-to-edge or face-to-face relationship around the ring. The cross-sectional area of the keeper ring is preferably the same as that of the variable-reluctance members and the bar magnet. Barium- or strontium- and ferric-oxide material is again preferred because of its high-frequency characteristics.

When both switches 48' and 49' are open, the pattern of the permanent magnetic field will be as illustrated in FIG. 17. With the coils de-energized, the path of least reluctance through members 29–32 is from face to face. Very little of the magnetic flux passes through members 29–32 to the ring 80 and the effect is as if the ring is spaced from magnet 25 by a substantial air gap. Thus, even though the edge-to-edge reluctance of the ring elements is considerably less than that of air, the greatest number of the external lines of magnetic force will be in the region between ring 80 and magnet 25, although some will extend through ring 80.

If switch 49' is closed, coils 39 and 41 will be energized causing the edge-to-edge reluctance of members 29 and 31 to be less than their face-to-face reluctance, so that the ends of these members in effect become the poles of the magnet. Since the ring 80 is in contact with the ends of variable-reluctance members 29 and 31 with no high-reluctance gap therebetween, and since the magnetic reluctance of the ring elements is much less than that of air, a low-reluctance path is formed between the effective poles of magnet 25. As a consequence, substantially all of the magnetic lines of force shift from the pattern of FIG. 17 and extend through the low-reluctance keeper ring.

If switch 48' is opened, coils 39 and 41 are de-energized so that the residual magnetism of members 29 and 31 again restore to a lamellar face-to-face distribution and the magnetic field shifts back to the pattern of FIG. 17. Closure of switch 49' causes coils 40 and 42 to be energized so that the magnetic field pattern shifts again to the position illustrated in FIG. 18.

The net effect is the same as physically moving a low-reluctance keeper into and out of engagement with the ends of a magnet. As will be apparent from a consideration of FIGS. 16–18, in order for the lines of magnetic force to shift back and forth from the keeper ring 80 to the cavity between the ring and magnet 25 so that the lines of force will cut the windings of output coil 81, which may be a single coil, as illustrated in FIG. 15, it is necessary to de-energize one set of coils before energization of the other set so that the field pattern can restore to the FIG. 17 pattern.

It is also apparent, from a consideration of FIGS. 16 and 18, that the direction of the lines of magnetic force in the ends 82 and 83 of the keeper ring is different, depending upon which set of coils 39 and 41 or 40 and 42 is energized. As a consequence output coils 84 and 85 could be wound around these ends of the keeper ring to be energized by the flux reversal in a cycle of operation, even if switches 48' and 49' are operated in such manner that the switches are opened alternately but only opened if the other is closed, i.e., if the field pattern shifts back and forth between the pattern of FIGS. 16 and 18 without restoring to the pattern of FIG. 17.

FIGS. 19–22 illustrate another modification of the invention, similar in design to the embodiment of FIG. 15, but differing therefrom in that keeper 90 is U-shaped, with legs 91 and 92 connected only at end 93. FIGS. 21, 20 and 22 illustrate the pattern of the magnetic field of permanent magnet 25 when both switches 48' and 49' are open, when switch 48' is closed, and when switch 49' is closed, respectively. Since keeper 90 does not connect directly between variable-reluctance members 31 and 32, the full magnetic flux extending through members 31 or 32, depending on which set of coils is energized, will extend through keeper leg 92 or 91, respectively.

As in the other embodiments, the output coil or coils will be disposed in fixed relation to the magnet 25 and positioned so that the windings are cut by the shifting magnetic lines of force. FIG. 19 illustrates an arrangement wherein two output coils 94 and 95 are utilized, these coils being wound around the legs 91 and 92, respectively, of keeper 90. The output coils are illustrated as being electrically connected in parallel, although they could be series-connected or have independent outputs. When electrically connected together, the output coils are connected together with due regard for the polarity of the induced voltages so that the voltages do not oppose each other.

In both of the embodiments of FIGS. 15 and 19, wherein a keeper is used, the external magnetic field of magnet 25 shifts back and forth from a high-reluctance path, i.e., the air cavity between the keeper and magnet 25, as illustrated in FIGS. 17 and 21, and a low-reluctance path through the keeper, as illustrated in FIGS. 16, 18, 20 and 22. Although the reluctance of the external magnetic circuit thus varies, the permanent magnetic flux of magnet 25 does not vary. Likewise, the number of lines of permanent magnetic force in the external magnetic circuit, which equals the number of lines in magnet 25, remain the same. As a consequence, the output is directly related to the degree of permanent magnetization of magnet 25 and the positioning of the output coils in the external field so that the windings thereof are cut by the shifting pattern of the constant number of permanent magnetic lines of force. The excitation coils, 39–42, wound in a direction to aid the permanent magnetic force will provide a variable magnetic field as the coils are energized and deenergized, in addition to the permanent field so that the total flux in the permanent magnet and in the external magnetic circuit will increase from the permanent magnetic flux to a high value and the decrease to the permanent magnetic flux. This variable magnetic field produced by the excitation coils also contributes to other output through mutual induction.

FIGS. 23–26 illustrate another modification of the invention wherein the permanent magnet 25 has relatively broad end pole faces and wherein the variable-reluctance members 29–32 are positioned with their side edges against the end pole faces of magnet 25 so that the longitudinal axis of magnet 25 is parallel to the faces of the variable reluctance members 29–32. A first U-shaped keeper 95 extends from member 29 to member 32 with the keeper legs 96 and 97 being in contacting engagement with the ends of members 29 and 32. A second U-shaped keeper 98 is similarly positioned with its legs 99 and 100 contacting variable-reluctance members 30 and 31.

With switches 48' and 49' both open, the permanent magnetic field of magnet 25 will be as illustrated in FIG. 25. When switch 48' is closed, coils 39 and 42 will both be energized, providing a low-reluctance path to keeper 95, so that the magnetic field of magnet 25 shifts to the pattern illustrated in FIG. 26. Similarly, if switch 48' is open and switch 49' is closed, the pattern of the magnetic field of magnet 25 will shift to the pattern illustrated in FIG. 24.

As illustrated in FIGS. 24–26, the magnetic lines of force of magnet 25 will shift back and forth across the end faces of magnet 25 as the switches 48' and 49' are alternately closed and opened. Output coil 101 may be wound around magnet 25 so that the coil windings will extend across the end faces of the magnet and be cut as field shifts back and forth across the end faces.

In all of the described embodiments, the variable-reluctance members and their excitation coils and the output coils are all positioned in fixed relation to the permanent magnet so that there is no mechanical motion of any of the components. As a consequence, no mechanical losses are present. Further, with no mechanical movement of the components, and with the switching of the excitation coils being performed electronically, there is no mechanical wear of the components and no arcing. The assembly can be easily cased and sealed against hostile environments.

What is claimed is:

1. A converter comprising:

a. permanent magnet means having spaced-apart poles of opposite polarity and having a permanent magnetic field externally of said magnet means, said field comprising magnetic lines of force extending from pole to pole of said magnet means,

b. variable-reluctance means for shifting the pattern of said lines of force, said variable-reluctance means having a relatively low magnetic reluctance in one direction therethrough when electrically energized and a relatively high magnetic reluctance in said one direction therethrough when electrically de-energized, said variable-reluctance means being disposed in said permanent magnetic field and in fixed relation to said permanent magnet means, said variable-reluctance means comprising at least one unmagnetized but magnetizable core having spaced-apart faces and side edges extending between said faces, the distance between said faces being the least distance through said core, said core having a lamellar distribution of magnetism from face to face thereof when magnetized,

c. means for cyclically electrically energizing and de-energizing said variable-reluctance means and including an electrically conductive excitation coil means surrounding said core, the plane of said coil means being substantially inclined relative to the planes of said faces,

d. electrical conductor means disposed in said permanent magnetic field in fixed relation to said permanent magnet means and having at least one conductor positioned to be cut by lines of magnetic force in said field during a shift in the pattern of said lines of magnetic force.

2. Apparatus as set forth in claim 1 wherein said core is composed of pressed and sintered barium- or strontium- and iron-oxide particles.

3. Apparatus as set forth in claim 1 wherein said core has spaced-apart and opposed side edges one of which is adjacent one of the poles of said permanent magnet means.

4. Apparatus as set forth in claim 3 wherein said one side edge of said core is in physical engagement with said permanent magnet means and the opposed side edge is spaced away from said permanent magnet means.

5. Apparatus as set forth in claim 4 wherein said faces of said core are inclined outwardly from a line extending through said permanent magnet means from pole to pole thereof.

6. Apparatus as set forth in claim 1 wherein said permanent magnet means comprises an elongated bar with the magnetic poles being at the ends of said bar.

7. Apparatus as set forth in claim 6 wherein said core has spaced-apart and opposed side edges one of which is in physical engagement with said permanent magnet bar and adjacent one of the poles thereof and the opposed side edge is spaced away from said permanent magnet bar, and wherein said faces of said core are inclined outwardly from a line extending through said permanent magnet bar from pole to pole thereof.

8. Apparatus as set forth in claim 7, wherein said permanent magnet bar comprises a plurality of permanently magnetized cores each having spaced-apart faces and side edges extending between said faces, the distance between said faces being the least distance through said core, said cores each having a stable lamellar distribution of magnetism from face to face thereof, said cores being stacked face to face with faces of opposite magnetic polarity adjacent each other.

9. Apparatus as set forth in claim 8 wherein the cores of said permanent magnet bar and said variable-reluctance means are composed of pressed and sintered barium- or strontium- and ferric-oxide particles.

10. Apparatus as set forth in claim 1 wherein said permanent magnet means is in the shape of an elongated bar and the magnetic poles are at the ends of said bar, and wherein said variable-reluctance means includes a second unmagnetized but magnetizable core having spaced-apart faces and side edges extending between said faces, the distance between said faces of said second core being the least distance through said second core, said second core having a stable lamellar distribution of magnetism from face to face thereof when magnetized, and wherein said means for energizing said variable-reluctance means includes a second electrically conductive excitation coil means associated with and surrounding said second core, the planes of the faces of said second core being substantially inclined relative to the axis of said second coil means, said cores being spaced from each other and each core having a side edge thereof in physical engagement with said permanent magnet bar and adjacent a magnetic pole thereof.

11. Apparatus as set forth in claim 10, wherein said permanent magnet bar comprises a plurality of permanently magnetized cores each having spaced-apart faces and side edges extending between said faces, the distance between said faces being the least distance through said core, said cores each having a stable lamellar distribution of magnetism from face to face thereof, said cores being stacked face to face with faces of opposite magnetic polarity adjacent each other.

12. Apparatus as set forth in claim 10 wherein said cores of said variable-reluctance means are disposed adjacent the same magnetic pole of said permanent magnet.

13. Apparatus as set forth in claim 12 wherein the faces of both of said cores of said variable-reluctance means are inclined outwardly from a line extending through said permanent magnet bar from pole to pole thereof.

14. Apparatus as set forth in claim 10 wherein said cores of said variable-reluctance means are disposed adjacent opposite magnetic poles of said permanent magnet.

15. Apparatus as set forth in claim 14 and further including a keeper means spaced from said permanent magnet and having a low magnetic reluctance, said keeper means being in physical engagement with and extending from a side edge of one of said cores to a side edge of the other of said cores.

16. Apparatus as set forth in claim 15, wherein said permanent magnet comprises a plurality of permanently magnetized cores each having spaced-apart faces and side edges extending between said faces, the distance between said faces being the least distance through said core, said cores each having a stable lamellar distribution of magnetism from face to face thereof, said cores being stacked face to face with faces of opposite magnetic polarity adjacent each other, and wherein the cores of said permanent magnet and said variable-reluctance means and said keeper means are composed of pressed and sintered barium- or strontium- and ferric-oxide particles.

17. Apparatus as set forth in claim 14 wherein the faces of both of said cores of said variable-reluctance means are inclined outwardly from a line extending through said permanent magnet bar from pole to pole thereof.

18. Apparatus as set forth in claim 17 wherein both of said cores are disposed on the same side of a line extending through said permanent magnet from pole to pole thereof.

19. Apparatus as set forth in claim 17 wherein said cores are disposed on opposite sides of a line extending through said permanent magnet from pole to pole thereof.

20. Apparatus as set forth in claim 1 wherein said permanent magnet means is in the shape of an elongated bar and the poles of said magnet are at the ends of said bar, and wherein said variable-reluctance means includes three additional unmagnetized but magnetizable cores each having spaced-apart faces and side edges extending between said faces, the distance between said faces of said additional cores being the least distance through a core, each additional core having a stable lamellar distribution of magnetism from face to face thereof when magnetized, and wherein said means for energizing said variable-reluctance means includes an additional electrically conductive excitation coil means associated with and surrounding each said additional core, the planes of the faces of each additional core being substantially inclined relative to the axis of the coil means associated therewith, said cores being spaced from each other and each core having a side edge thereof in physical engagement with said permanent magnet and adjacent a magnetic pole thereof.

21. Apparatus as set forth in claim 20, wherein said permanent magnet comprises a plurality of permanently magnetized cores each having spaced-apart faces and side edges extending between said faces, the distance between said faces being the least distance through said core, said cores each having a stable lamellar distribution of magnetism from face to face thereof, said cores being stacked face to face with faces of opposite magnetic polarity adjacent each other.

22. Apparatus as set forth in claim 20 wherein two of said cores of said variable-reluctance means are disposed adjacent the other of the poles of said permanent magnet.

23. Apparatus as set forth in claim 22 including a keeper means spaced from said permanent magnet and having a low magnetic reluctance, said keeper means being in physical engagement with and extending from the side edges of the cores at one of the poles of said magnet to the side edges of the cores at the other of the poles of said magnet.

24. Apparatus as set forth in claim 23 wherein said keeper means comprises a first keeper portion extending

directly between one of said cores at one of said magnet poles to one of said cores at the other of said magnet poles and a second keeper portion extending directly between the other cores at the poles of said magnet.

25. Apparatus as set forth in claim 24 wherein said keeper means includes a third keeper portion extending directly between the cores at one of the poles of said magnet.

26. Apparatus as set forth in claim 26 wherein said keeper means includes a fourth keeper portion extending directly between the cores at the other of the poles of said magnet.

27. Apparatus as set forth in claim 23, wherein said permanent magnet comprises a plurality of permanently magnetized cores each having spaced-apart faces and side edges extending between said faces, the distance between said faces being the least distance through said core, said cores each having a stable lamellar distribution of magnetism from face to face thereof, said cores being stacked face to face with faces of opposite magnetic polarity adjacent each other, and wherein the cores of said permanent magnet and said variable-reluctance means and said keeper means are composed of pressed and sintered barium- or strontium- and ferric-oxide particles.

28. Apparatus as set forth in claim 22 wherein all of said cores are disposed with the faces thereof inclined outwardly from a line extending through said permanent magnet from pole to pole thereof, two of said cores being on one side of said line and two of said cores being on the other side of said line.

29. Apparatus as set forth in claim 28 wherein said coils associated with cores on the same side of said permanent magnet are electrically connected for simultaneous energization.

30. Apparatus as set forth in claim 28 wherein a coil associated with a core at one pole and at one side of said permanent magnet is electrically connected for simultaneous energization with a coil associated with a core at the other pole and on the opposite side of said permanent magnet.

31. Apparatus as set forth in claim 1 wherein said variable-reluctance means includes a second unmagnetized but magnetizable core having spaced-apart faces and side edges extending between said faces, the distance between said faces of said second core being the least distance through said core, said second core having a stable lamellar distribution of magnetism from face-to-face thereof, one of said cores having a side edge thereof in physical engagement with said permanent magnet means adjacent one pole thereof and the other of said cores having a side edge thereof in physical engagement with said permanent magnet means adjacent the other pole thereof, and wherein said means for energizing said variable-reluctance means includes an excitation coil means associated with said second core, each said coil means including a plurality of windings wound around the core associated therewith with the axis of said windings being substantially inclined from the faces of the core, and wherein said means for energizing said variable-reluctance means further includes a source of direct current, a switching means, excitation circuit means electrically connecting both of said excitation coil means to said source of direct current through said switching means, and oscillator means for closing and opening said switch means at a predetermined frequency.

32. Apparatus as set forth in claim 31 and further including means associated with said excitation coil means for tuning said excitation circuit means to resonance at the frequency of said oscillator.

33. Apparatus as set forth in claim 31 wherein said conductor means comprises an output coil having a plurality of windings, and further including output circuit means connected to said output coil, said output circuit means including a rectifier means connected for converting alternating current output of said output coil to a direct current output and inverter means for converting said direct current output to an alternating current output of predetermined frequency independent of the frequency of said oscillator.

34. Apparatus as set forth in claim 33 and further including means associated with said excitation coil means for tuning said excitation circuit means to resonance at the frequency of said oscillator and further including means associated with said output coil for tuning said output circuit means to resonance at the frequency of said oscillator.

35. Apparatus as set forth in claim 31, wherein said permanent magnet means comprises a plurality of permanently magnetized cores each having spaced-apart faces and side edges extending between said faces, the distance between said faces being the least distance through said core, said cores each having a stable lamellar distribution of magnetism from face-to-face thereof, said cores being stacked face-to-face with faces of opposite magnetic polarity adjacent each other to form an elongated bar magnet.

36. Apparatus as set forth in claim 31 and further including a keeper means spaced from said permanent magnet means and having a low magnetic reluctance, said keeper means extending from side edge of one of said variable-reluctance cores to the side edge of the other of said variable-reluctance cores.

37. Apparatus as set forth in claim 36, wherein said permanent magnet means comprises a plurality of permanently magnetized cores each having spaced-apart faces and side edges extending between said faces, the distance between said faces being the least distance through said core, said cores each having a stable lamellar distribution of magnetism from face-to-face thereof, said cores being stacked face-to-face with faces of opposite magnetic polarity adjacent each other to form an elongated bar magnet, and wherein said keeper means and said cores of said variable-reluctance means and said cores of said permanent magnet are composed of pressed and sintered barium- or strontium- and ferric-oxide particles.

38. Apparatus as set forth in claim 37 and further including means associated with said excitation coil means for tuning said excitation circuit means to resonance at the frequency of said oscillator.

39. Apparatus as set forth in claim 37 wherein said conductor means comprises an output coil having a plurality of windings, and further including output circuit means connected to said output coil, said output circuit means including a rectifier means connected for converting alternating current output of said output coil to a direct current output and inverter means for converting said direct current output to an alternating current output of predetermined frequency independent of the frequency of said oscillator.

40. Apparatus as set forth in claim 39 and further including means associated with said excitation coil means for tuning said excitation circuit means to reso-

nance at the frequency of said oscillator and further including means associated with said output coil for tuning said output circuit means to resonance at the frequency of said oscillator.

41. Apparatus as set forth in claim 1 wherein said variable-reluctance means includes three additional unmagnetized but magnetizable cores each having spaced-apart faces and side edges extending between said faces, the distance between said faces of said additional cores being the least distance through said cores, said additional cores each having a stable lamellar distribution of magnetism from face-to-face thereof, two of the four cores being spaced apart from each other and each having a side edge thereof in physical engagement with said permanent magnet means adjacent one pole thereof and the other two of said cores being spaced apart from each other and each having a side edge thereof in physical engagement with said permanent magnet means adjacent the other pole thereof, and wherein said means for energizing said variable-reluctance means includes an additional excitation coil means associated with each of said additional cores, each of said excitation coil means including a plurality of windings wound around the core associated therewith with the axis of said windings being substantially inclined from the faces of the core, and wherein said means for energizing said variable-reluctance means further includes a source of direct current, first and second switching means, excitation circuit means electrically connecting one of said excitation coils at one pole of said magnet and one of said excitation coils at the other pole of said magnet to said source of direct current through said first switching means and electrically connecting the other two of said excitation coils to said source of direct current through said second switching means, and oscillator means for alternately closing and opening said first and second switching means at a predetermined frequency.

42. Apparatus as set forth in claim 41 and further including means associated with said excitation coils means for tuning said excitation circuit means to resonance at the frequency of said oscillator.

43. Apparatus as set forth in claim 41 wherein said conductor means comprises an output coil having a plurality of windings, and further including output circuit means connected to said output coil, said output circuit means including a rectifier means connected for converting alternating current output of said output coil to a direct current output and inverter means for converting said direct current output to an alternating current output of predetermined frequency independent of the frequency of said oscillator.

44. Apparatus as set forth in claim 43 and further including means associated with said excitation coil means for tuning said excitation circuit means to resonance at the frequency of said oscillator and further including means associated with said output coil for tuning said output circuit means to resonance at the frequency of said oscillator.

45. Apparatus as set forth in claim 41, wherein said permanent magnet means comprises a plurality of permanently magnetized cores each having spaced-apart faces and side edges extending between said faces, the distance between said faces being the least distance through said core, said cores each having stable lamellar distribution of magnetism from face-to-face thereof, said cores being stacked face-to-face with faces of opposite magnetic polarity adjacent each other to form an elongated bar magnet.

46. Apparatus as set forth in claim 45 and further including means associated with said excitation coil means for tuning said excitation circuit means to resonance at the frequency of said oscillator.

47. Apparatus as set forth in claim 45 wherein said conductor means comprises an output coil having a plurality of windings, and further including output circuit means connected to said output coil, said output circuit means including a rectifier means connected for converting alternating current output of said output coil to a direct current output and inverter means for converting said direct current output to an alternating current output of predetermined frequency independent of the frequency of said oscillator.

48. Apparatus as set forth in claim 47 and further including means associated with said excitation coil means for tuning said excitation circuit means to resonance at the frequency of said oscillator and further including means associated with said output coil for tuning said output circuit means to resonance at the frequency of said oscillator.

49. Apparatus as set forth in claim 41 and further including a keeper means spaced from said permanent magnet means and having a low magnetic reluctance, said keeper means having a first keeper portion physically engaging and extending from a side edge of one of said variable-reluctance cores at one pole of said permanent magnet means to a side edge of one of said variable-reluctance cores at the other pole of said magnet means and a second keeper portion physically engaging and extending between side edges of the others of said variable-reluctance cores.

50. Apparatus as set forth in claim 49, wherein said permanent magnet means comprises a plurality of permanently magnetized cores each having spaced-apart faces and side edges extending between said faces, the distance between said faces being the least distance through said core, said cores each having a stable lamellar distribution of magnetism from face-to-face thereof, said cores being stacked face-to-face with faces of opposite magnetic polarity adjacent each other to form an elongated bar magnet, and wherein said keeper means and said cores of said variable-reluctance means and said cores of said permanent magnet are composed of pressed and sintered barium- or strontium- and ferric-oxide particles.

51. Apparatus as set forth in claim 50 and further including means associated with said excitation coil means for tuning said excitation circuit means to resonance at the frequency of said oscillator.

52. Apparatus as set forth in claim 50 wherein said conductor means comprises an output coil having a plurality of windings, and further including output circuit means connected to said output coil, said output circuit means including a rectifier means connected for converting alternating current output of said output coil to a direct current output and inverter means for converting said direct current output to an alternating current output of predetermined frequency independent of the frequency of said oscillator.

53. Apparatus as set forth in claim 52 and further including means associated with said excitation coil means for tuning said excitation circuit means to resonance at the frequency of said oscillator and further including means associated with said output coil for tuning said output circuit means to resonance at the frequency of said oscillator.

* * * * *

United States Patent [19]

Villasenor de Rivas

[11] **4,006,401**

[45] **Feb. 1, 1977**

[54] **ELECTROMAGNETIC GENERATOR**

[75] Inventor: **Eduardo Villasenor de Rivas**, Los Angeles, Calif.

[73] Assignee: **Rene Villasenor de Rivas**, Los Angeles, Calif.

[22] Filed: **Dec. 12, 1975**

[21] Appl. No.: **640,064**

[52] U.S. Cl. **323/92;** 307/104; 336/110

[51] **Int. Cl.²** **G05F 7/00**

[58] **Field of Search** .... 307/101, 104, 106; 323/75 S, 75 R, 89 C, 92; 324/34 PE, 34 PL, 48; 336/110

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[57] **ABSTRACT**

An electromagnetic generator including a permanent magnet and a core member wherein the direction of magnetic flux flowing from the magnet in the core member is rapidly alternated by switching to generate an alternating current in a winding on the core member.

4 Claims, 7 Drawing Figures

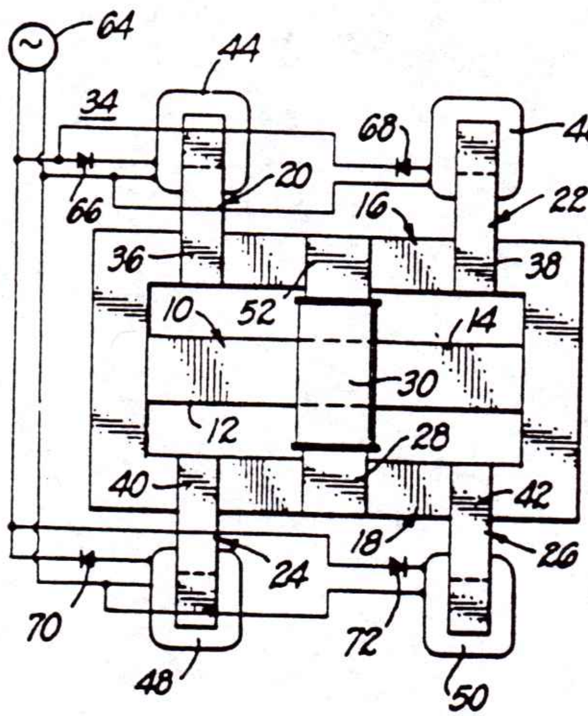


FIG. 1.

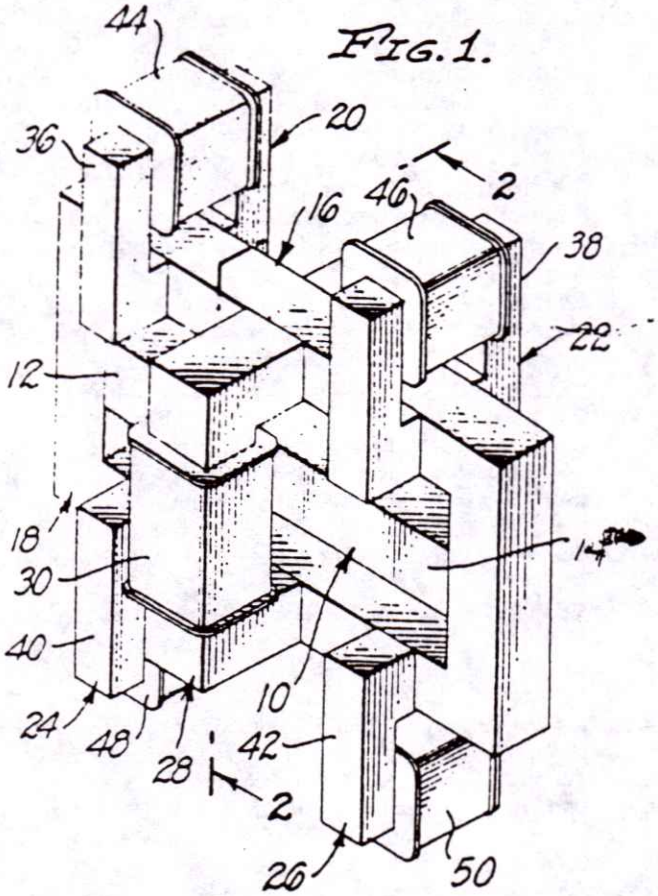


FIG. 4a.

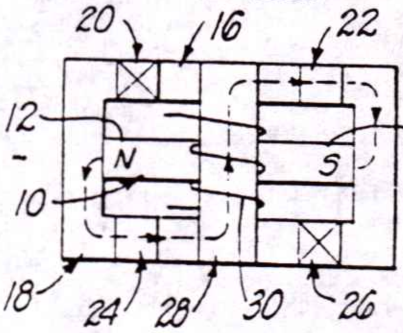


FIG. 4b.

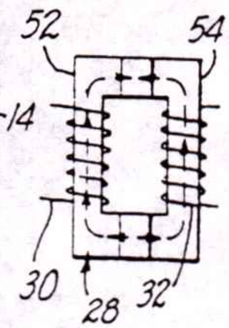


FIG. 5a.

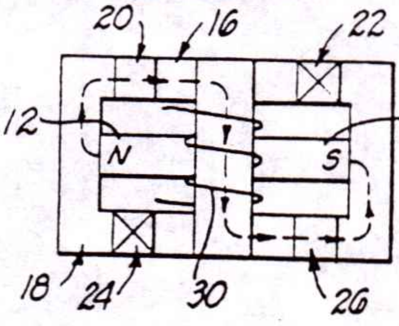


FIG. 5b.

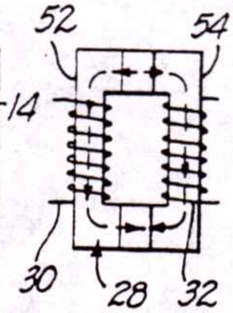


FIG. 2.

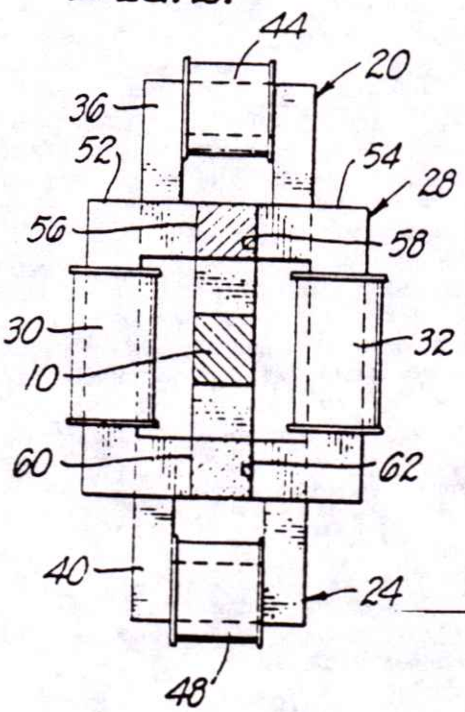
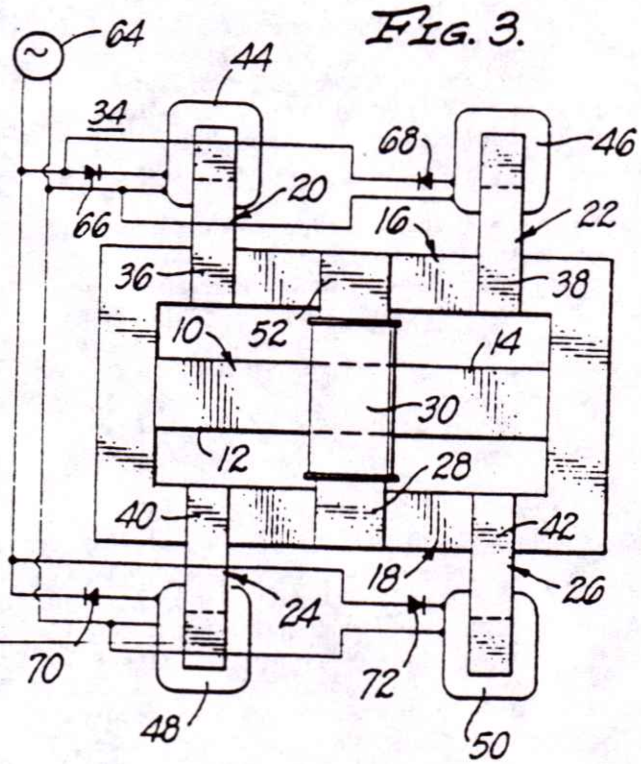


FIG. 3.



ELECTROMAGNETIC GENERATOR

The present invention relates to apparatus for generating electrical energy from magnetic energy and, more particularly, to a low cost electromagnetic generator wherein the direction of magnetic flux from a permanent magnet and flowing in a core member is rapidly alternated to generate an alternating current in a winding on the core member.

Permanent magnets have long been recognized and used as sources of magnetic flux both separately and in combination with electromagnets as means of intensifying current flow. In such instances, as the frequency of the control signal to the electromagnet has increased, so has the coil inductance of the electromagnet and the effective reluctance of the magnetic flux path to limit the magnitude of the generated current.

It is an object of the present invention to provide an electromagnetic generator including a permanent magnet as a flux source wherein the magnitude of the generated current increases as a function of the frequency of the signals applied to control the direction of flux flow from the magnet.

Another object of the present invention is to provide a low cost electromagnetic generator including a permanent magnet and a core member in combination wherein the direction of magnetic flux flowing from the magnet in the core member is rapidly alternated by switching means to generate an alternating current in a winding on the core member.

A further object of the present invention is to provide an electromagnetic generator including a permanent magnet and two separate magnetic flux circuit paths between the north and south poles of the magnet each including switching means for opening and closing the flux circuits in combination with a core member and means for alternately operating the switching means such that the direction of magnetic flux in the core member is rapidly alternated to generate an alternating current in a winding on the core member.

Still another object of the present invention is to provide an electromagnetic generator of the foregoing character wherein the switching means includes means for saturating regions of the magnetic flux paths in directions substantially normal to the direction of flux flow from the permanent magnet to selectively block such flux flow and effectively open the magnetic flux circuits.

The foregoing as well as other objects and features of the present invention may be more clearly understood by reference to the following detailed description when considered with the drawing which, by way of example only illustrates one form of electromagnetic generator including the features of the present invention.

In the drawing:

FIG. 1 is a perspective view of the an electromagnetic generator constructed in accordance with the present invention;

FIG. 2 is a sectional side view of the electromagnetic generator taken along the line 2—2 in FIG. 1;

FIG. 3 is a front view of the electromagnetic generator of FIG. 1, including a diagrammatic representation of the circuitry for applying a high-frequency, low magnitude control signal to the electromagnetic generator to rapidly alternate the direction of magnetic flux flow from a permanent magnet in a core member to produce a relatively high magnitude alternating current in windings on the core member;

FIGS. 4(*a*) and 4(*b*) are front and side views respectively of the electromagnetic generator diagrammatically representing the condition of the generator during a first half-cycle of the control signal to cause magnetic flux from the permanent magnet to flow in a first direction through a core member; and

FIGS. 5(*a*) and 5(*b*) are front and side views similar to FIGS. 4(*a*) and 4(*b*) diagrammatically representing the condition of the electromagnetic generator during a second half cycle of the control signal to cause magnetic flux from a permanent magnet to flow in an opposite direction in the core member.

Generally speaking, the electromagnetic generator of the present invention comprises a strong permanent magnet **10** having a north pole **12** and a south pole **14**. Connecting the north and south poles of the permanent magnet are two magnetic flux circuit means or paths **16** and **18**. The magnetic flux path **16** includes first and second switching means **20** and **22** for opening and closing the magnetic flux path **16** while the magnetic flux path **18** inncludes first and second switching means **24** and **26** for functioning in a similar manner relative to the second magnetic flux path. Intersecting the flux paths **16** and **18** and connected thereto between the first and second switching means **20** and **22** and **24** and **26**, respectively, is a core member **28** of highly permeable material carrying windings **30** and **32** of electrically conductive material for connecting to an external load circuit.

Normally, magnetic flux from the north pole **12** of the permanent magnet **10** will divide and flow simultaneously through the magnetic flux paths **16** and **18** to the south pole **14**. In operation of the present invention, however, electric circuit means **34** functions to alternately operate the switching means **20** and **26** and the switching means **22** and **24** to selectively open and close segments of the flux paths **16** and **18** such that the direction of magnetic flux from the permanent magnet **10** is alternated in flowing in the core member **28** to generate an alternating current in the windings **30** and **32** for application to an external load circuit.

Preferably, the switching means are capable of operating in response to a low magnitude, high frequency control signal to produce a high frequency alternation in the direction of flux flow in the core member to generate a relatively high magnitude alternating current: the magnitude of the alternating current being a function of the rate of change of the direction of flux flow in the core member.

More particularly, in the illustrated form of the present invention, the permanent magnet **10** is a bar magnet while the two magnetic flux paths **16** and **18** comprise a member of highly permeable material formed as a closed loop external to and between the north and south poles **12** and **14**. While such a member is illustrated in FIG. 1 as being a single piece member, it is appreciated that the member may be segmented as desired.

In the present invention, various forms of switching means may be employed. Of course, for a very low frequency generator, segments of the highly permeable member comprising the flux paths **16** and **18** may form the switching means in combination with means for mechanically or manually moving the segments from the member to open the flux paths on a selective basis.

Preferably, for high frequency operations, the switching means each include means for cross-saturating a region of the highly permeable member substantially normal to the direction of flux flow from the magnet 10. Such saturation immediately increases the reluctance of the flux path to effectively open the associated magnetic flux path in the region of the actuated switching means.

One form of such a cross-saturating mechanism is illustrated in the drawing for each switching means and comprises a horseshoe-shaped core with ends on opposite sides of the highly permeable member and carrying a low inductance coil. For the switcing means 20, 22, 24 and 26 such horseshoe-shaped cores are represented by the numerals 36, 38, 40 and 42 and their associated low inductance coils by the numberals 44, 46, 48 and 50, respectively. The structure and operation of each such switching means is the same. For example, to operate the switching means 20, current is applied to the coil 44. This generates a magnetic flux in the core member 36 flowing perpendicular to the highly permeable member comprisng the flux path 16 to saturate the region between the ends of the core member 36 substantially normal to the direction of flux flow from the magnet 10. This effectively opens the flux circuit means 16 to block the flux flow from the magnet through the switching means 20. When current ceases flowing in the coil 44, the magnetic flux flowing in the core 36 terminates to again return the switching means 20 and the flux path 16 to an effective closed circuit condition.

As previously indicated, the selective and alternating operation of the switching means 20, 22, 24 and 26 in accordance with the present invention causes the direction of flux flow in the core member 28 to be rapidly alternated thereby inducing an alternating current in the windings 30 and 32. In this regard, and as illustrated most clearly in FIG. 2, the core member 28 preferabiy comprises a pair of generally U-shaped elements 52 and 54 of highly permeable material carrying the windings 30 and 32 respectively, and having corresponding ends 56, 58 and 60, 62 bearing on opposite sides of the member comprising the flux paths 16 and 18 between the switching means 20 and 22, and between the switching means 24 and 26. Because of the high permeability of the elements 52 and 54 and the location of their end faces against the member comprising the flux paths 16 and 18, as the switching means are selectively and alternately operated, the core member 28 becomes a relatively low reluctance path for flux from the permanent magnet 10 between the north and south poles thereof.

The circuit means 34 for controlling the switching means and hence the direction of magnetic flux flow in the core member 28 is diagrammatically represented in FIG. 3 and comprises a source 64 of a high frequency alternating current control signal having its output connected in common to four parallel circuits connected to the coils 44, 46, 48 and 50 of the switching means 20, 22, 24 and 26, respectively. Each parallel circuit includes a diode or other unidirectional current conductive device illustrated at 66, 68, 70 and 72 for the parallel circuits associated with the switching means 20, 22, 24 and 26, respectively. The diodes 66 and 68 associated with the switching means 20 and 22 are poled in opposite directions as are the diodes 70 and 72 associated with the switching means 24 and 26. The diodes 66 and 72 and the diodes 68 and 70 being poled in like directions.

Thus, during a first or positive going half cycle of the control signal from the source 64, current flows through diodes 66 and 72 and the coils 44 and 50 while current is blocked by the diodes 68 and 70 from the coils 46 and 48. The current flowing in the coils 44 and 50 induces a magnetic flux in the associated core members 36 and 42 to saturate regions of the highly permeable member comprising the flux paths 16 and 18 and effectively blocks flux flow from the magnet beyond the switching means 20 and 26—there being a high reluctance in the region of the switching means and flux from the permanent magnet 10 following the path of lowest reluctance from the north pole 12 of the magnet through the flux path 18 and switching means 24 to a junction with the core member 28. Such a condition for the electromagnetic generator of the present invention is diagrammatically depicted in FIGS. 4(*a*) and 4(*b*), the cross at switching means 20 and 26 representing that they are in an effectively open condition.

As depicted in FIG. 4(*b*) at the junction of the path 18 and core member 28, the flux divides flowing upwardly in the elements 52 and 54 and joining at the junction of the core member 28 and the flux path 16 to flow through the flux path 16, the switching means 22, and to the south pole 14 of the magnet. Such flux flow in the core member 28 induces a current in a first direction in the windings 30 and 32.

During a second or negative going half cycle of the alternating control signal from the source 64, current only passes through the diodes 68 and 70 to flow through the coils 46 and 48. Such current flow produces a cross saturation of the highly permeable member comprising the flux paths 16 and 18 in the regions of the switching means 22 and 24 to effectively open such portions of the flux paths. Under such conditions and as illustrated diagrammatically in FIGS. 5(*a*) and 5(*b*), magnetic flux from the permanent magnet 10 following the path of lowest reluctance flows upwardly in the flux path 16 through the switching means 20 to a junction of the core member 28. There, the magnetic flux divides and flows downwardly through the elements 52 and 54 to join at a junction of the flux path 18. Flux then continues to flow in the flux path 18 to the south pole 14 of the magnet 10. Such flux flow in the elements 50 and 52 of the core member 38 induces a current in the windings 30 and 32 flowing in an opposite direction to that induced during the positive-going half cycle of the control signal from the source 64. Thus, during alternate half cycles of the control signal, relative negative and positive going signals are induced in the windings 30 and 32 to produce an alternating current for application to a load circuit connected to the windings.

By use of core members of highly permeable material and low inductance coils in the switching means of the present invention, the necessary cross saturation to effect an opening of the flux paths 16 and 18 on an alternating and high frequency basis may be accomplished using low magnitude control signals. Yet, by using a strong permanent magnet, the induced alternating current generated by a alternating of the direction of magnetic flux in the core member 28 is of a relatively high magnitude. Further, the more rapid or the greater the frequency of the control signal, the higher the frequency of alternation of the direction of flux flow in the core member to produce an alternating current in the windings 30 and 32 of increased magnitude.

In view of the foregoing, it is to be appreciated that the present invention provides a simple electromagnetic generator for converting magnetic to electrical energy by rapidly alternating the direction of magnetic flux flow in a core member. This is accomplished in a manner such that as the frequency of the operation of the means for controlling flux flow direction increases the magnitude of the induced alternating current also increases.

While a particular form of electromagnetic generator has been described in some detail herein, changes and modifications may be made without parting from the spirit of the invention. Accordingly, it is intended that the present invention be limited in scope only by the terms of the following claims.

I claim:

1. An electromagnetic generator comprising:

a permanent magnet having a north and a south pole;

first and second magnetic flux circuit means each including a highly permeable member between said north and south poles external to said permanent magnet;

first and second core members associated with each of said first and second magnetic flux circuit means and each including means for saturating a region of the highly permeable member of said associated flux circuit substantially normal to the direction of flux flow in said highly permeable member to selectively block flux flow from said magnet in said associated highly permeable member;

a third core member composed of a highly permeable material connected at opposite ends to said first and second magnetic flux circuit means between said first and second core members respectively;

a winding of electrically conductive material on said third core member for connection to an external load circuit; and

means for alternately operating said first core member and said second core member of said first and second flux circuit means respectively, and said second core member and said first core member of said first and second flux circuit means respectively whereby the direction of magnetic flux in said third core member from said permanent magnet is rapidly alternated to generate an alternating current in said winding for application to said load circuit.

2. The electromag tic generator of claim 1 wherein each of said means for saturating a region of said highly permeable members include a horseshoe-shaped core with ends on opposite sides of said highly permeable member and carrying a low inductance coil.

3. The electromagnetic generator of claim 2 wherein the means for saturating a region of said highly permeable members includes:

a source of high frequency alternating current; and

circuit means for passing said high frequency alternating current through said coils associated with said first core member and second core member of said first and second flux circuit means respectively, and said second core member and first core member of said first and second flux circuit means respectively during alternate half-cycles of said current.

4. The electromagnetic generator of claim 1 wherein:

said third core member includes a pair of elements of highly permeable material having corresponding ends on opposite sides said highly permeable members comprising said first and second magnetic flux circuit means between said first and second core members thereof respectively;

said winding is on a first one of said pair of elements; and

said generator includes a second winding on a second one of said pair of elements in circuit with said first mentioned winding and said external load.

* * * * *

Feb. 6, 1968 C. SUBIETA-GARRON 3,368,141
TRANSFORMER IN COMBINATION WITH PERMANENT MAGNET
Filed Sept. 23, 1964 2 Sheets-Sheet 1

FIG. 3

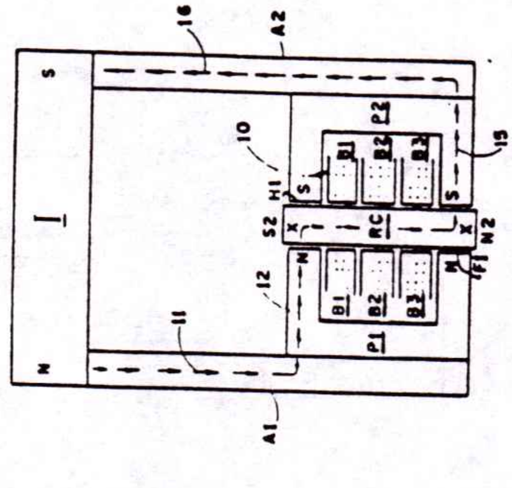


FIG. 2

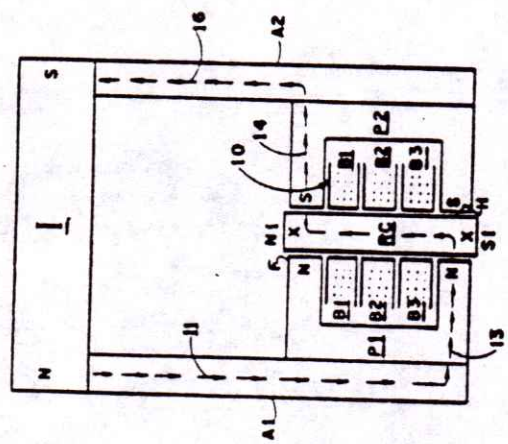


FIG. 1

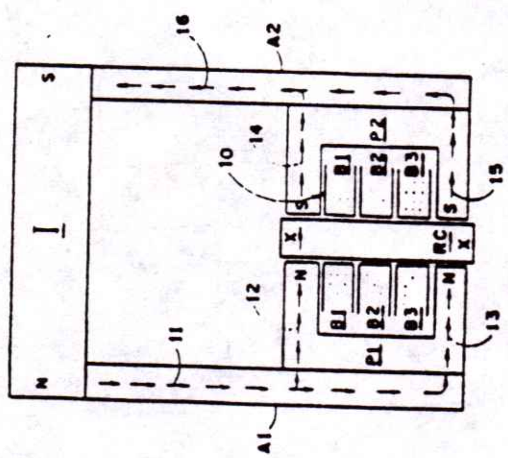


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FIG. 6

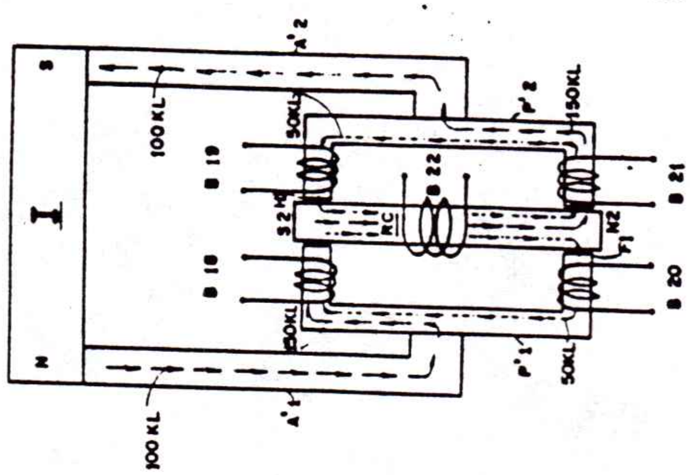


FIG. 5

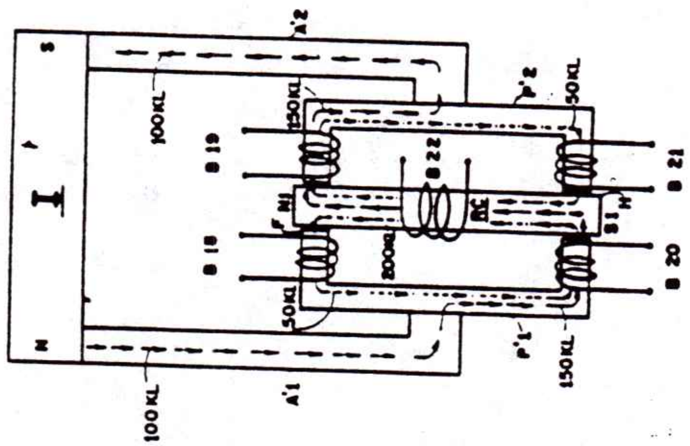
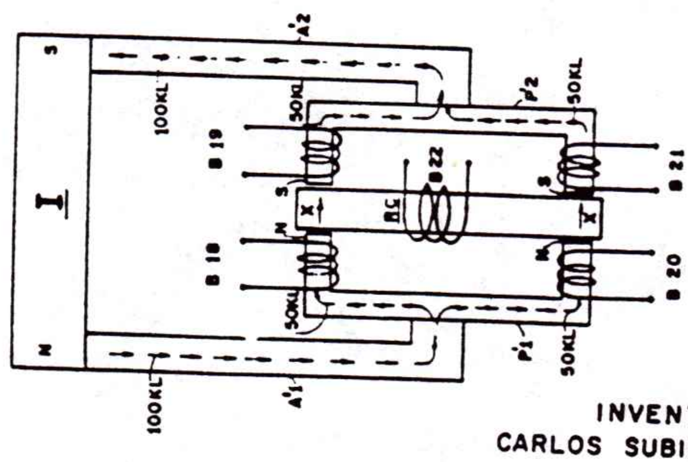


FIG. 4



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3,368,141

TRANSFORMER IN COMBINATION WITH PERMANENT MAGNET

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Filed Sept. 23, 1964, Ser. No. 398,604
6 Claims. (Cl. 323—44)

ABSTRACT OF THE DISCLOSURE

A permanent magnet in combination with a transformer having first and second windings about a core, there being two paths for magnetic flux leading from each pole of the permanent magnet to either end of the core so that when an alternating current induces magnetic flux direction changes in the core the magnetic flux from the permanent magnet is automatically directed through the path which corresponds with the direction taken by the magnetic flux through the core due to the current, whereby the magnetic flux in the core is intensified.

Summary and objects of the invention

The invention relates to a system for intensifying an electrical current. More particularly, it concerns a method and apparatus for the selective combining of the magnetic flux induced by an alternative electrical current in a high-permeability material with that of a permanent magnet.

It is fundamental that in a transformer the voltage ratio between the primary and the secondary windings is a function of the turns ratio. Thus, except for transformer losses, $N_1I_1=N_2I_2$ in which N_1 is the number of turns of the primary, N_2 is the number of turns of the secondary and I_1 and I_2 are the effective currents in the primary and secondary, respectively. With efficient transformers, the voltage ratio is very nearly N_1/N_2. Losses which occur in a transformer are largely iron losses which appear as heat and require removal. For maximum power transfer, the magnetic hysteresis loop should be narrow. At the same time, both the primary and secondary circuits should operate at their characteristic impedance. While ideally an alternating current generator would produce a sine wave output with the voltage and current in exact phase, in practice this does not occur and the wave form of the output voltage and current is frequently modified by harmonics and other factors. Where a circuit operates at its characteristic impedance and the voltage and current output wave forms are satisfactory, the efficiency or power factor of the circuit approaches unity. Also, since it is not difficult to demonstrate that the economy of power transmission varies as the square of the power factor, it is extremely desirable to operate at a unity power factor. But because of the factors discussed above, the induction characteristics of most electrical loads, and the capacitive effect of the transmission line itself, the current of the transmission line tends to vary from lagging to leading, or vice versa with the load although usually it tends to lag. For such reason, synchronous motors, static capacitors and the like are incorporated in the circuit to increase the power factor.

It is an object of this invention to provide apparatus and method which increase the power factor of a circuit.

A further object of the invention is the inclusion of a transformer in an alternating electrical circuit which improves the voltage and current wave form of the circuit—particularly at distant points of delivery.

A still further object and advantage of the invention is the provision of means to intensify electrical current output by the selective adding of the magnetic flux of a permanent magnet to that induced in a transformer to intensify the electrical current delivered from the transformer.

A yet further advantage of the invention lies in the delivery of an electrical current from a transformer of an intensity above that which would be otherwise expected from a number of secondary windings involved.

Another major advantage of the invention lies in the delivery of electrical power to rural and other areas where the price of electricity is high. In such locations, expenditures for conversion required to practice the instant invention are quickly regained from the savings in costs to the powerhouse in supply requirements.

Other objects, adaptabilities, and capabilities will appear as the description progresses, reference being had to the accompanying drawing.

Description of the drawings

FIGURE 1 is a diagrammatic illustration of apparatus in accordance with the invention wherein electrical current is not passing through the primary;

FIGURE 2 is an illustration similar to FIGURE 1 wherein current is flowing through the primary coil and inducing a magnetic flux in the core member of the apparatus;

FIGURE 3 is an illustration similar to FIGURE 2 except that current in the primary is flowing in an opposite direction and the disposition of the magnetic flux in the core member is reversed.

FIGURE 4 shows a modified apparatus of the invention wherein electrical current is not passing through the primary;

FIGURE 5 is similar to FIGURE 4 with the current passing through the primary coil in one direction; and

FIGURE 6 is similar to FIGURE 4 but with the current passing through the primary coil in the opposite direction.

Description of the preferred embodiments

In the figures, the reference character I represents a permanent magnet with its poles marked N and S for the north and south magnetic poles thereof, respectively. Leading from the north pole of the magnet I is an armature A1 which is composed of a magnetic material having a high permeability so as to carry substantially all of the magnetic flux which emanates from said pole. A similar armature A2 leads from the south pole of the magnet I. The armatures A1 and A2 join with pole shoes P1 and P2, respectively, of a transformer designated generally by reference numeral **10**. The primary coils of the transformer **10** are represented by reference characters B1 and B3 whereas the core and magnetic flux bridge member about which coils B1 and B3 are wound is designated RC. The secondary coil, also wound around the core member RC is designated B2.

In FIGURE 1 with no current flowing through the coils B1, B2 and B3, the magnetic flux from the magnet I follows the paths designated by arrows **11, 12, 13, 14, 15** and **16**. It will thus be noted that the flux path **11** splits into two paths **12** and **13** which traverse the terminal or bridge portions X of core member RC and are carried by paths **14** and **15** to be joined by path **16** to the south pole of magnet I thus completing the magnetic circuit. It will be appreciated that the magnetic flux contained in path **11** is split into approximately equal quantities carried through path **12**–X–**14** on the upper part of core member RC and path **13**–X–**15** on the lower part of core member RC. Also, of course, the magnetic orientation of the armatures A1 and A2, the pole shoes P1 and P2 and the bridge portions X is dominated by the disposition of the magnetic flux.

When current is circulated through the primary coils B1 and B3 in a direction so that a magnetic flux is induced in core member RC to render the north pole at N1 and the south pole at S1, the magnetic orientation of the pole shoes P1 and P2 and the bridge portions X is modified so that the magnetic flux flows between paths 11 and 16 through the 13–X–RC–X–14 path shown in FIGURE 2. Because of the proximity of like poles at locations F and H, the conduction of magnetic flux is severely inhibited at such locations and for practical purposes the number of lines of magnetic flux in the 13–X–RC–X–14 path emanating from magnet I, as shown in FIGURE 2, will be equal to the number of lines in FIGURE 1 contained in both the paths 12–X–14 and 13–X–15. This effect takes place practically instantaneously, depending primarily upon the hysteresis qualities of the pole shoes and core member and the characteristics of the current applied through the primary coils B1 and B3. The interaction of the magnetic flux from the permanent magnet I through core member with the current in the primary B1 and B3 is in accordance with well-known physical laws, and it will be appreciated that the flux generated by such current combines with that of the permanent magnet whereby if the fluxes are approximately equal the flux density in core member RC is approximately doubled at its maximum intensity. The interaction tends to align the current and voltage phases in the primary circuit and current induced in the secondary coils is intensified by an improved phase alignment and by the rapid change in flux occurring in the core member RC as the flux from magnet I is channeled through same.

When the current in the primary coils B1 and B3 is reversed, the magnetic orientation of the core member RC and also the pole shoes P1 and P2 is changed so that the path of magnetic flux between paths 11 and 16 assumes the path 12–X–RC–X–15 as shown in FIGURE 3, with substantially the entire flux from magnet I following such path. In this connection it is to be noted that the south pole of the core RC is in this aspect disposed at S2 in the upper portion of RC with the north pole at N2 in the lower portion and the conduction of magnetic flux is accordingly severely restricted at locations H1 and F1 by the proximity of like poles.

It is to be understood that the material making up the armatures A1 and A2, the pole shoes P1 and P2 and the core member RC should not only have a narrow hysteresis loop, but also should be so dimensioned that the maximum permeability exceeds that which they may be subjected to by reason of the magnetic flux from permanent magnet I and that induced by the primary windings B1 and B3.

FIGURES 4, 5, and 6 discloses a further method of carrying out the invention which is advantageous inasmuch as the self-induction of the system is substantially decreased.

Referring now to these FIGURES, it is to be noted that the reference character I is, as previously, a permanent magnet with its poles marked N and S for the north and south poles, respectively. Also, the armatures A'1 and A'2 are essentially the same as armatures A1 and A2 shown in FIGURES 1–3.

The magnet I is saturated with its own flux and the armatures A'1 and A'2 are composed of magnetic material having a high permeability so as to carry substantially all of the magnetic flux which emanates from the poles of the magnet I. The armatures A'1 and A'2 join with pole shoes P'1 and P'2, respectively, also composed of highly permeable material which function as branches for the conduction of magnetic flux from such armatures.

A core member RC which may be structurally the same as the core member having the same reference character in FIGURES 1–3, is disposed adjacent the terminal ends of the pole shoes P'1 and P'2. The core member RC is wound with a primary winding B22 which is adapted for connection to a source of alternating current. Each branch of the pole shoes P'1 and P'2 has a secondary winding, B18 and B20 for pole shoe P'1 and B19 and B21 for pole shoe P'2.

These secondary windings may be connected in series or parallel, or may lead to different circuits, as desired.

Looking now at FIGURE 4 wherein no current is passing through the primary windings B22, it will be assumed for the purpose of illustration that a magnetic flux of 100 kilolines is being conducted from the north pole of the magnet I to the armature A'1 and into the branches of the pole shoe P'1 wherein it is split into a pair of 50 kiloline segments. The path of the flux passes through terminal ends of the core member RC which are designated X and into the branches of the pole shoe P'2 from whence it is conducted through the armature A'2 to the south pole of the magnet I. It is to be noted that the secondary coils B18, B19, B20 and B21 are each cut by a flux of 50 kilolines. But inasmuch as the flux is not changing at this moment, no current is induced in the secondary coils.

In FIGURE 5 an electrical current is circulating in the primary B22 in such a direction as to magnetize the core member RC and to produce a total of 100 kilolines of flux in the core member RC with the north and south poles being indicated by N1 and S1, respectively. It will be appreciated that when current is first initiated through the primary B22 the conduction of magnetic flux at the locations F and H are inhibited and accordingly the 50 kilolines of flux which pass through these points and also through the coils B18 and B21 are diverted so as to pass through the coils B20 and B19. This diversion of magnetic lines which occurs within the windings of B18 and B21 initiates a current in such windings. At the same time the diversion or increase of magnetic lines of force within the windings B19 and B20 causes a similar conduction of current in such windings. As the current in the primary, B22, increases to its maximum amount, a total of 200 kilolines of magnetic flux are conducted in the core member RC as shown in FIGURE 5. However, since the magnet I is saturated, only 100 kilolines are conducted through the armatures A'1 and A'2. The additional 100 kilolines of flux split into the branches of the pole shoes P'1 and P'2 as shown by the arrows on the dot-dash lines so that 50 kilolines are distributed in each of the pole shoes P'1 and P'2. Accordingly, it will be understood that aside from the change in flux which occurs by diversion of the flux path a further 50 kiloline increase occurs in direct response to the electrical current flow in the primary B22 and flux thereby created through each of the secondary coils B18, B19, B20 and B21. When the current is reversed in the primary B22, the magnetic status of the system will almost immediately return to that shown in FIGURE 4. The system goes through the same type of transformation except that the paths of magnetic flux are inhibited at locations H1 and F1 because of the reversal of the north pole of core member RC to N2 and the south pole to S2. Thus an increase in kilolines takes place through coils B18 and B21, first, due to the transformation of the path of magnetic flux from the magnet I and, second, due to the induction of magnetic lines of force by the primary B22 in the opposite direction. Accordingly, the current induced in the coils B18, B19, B20 and B21 is opposed and equal to that previously induced as shown with reference to FIGURE 4.

The maximum permeability of pole shoes P'1 and P'2 should be sufficient to carry the maximum flux which may be induced therein without saturation. So that the assembly will not work as an annular magnet, there should be a small air gap between the core member and shoe poles. Instead of armatures together with a permanent magnet, a curved or horseshoe-shaped magnet may be employed which has poles engaging the pole shoes.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom for further modifications will be obvious to those skilled in the art.

Having described my invention, what I claim as new and desire to cover by Letters Patent of the United States is:

1. The combination of an electromagnetic device and a permanent magnet for use in an alternating current circuit, said combination comprising a permanent magnet, a core member composed of highly permeable material, a primary winding of an electrically conductive material about said core member, an adjacent secondary winding of an electrically conductive material about said core member, said primary winding adapted to have alternating electrical current from said circuit passed therethrough, a magnetic flux circuit means leading from the north pole of said permanent magnet in two further paths to said core member so as to be adjacent said core on each side of said windings, a further magnetic flux circuit means leading from said south pole in two paths to said core so as to be adjacent said core on each side of said windings whereby when an electrical current moves through said winding the magnetic flux from said permanent magnet is conducted from said north pole through one of said paths to said core and thence through one of said further paths to said south pole, the direction of the flux through said core being the same as that induced by said electrical current thereby intensifying the magnetic flux induced by said alternating electrical current in said primary winding.

2. An electrical output source which comprises a permanent magnet, a transformer, an alternating electrical current source connected to primary windings of said transformer, said windings disposed about a core in said transformer, a first magnetic flux path from the north pole to the south pole of said magnetic arranged to pass in a first direction through the core of said transformer, a second magnetic flux path from the north to the south pole of said magnet arranged to pass in a second direction opposite to said first direction through the core of said transformer, the direction of said magnetic flux in said core changed by shifting between said first magnetic flux path and said second magnetic path responsive to changes in the direction of magnetic flux induced in said core by current passing through said primary windings, and a secondary winding about said core for delivering electrical current produced by the alternating magnetic flux in said core, said secondary windings being disposed relative to said paths and said core whereby the magnetic fluxes from said magnet via said paths pass through said secondary windings.

3. In a transformer for alternating electrical current, a core having primary and secondary windings, permanent magnet means, a pair of magnetic flux paths provided for the magnetic flux of said magnet means, the first of said flux paths passing transversely through said core on one side of said windings and the other of said paths passing transversely through said core on the other side of said windings when no current is passing through said windings, the induction of magnetic flux longitudinally in said core by energizing said primary winding inhibiting the conduction of flux transversely through said core and conducting said flux from said permanent magnet means longitudinally through said core in the direction of said induced flux partly through the first of said paths and partly through the second of said paths.

4. Electrical apparatus which comprises a flux saturated permanent magnet, a first magnetic flux conductor connected to the north pole of said magnet composed of highly permeable material, a second magnetic flux conductor connected to the south pole of said magnet composed of highly permeable material, a core member, a primary winding of electrically conductive material around said core member adapted to be connected to an alternating current source and induce an alternating magnetic flux in said core member, said first magnetic flux conductor having first and second branches terminating adjacent said core member on opposite sides of said primary winding, said second magnetic flux conductor also having first and second branches terminating adjacent said core member at opposite sides of said primary winding, the path of said magnetic flux from said permanent magnet passing through said core member in one direction via said first branch of said first conductor and said second branch of said second conductor responsive to magnetic flux induced in said one direction by current passing through said primary winding and through said core member in an opposite direction via said second branch of said first conductor and said first branch of said second conductor responsive to magnetic flux induced in said opposite direction by current passing through said primary winding.

5. Apparatus in accordance with claim 4 wherein secondary windings are provided around each of said branches.

6. Apparatus in accordance with claim 5 wherein the maximum number of magnetic lines induced in said core member by current passing through said primary windings is approximately equal to the magnetic lines conducted from said magnet through said magnetic flux conductors.

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JOHN F. COUCH, *Primary Examiner.*

A. D. PELLINEN, *Assistant Examiner.*

United States Patent [19]

Phillips, Sr.

[11] **Patent Number: 4,685,047**

[45] **Date of Patent: Aug. 4, 1987**

[54] **APPARATUS FOR CONVERTING RADIO FREQUENCY ENERGY TO DIRECT CURRENT**

[76] Inventor: **Raymond P. Phillips, Sr.**, 1200 S. Frances, Terrell, Tex. 75160

[21] Appl. No.: **886,138**

[22] Filed: **Jul. 16, 1986**

[51] **Int. Cl.**[4] **H02M 7/06**

[52] **U.S. Cl.** **363/126**; 307/151

[58] **Field of Search** 363/125, 126; 307/151

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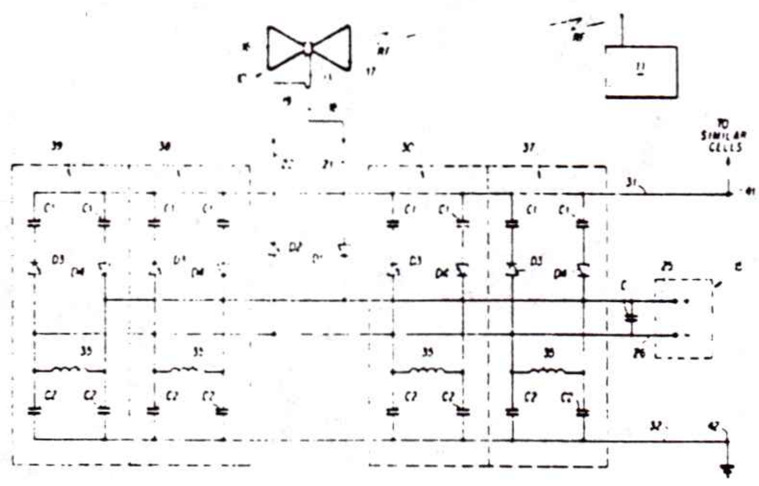
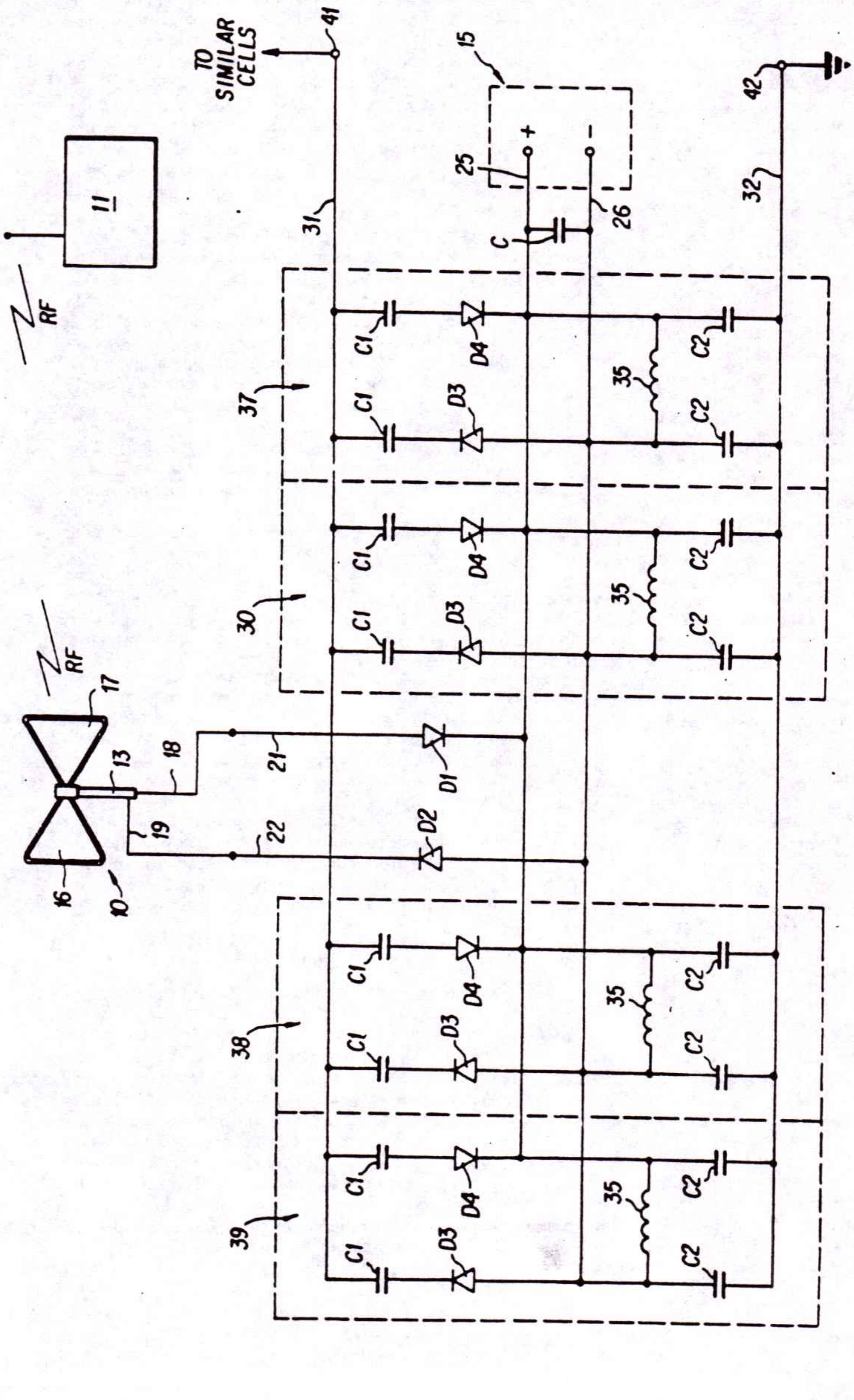
Primary Examiner—Patrick R. Salce
Assistant Examiner—Jeffrey Sterrett
Attorney, Agent, or Firm—Millen & White

[57] **ABSTRACT**

Apparatus for and methods of converting radio frequency energy into direct current for generating electric power includes a dipolar antenna for receiving radio frequency energy and a circuit connected thereto for converting the radio frequency energy to direct current. The circuit has a positive output line connected to one pole of the antenna and a negative output line connected to the other pole of the antenna. A positive transmitting diode is in the positive output line and a negative transmitting diode is in the negative output line. First and second bus lines and a pair of tuned circuits of opposite polarity couple the positive output line and negative line to the bus line with one of the bus lines being connected to ground. Each tuned circuit includes a first bridging line connecting the positive output line to the first and second ground lines and a second bridging line connecting the negative output line to the first and second ground lines. Each bridging line has a diode therein oriented at a polarity which is reverse with respect to the input diode. The bridging lines of each tuned circuit are connected to one another by an inductance and have capacitors disposed between the diode and the bus lines. A direct current device is connected to the positive line of the circuit.

11 Claims, 1 Drawing Figure

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APPARATUS FOR CONVERTING RADIO FREQUENCY ENERGY TO DIRECT CURRENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The instant invention relates to methods of an apparatus for converting radio frequency energy to direct current; more particularly, the instant invention relates to methods and apparatus for converting radio frequency energy to direct current wherein the direct current is of sufficient magnitude to power devices such as battery charges and electric motors without the use of amplification.

2. Technical Considerations in Prior Art

There has long been interest in technology directed to transmitting electrical energy over a distance without utilizing conductors, such as wire conductors. Development of such a technology has enormous potential. This was first recognized by Nikola Tesla who in 1899 constructed a 200 foot Tesla coil rated at 300 kilowatts and 150 kilocycles. Tesla hoped to set up standing waves of electrical energy around the whole surface of the earth, so that receiving antennas set at optimum points could tap the power when needed. Tesla was able to light hundreds of lamps at a distance of about 40 kilometers with his device without utilizing electrical conductors. The scheme has generally remained a scientific curiosity but has provided the initial groundwork for current developments wherein attempts are being made to transmit power by microwaves. However, power transmitted by microwaves is envisioned in the form of a beam of very high intensity which is focused from a microwave generator to a receiving antenna. This technology is envisioned as being used for many types of purposes such as transmitting microwave energy collected from gigantic solar power satellites and "star wars"-type weapons systems. However, the focused microwave beam is not suitable for many applications in that the beam must be directed toward a receiving antenna and cannot be transmitted through most objects, including living objects, without destroying the objects.

The instant invention relies on converting energy from standing waves which are emitted from radio frequency antennas in the RF range rather than the microwave range. Of particular interest are very low frequencies which are not used in communications and are available for transmitting power. Also of interest with respect to the instant invention are the low frequency waves emitted by the earth due to pulsation thereof caused by its magnetic field. These low frequency standing "earth" waves can be picked up by receivers tuned thereto.

SUMMARY OF THE INVENTION

It is an object of the invention to provide new and improved methods of an apparatus for converting radio frequency currents to direct current for practical uses other than communications, wherein the direct current energy converted from the radio frequency input energy does not require amplification.

Upon further study of the specification and appended claims, further objects and advantages of this invention will become apparent to those skilled in the art.

The instant invention contemplates an RF antenna for receiving radio waves. The RF antenna connected to a circuit configured in accordance with the principles of the instant invention to convert the RF signals to direct current. The radio frequency signals received by the antenna are transmitted to first and second leads, with one lead being rectified to transmit positive voltage and the other lead being rectified to transmit negative voltage. The positive voltage lead being connected directly to a positive output line and the negative voltage lead being connected directly to a negative output line. The positive output line is connected to a pair of bus lines through a first pair of capacitors, while the negative output line is connected to the pair of bus lines by a second pair of capacitors. Disposed between the first bus line and the positive output line is a reverse diode of negative polarity, while disposed between the negative output line and first bus line is a reverse diode of positive polarity. The positive and negative output lines are connected to one another through an inductance which is in parallel with the capacitors of the first and second pair connected between the second bus line and the positive and negative output lines.

In accordance with one embodiment of the invention the afore-described circuit is duplicated for each positive and negative output line. In accordance with another embodiment of the invention, the afore-described circuitry is coupled to additional circuits identically configured in order to increase the direct current output of the arrangement.

In accordance with a further configuration of the invention, the antenna utilized is a dipolar antenna of aluminum wire arranged in a "butterfly" configuration.

The instant invention further contemplates the method of utilizing the afore-described elements so as to generate direct current having sufficient power to perform tasks such as charging batteries, lighting lamps and powering direct current electric motors without the use of amplifiers.

BRIEF DESCRIPTION OF THE DRAWING

Various other objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood when considered in connection with the accompanying drawing, in which like reference characters designate the same or similar parts throughout the several views, and wherein:

There is shown a diagram of a circuit in accordance with the instant invention in combination with a driven device and a dipolar antenna which receives radio frequency waves which are converted to DC current for powering the driven device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, there is shown a dipolar antenna, designated generally by the numeral 10, which receives radio frequency waves from an RF transmitter 11. The radio frequency waves are transmitted to a radio frequency to direct current converting circuit, designated generally by the numeral 12, through a coaxial cable 13 and DC current from the circuit 12 is used to power an output device, designated generally by the numeral 15, which may for example by a battery charger DC motor or lighting device. The circuit 12 has no other power inputs other than the radio frequency energy transmitted thereto by the antenna 10 and therefore includes no amplifiers for amplifying the RF energy.

The source of radio frequencies convertible to direct current by the circuit shown may include sources of high frequency, low frequency (LF), very low frequency (VLF) and extremely low frequency (ELF) radio waves as well as seismic vibration of the earth's magnetic fields.

Preferably, the dipolar antenna 10 is formed of two triangular loops of aluminum wire 16 and 17, one of which is connected to the annular conductor 18 of the coaxial cable 13 and the other of which is connected to the center conductor 19 of the coaxial cable. The size of the bipolar antenna 10 is dependent on the particular application to which it is put. In accordance with one embodiment of the invention, the antenna 10 is approximately 12 inches in width and 18 inches in length. Such an antenna is used to receive five watt energy, such as that generated by a walkie-talkie or citizen-band radio.

The annular conductor 18 of the coaxial cable 13 is connected to a positive lead 21 of the circuit 12, while the center conductor 19 of the coaxial cable is connected to a negative lead 22 of the circuit. A positive transmitting diode D1 is disposed between the lead 21 and the remainder of the circuit 12 while a negative transmitting diode D2 is disposed between the lead 21 to a positive output line 25 while the negative diode D2 is connected to a negative output line 26. Accordingly, the positive voltages with respect to ground are produced on output line 25 and negative voltages with respect to ground are produced on output line 26.

In order to provide a DC output of sufficient power, a plurality of inductance-capacitance, RF, tuned circuits 30, each forming a positive cell, or a negative cell, are utilized for connecting the positive output line 25 and negative output line 26 to first and second bus lines 31 and 32, respectively. Bus line 32 is connected to ground while bus line 32 can be connected to circuits similar to circuit 12. The positive output line 25 is connected by a first bridging line 33 to the first and second bus lines 31 and 32 while the negative output line 26 is connected by a second bridging line 34 to the first and second bus lines. The bridging line 33 has capacitors C1 and C2 disposed between the positive output line 25 and the first and second bus lines 31 and 32, while the bridging line 34 also has capacitors C1 and C2 dispensed between the negative output line 26 and the first and second bus lines 31 and 32. Connected between the bridging lines 33 and 34, is an inductor 35 which serves as an RF choke, while disposed between the positive output line 25 and the capacitor C1 there is a negative polarity diode D4 referred to herein as a bridging diode and disposed between the negative output line 26 and capacitor C1 in line 34 there is a positive polarity diode D3 referred to herein as a bringing diode. As is seen of the drawing, the RF tuned circuit cell 30 is repeated a plurality of times. In the specific example shown, the circuit 12 has separate cells 30, 37, 38 and 39. The cells 30 and 38 are of opposite polarity and balance one another while the cells 37 and 39 of opposite polarity and also balance one another. In order for the system to function, a pair of opposite polarized cells must be utilized. The particular number of cells 30 and the value of the components thereof are determined by the configuration of the dipolar antenna 10 and the power and frequency of the RF transmitter 11.

The radio frequency to direct current conversion circuit 12 may itself be connected to a duplicate circuit via pins 41 so as to provide additional direct current output on lines similar to positive output line 25 and negative output line 26 the output lines may be connected together in order to boost the total output of the system.

An operative embodiment of the invention utilizes the following elements:

Diodes D1, D2, D3 and D4—Germanium Diodes, Archer 1 N34A, Catalog #1123.

Inductor 35-47 Milli henry R. F. Choke

Capacitors C1 and C2-0.47 Pico Farads at 200 volts

Coaxial Cable 13—50 ohms

Dipolar Antenna 10—aluminum wire triangular loops approximately 12 inches by 18 inches.

From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention, and without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various usages and conditions.

What is claimed is:

1. Apparatus for converting radio frequency energy into direct current for generating electric power, the apparatus comprising:

a dipolar input for receiving radio frequency energy;

a positive output line connected to one pole of the dipolar input and a negative output line connected to the other pole of the dipolar input;

a positive transmitting input diode means in the positive output line and a negative transmitting input diode means in the negative output line;

first and second bus lines and a pair of tuned circuits of opposite polarity coupling the positive output line and negative output line to the bus lines, one of the bus lines being connected to ground;

each tuned circuit including a first bridging line connecting the positive output line to the first and second bus lines and a second bridging line connecting the negative output line to the first and second bus lines, each bridging line having a bridging diode means therein oriented at a polarity which is reverse with respect to the transmitting input diode means of the respective output line; the bridging lines of each tuned circuit being connected to one another by an inductance and having capacitors disposed between the bridging diode means thereon and the bus lines, and

a direct current device connected to the bridging lines of the tuned circuit.

2. The apparatus of claim 1, wherein there are a plurality of similarly configured tuned circuits connected between the output lines and the bus lines.

3. The apparatus of claim 2, wherein there are a plurality of radio frequency-to-direct current conversion circuits connected to one another to provide a direct current power array tuned to a specific radio frequency such as a high frequency source, low frequency source, very low frequency source, extremely low frequency source, or source created by seismic vibrations of the earth's magnetic field.

4. The apparatus of claim 3 wherein the dipolar input is a dipolar antenna.

5. The apparatus of claim 1, wherein the device connected to the output lines is a direct current motor.

6. The apparatus of claim 1, wherein the device connected to the output line is an illuminating device.

7. The apparatus of claim 1, wherein the device connected to the output lines is a battery charger.

8. The apparatus of claim 1, wherein the device connected to the output lines is a DC-to-AC inverter.

9. The apparatus of claim 1, wherein there are a plurality of radio frequency to direct current converter circuits connected to one another to form an array of circuits tuned to a particular radio frequency.

10. The apparatus of claim 1 wherein the dipolar input is a dipolar antenna.

11. The apparatus of claim 10, wherein the dipolar antenna utilizes aluminum wire arranged in pair of triangular loops.

* * * * *

United States Patent [19]

O'Hare

[11] **4,151,409**

[45] *** Apr. 24, 1979**

[54] **DIRECT CURRENT VARIABLE CAPACITANCE ELECTRIC GENERATOR**

[76] Inventor: **Louis R. O'Hare**, 1041 Ponderosa #2, Fort Collins, Colo. 80521

[*] Notice: The portion of the term of this patent subsequent to Jul. 27, 1993, has been disclaimed.

[21] Appl. No.: **761,456**

[22] Filed: **Jan. 21, 1977**

[51] **Int. Cl.**[2] **H01J 39/12**

[52] **U.S. Cl.** **250/212; 250/336**

[58] **Field of Search** .... 250/211 R, 212, 336, 250/215

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,426,209 2/1969 Sihvonen et al. .... 250/211 R

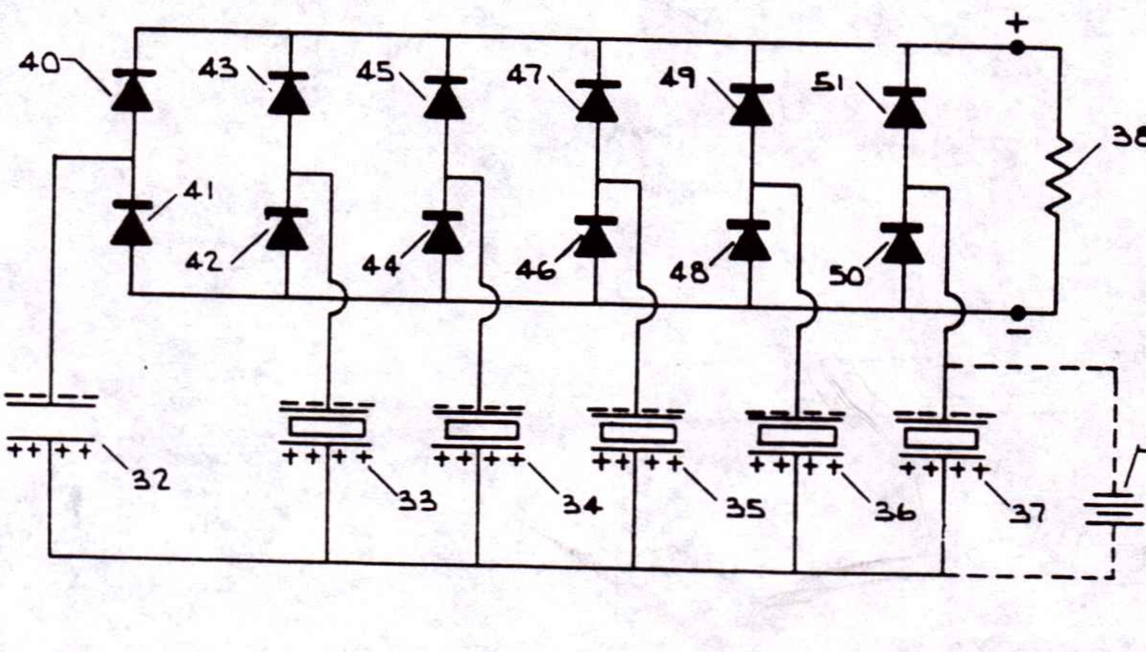
3,971,938 7/1976 O'Hare 250/336

Primary Examiner—David C. Helms

[57] **ABSTRACT**

A direct current, high voltage generator is disclosed in which electric power is produced by repeated capacitance changes. In various embodiments of the basic electric circuitry, the required capacitance change is effected by various methods, including, especially in the principal embodiment, the method of capacitance change by radiation-variable capacitors the dielectric material of which is uniquely a non-photoconducting material. This generator is distinctive in two basic ways, namely in that it is a complete d.c. generator without an iron core transformer not merely a voltage augmentor and secondly in that the light-variable dielectric material is different from that of prior art generators.

8 Claims, 11 Drawing Figures



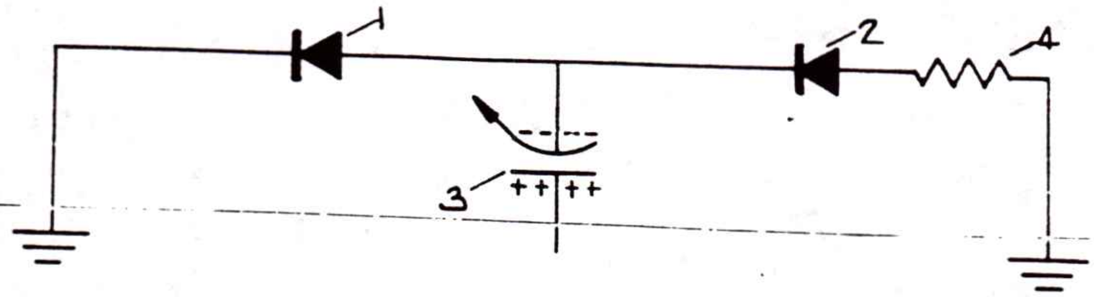


FIG. 1

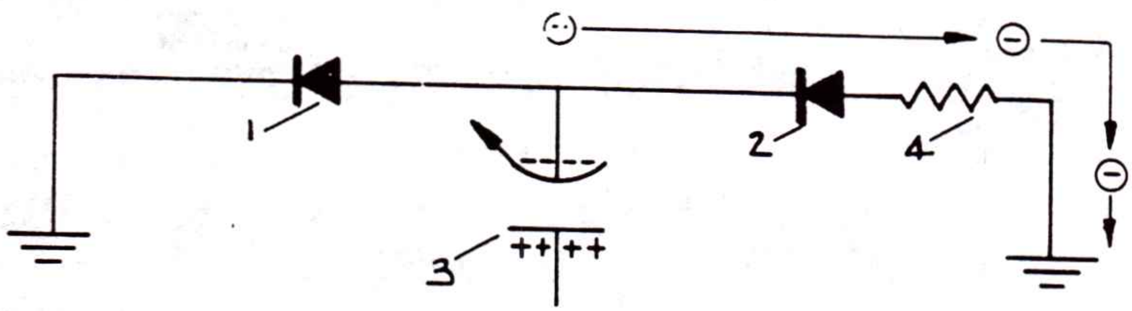


FIG. 1a

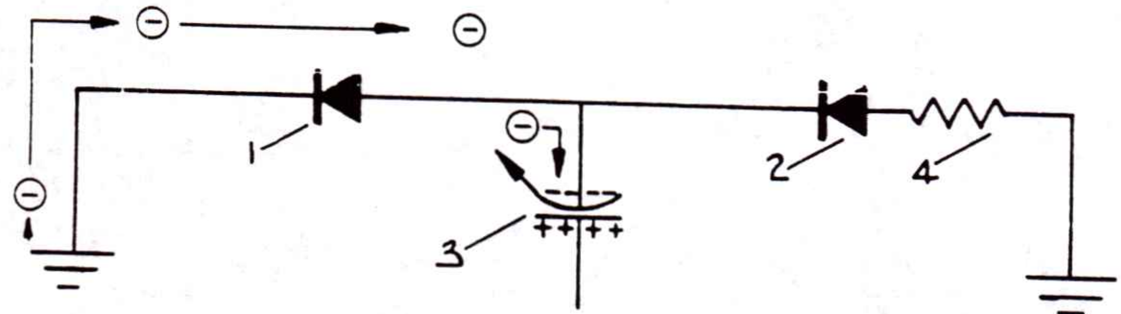


FIG. 1b

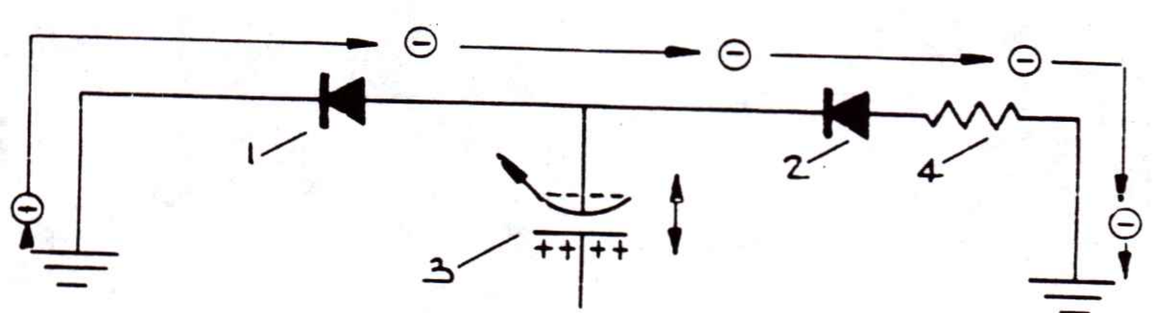


FIG 1c

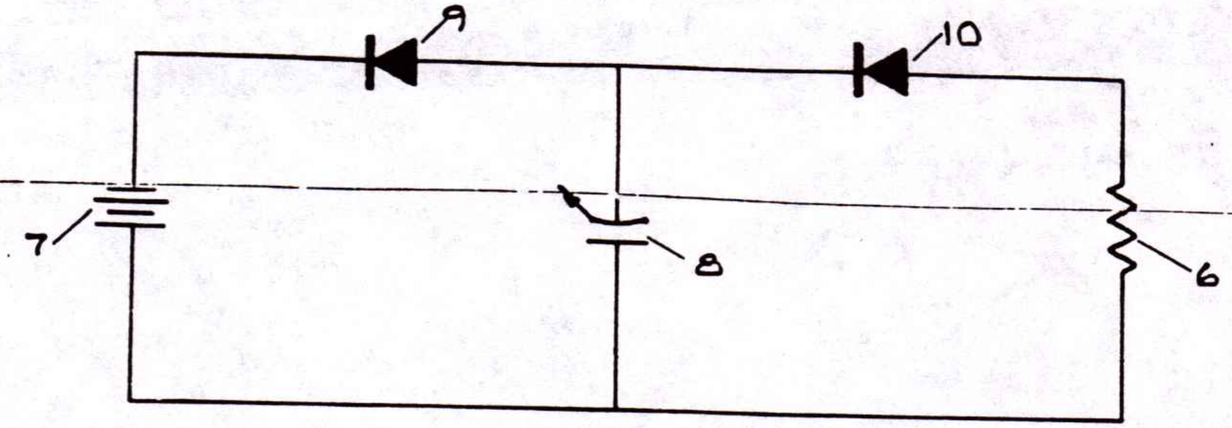


FIG. 2

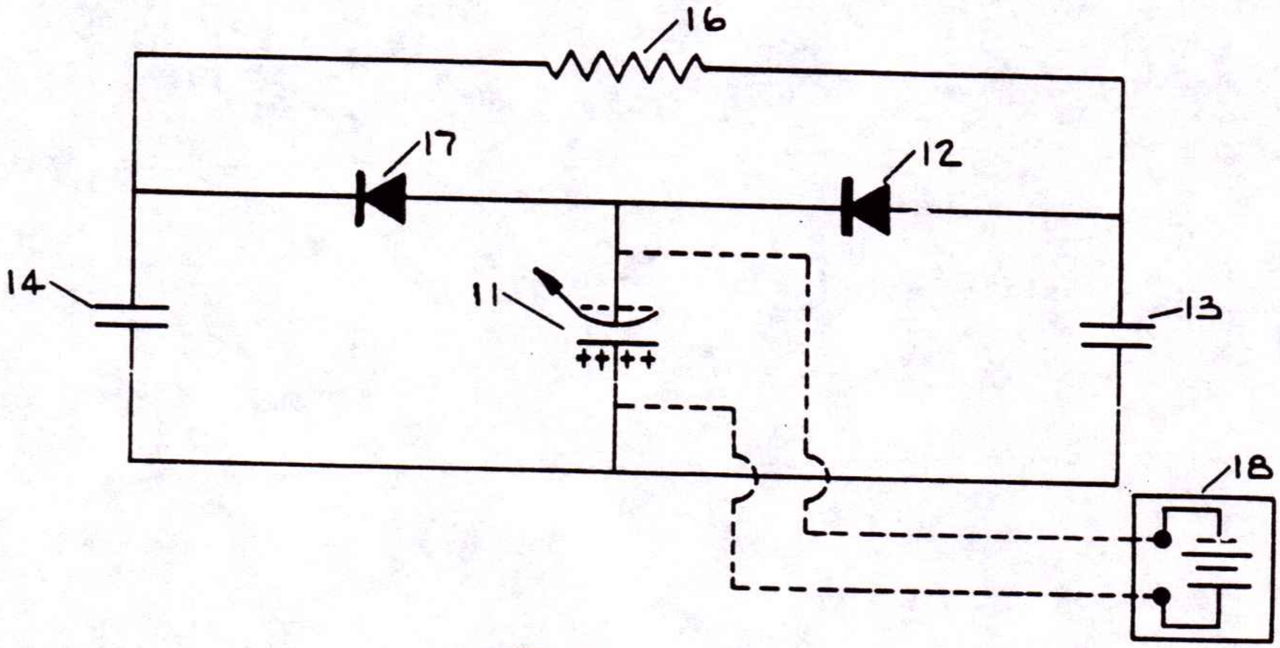


FIG. 3

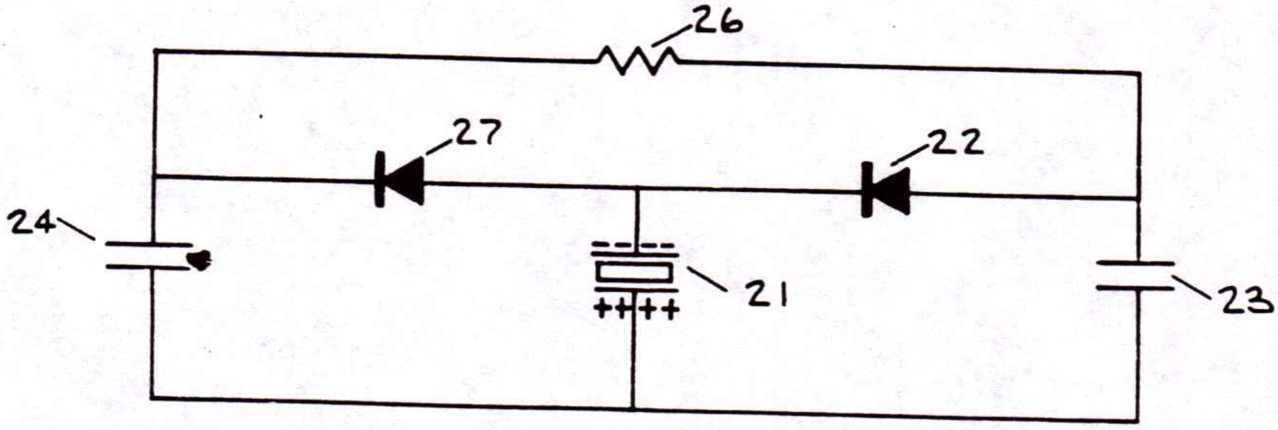


FIG. 4

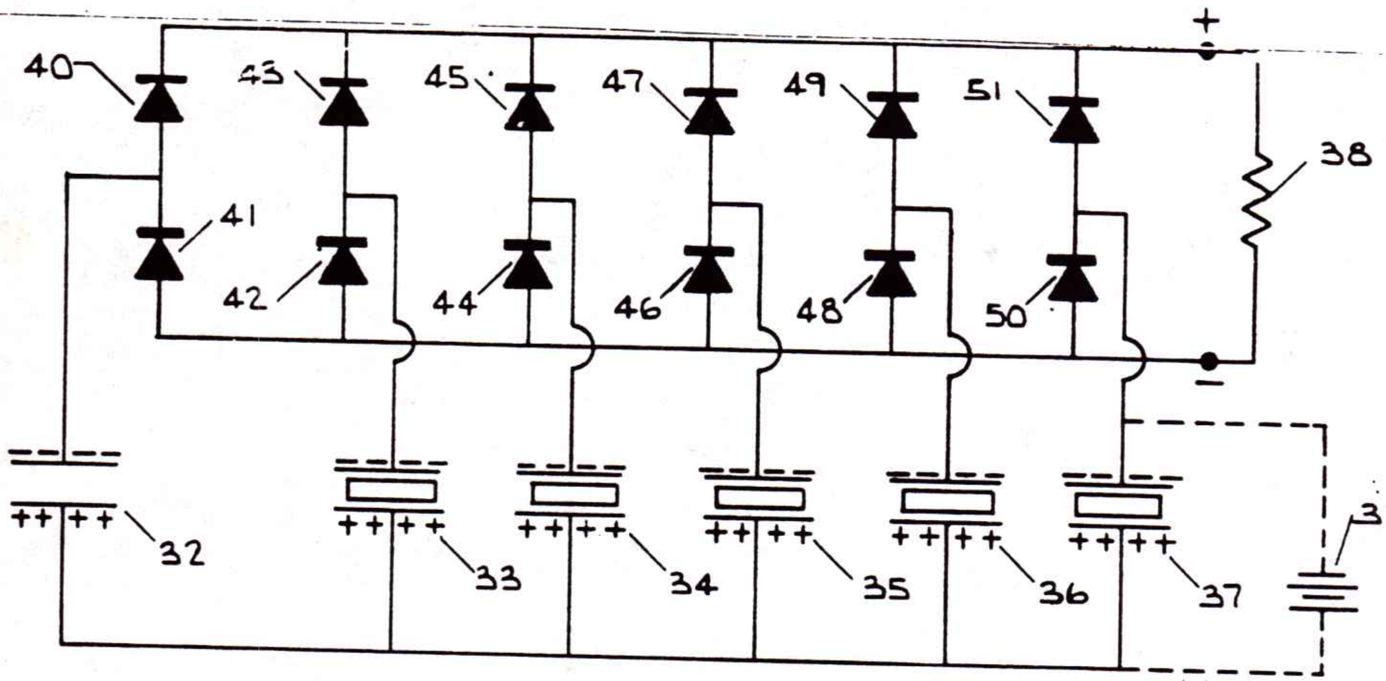


FIG. 5

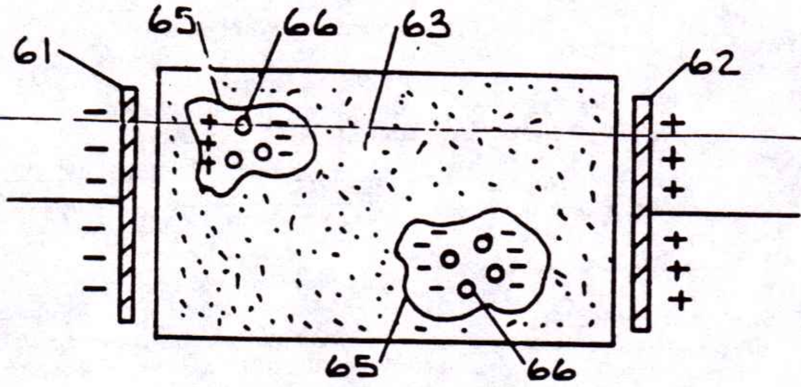


FIG 6

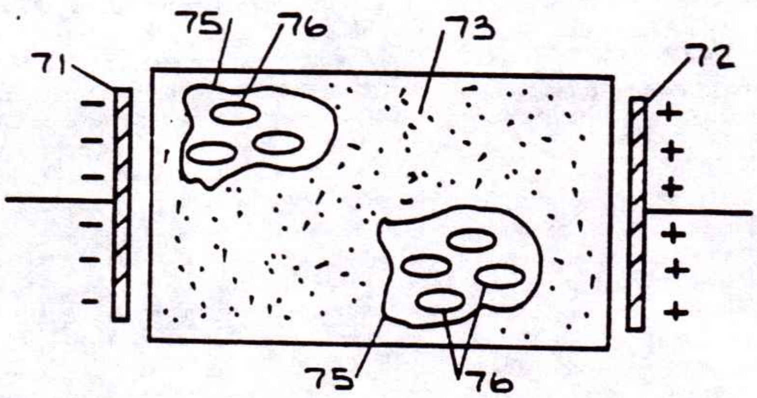


FIG 7

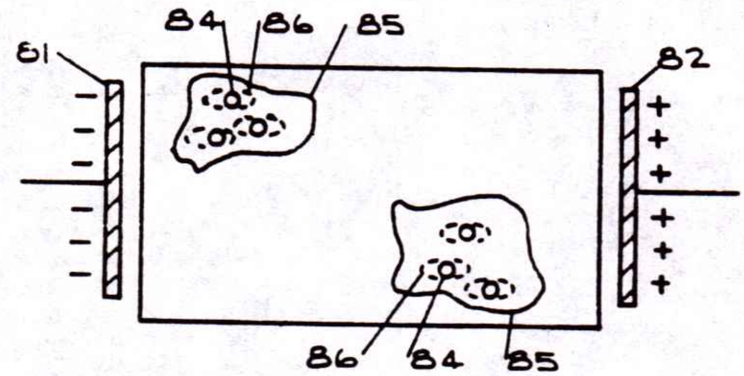


FIG 8

DIRECT CURRENT VARIABLE CAPACITANCE ELECTRIC GENERATOR

This invention relates to generators of electric power and methods of producing electricity from energy acting against an electric field. It is one of the types of electric generators which cause a current to flow by moving a charge to and from the plates of a charged electric condenser when the capacitance of the condenser is caused to alternately increase and then decrease. A similar mechanism is to be found in my copending patent applications Ser. No. 669,384, now U.S. Pat. No. 4,074,129, and Ser. No. 663,927, now U.S. Pat. No. 4,087,735, as well as in my former U.S. Pat. No. 3,971,938. It differs from prior generators in that a transformer is not an integral nor necessary part of its electrodynamic action. It is uniquely able to function at very slow rates of capacitance change. Other similar generators using transformers cannot operate with very slow alternations in current direction change without requiring very large iron core transformers. My present invention therefore is a practical and less expensive apparatus and method of producing electrical energy from relatively slow capacitance changes. For instance, in a particular embodiment it is found that some particularly efficient radiation-variable capacitors undergo very large capacitance changes when excited by light or other radiation, but that the capacitance change was necessarily slow and unable to be employed in generators of the prior art, using transformers with magnetic cores, whereas these slow changing capacitors can be employed very effectively in the present invention. The same radiation-variable capacitors could be employed in other generators or they can be employed in apparatus used merely to increase the voltage on a current flowing from another source, that is to say, they could be employed in a voltage augmentor such as the type described in the encyclopedia *Britannica*. But it is the object of this present invention to provide a true electric generator which goes beyond merely increasing voltage on a current flow that is provided by an outside source. On the contrary, this present invention does not merely augment or increase voltage on a current already present, but it generates its own current flow and it is an integral electric generator. Another principal object of the present inventive concept is to provide a very specific type of radiation-variable capacitor to be used in this as well as in other radiation-variable capacitance generators. The type herein described undergoes a repeated change even when a direct current charge is placed across its plates. The unique character of the dielectric of this invention is that it is not of the type founded on photoconductive phenomena within the condenser's dielectric. The light-variable dielectric of the variable capacitors of this present invention does not employ photoconductive materials. It does not surround photoconductive grains with insulating material to form a dielectric material. Consequently, the capacitance changes of this present novel dielectric are not achieved by effectively shortening the separation distances between the plates of a condenser by providing a periodic conductivity in the small parts of the area between the condensers' plates occupied by photoconductive grains. That is to say that in former systems the action of light was to produce many small isolated conductors between the condenser's plates. Light, so to speak, made conductors out of the photoconductor grains and this was like placing isolated conductors between the condenser's plates increasing the capacitance by effectively bringing the condenser's plates closer together shortening their separation distance. In the present invention the necessary increasing of capacitance is not achieved by the formation of conductive areas between the condenser's plates. Insulated photoconductive grains or particles are not used. On the contrary, it is one of the very objects and one of the important achievements of this present invention to exclude or to greatly minimize all kinds of electric conductivity between atoms, ions and molecules within the dielectric of its condenser.

The positive means taken to eliminate or drastically reduce photoconductivity and other types of conductivity distinguishes this present invention from former photoconductive light-variable capacitors and it distinguishes it from former light-variable capacitors not based upon photoconductivity, but which were impeded by photoconductivity and impeded by other forms of conductivity.

Former light-variable dielectrics were of various kinds. They either employed insulated photoconductors such as in U.S. Pat. No. 3,426,209 by Sihvonen, et al., increasing conduction in a limited area to effectively bring a condenser's plates closer together or, on the other hand, they employed materials with variable polarizability characteristics (as in U.S. Pat. No. 3,971,938 by O'Hare). Therein, phosphors effectively shorten the distance between the plates with a d.c. charge, but also effectively increase that distance in alternate periods in order that electricity might be generated. However, the former art light-variable dielectrics operating by the mechanism of variable polarizability have been found to be largely unsatisfactory for purposes of electric power generation and this is due precisely to undesired photoconductivity of the phosphors employed in the prior art. This is because of the fact that when an electric conductor is placed in an electrostatic field the inside of the conductor does not experience the effect of the field. There is no field inside of a conductor. Therefore, conduction photoinduced or otherwise, precludes or at least greatly reduces field interaction with polarizable ions, atoms, or molecules. This is because every polarizability change due to radiation absorption is to be found within a conductor as photoconductivity makes conductors of the radiation sensitive grains. Once the polarizability change is within a conductor it cannot contribute to the dielectric constant nor to the dielectric constant change of the condenser's dielectric.

Both types of the prior art light-variable capacitors are very effective in an a.c. circuit, i.e., when a.c. current is provided for them by some external source and when the a.c. conduction change across the condenser is measured by an a.c. current meter in series with the source and the capacitor. In such a circuit the changes in capacitance of the capacitor with radiation and without radiation can be seen clearly from the changes in the current value conducted in the circuit. Any photoconductivity within the insulating dielectric helps make the dielectric constant of the dielectric photovariable providing a kind of radiation variable capacitor. But these former art light-variable capacitors are not able to effectively undergo repeated capacitance changes when used in a circuit with direct current charge placed upon them, since conductivities within dielectric merely provide for many areas of charge separation. Once there are many places where negative charges can move closer to the positive plate and positive charges can move closer to the negative plate to cause a charge separation within the dielectric itself then the more the total capacitance of the condenser, and the charge it can carry, is going to be determined by the charge separation across those conducting areas than by any dynamics of polarizability happening with the conducting areas. For instance, if granules of metal were embedded in an insulator and used as a dielectric of a d.c. charged condenser, charges would separate across each granule in a very short time and the condenser's value would not be affected by subsequent changes in conductivity of the granules. There is no way in which the dielectric constant could decrease in this d.c. charge situation unless there were something within the metal granules that can cause combining of the charges separated across the metal by the electric field between the plates. There is no provision here for effecting a charge recombination once charges have been separated in a charged condenser. It is not the object of this present invention to provide a mechanism for such a recombination. It is not the object of this present invention to cause the voltage on the plates of a d.c. charged capacitor to elevate by decreasing its capacitance by recombining opposite charges within its dielectric. But it is the object of this present invention to remove nearly all conductivity of whatever kind in order that radiation variable polarizability changes may alone influence dielectric constant changes. This is for the purpose of providing a condenser whose dielectric constant can repreatedly change more effectively when a d.c. charge is placed across its plates. The provision of such a condenser enables a d.c. charged light-variable condenser to have its voltage both rise and fall repreatedly with alternations of dark and light periods. Accordingly, a very specific object of this present invention is to designate light and radiation-variable material that is variable only with respect to polarizability and that is entirely (or nearly so) nonconductive. The active material then is not only embedded in sulating medium but it is of itself of a highly insulating nature. The materials of this present invention then specifically are highly insulating phosphors, i.e., they are a particular class of phosphorescent material as well as a particular class of photo sensitive ferroelectric material which is nonconductive. The phosphors employed here are phosphors whose emission is based on metastable states within an ion or atom or molecule rather than phosphors whose emission is based upon charge separation mechanisms, photoconductivity or trapping centers.

For purposes of clarity the most simple form of the electric mechanism is described first, subsequently the full generating mechanism is described and finally there follows the description of the more effective light-variable dielectrics and capacitors.

Concerning the simple form of the electric mechanism, when a charge is placed on a variable condenser and the condenser is isolated from the source of its charge, one side, i.e., one terminal of the condenser may be grounded without discharging the condenser. If the plates of the condenser are separated a little, the voltage will increase during this separation because the charge is constant (since the condenser is essentially isolated). Then when the charge is constant, and the capacitance is decreased, the voltage must increase because the product of voltage and capacitance must continue to be equal to the unchanged charge. If the action to pull the plates apart continues, there is a point at which there will be very little binding of charges, and negative charges on one side of the condenser will no longer "bind" or hold the opposite positive charges on the opposite plates and visa versa. The charge on the grounded plates will then be free to move to the ground. Then, the nongrounded side of the condenser will be left with a high voltage isolated charge. It is isolated in the sense that it has nowhere to go. If subsequently the grounded plate is repositioned closer to the charged plate, it will acquire a charge of sign opposite to that on the isolated plate. This action of separating these respective plates can be repeated. In this case a current would alternate back and forth to the ground from the grounded plate as a charge moved to and from this plate. When a rectifier is placed in series with this same grounded plate so that the charge can flow from the ground to the condenser plate but not back to the ground, then pulling the condenser plates apart will cause a voltage increase on opposite plates. When a second rectifier and a resistor are connected to the grounded plate of the condenser and grounded then, when that charged condenser's plates are again separated, the voltage elevation (as the charges no longer bind each other) will not cause a current flow through the first rectifier to the ground, but, due to the polarity positioning of the second rectifier, the charge will flow through the second rectifier and the series resistor to the ground. When the positioning of the plates is again closer, the charge on the isolated plate will bring a charge up from the ground through the first rectifier to the grounded plate. Again opening the plates will cause a return of the charge to the ground through the second rectifier. An electric pumping action resulting in a single direction flow to and from the ground takes place. The ground acts as the reservoir for the charge that is brought from it in one place, and returned to it in another place.

Now, however, in a principal embodiment of this present invention, instead of using the ground as a source of charge, another condenser is used as a source from which the charge is moved. Instead of returning the charge to the ground, the mobile charge is moved by the same kind of action described above, to a third condenser. In short, the same type of pumping action, described above, makes use of a variable condenser to remove a charge of one sign from one uncharged condenser, and to place this charge on a third condenser. For instance, the variable capacitor removing electrons from an uncharged, fixed capacitor may place these electrons on a third, formerly uncharged capacitor. A single rectifier on what was called the "isolated" plate of the variable condenser adequately maintains the isolation of its charge, while enabling condensers to take the place of grounds as reservoirs from which and to which a charge may be moved by a variable capacitor. Using condensers as reservoirs has the advantage over using the ground as a source of electrons or other charges in that the condensers become sources of energy for doing electrical work when a charge separation is produced across their plates. Since radiant energy can be made to change capacitance repeatedly through the use of a radiation-variable capacitor, it can hereby cause a charge separation which results in charging capacitors according to the mechanism of this present generator. Electrical energy may be removed from the fixed capacitors in the form of usable electric power at the same time that the condensers continue to be charged.

Further clarification of the electric mechanism as well as clarification of the way in which dielectric constant change is improved is given by reference to the drawings.

FIG. 1 of the drawings shows a d.c. variable capacitance generator without a transformer and in a simple form.

FIG. 1a is a diagram of a charge flow as capacitance decreases and voltage increases.

FIG. 1b is a diagram of charge flow as capacitance increases.

FIG. 1c shows total current flow as the variable capacitor repeatedly changes.

FIG. 2 is a partial and incomplete generator requiring an external source of current.

FIG. 3 shows a schematic of an integral variable capacitance generator for producing a direct current and without a transformer.

FIG. 4 depicts a variable capacitance generator circuit employing a radiation-variable capacitor as the variable capacitance source.

FIG. 5 shows a radiation-variable capacitance generator employing multiple radiation-variable capacitors.

FIG. 6 shows a diagramatic view of a charged capacitor in which the conductivity of a phosphor grain enables a charge separation across the grain and reduces the effect of the electrostatic field within the grain.

FIG. 7 of the drawings shows a nonconducting grain in which the electron polarization of the ions, atoms and molecules within the grain can greatly affect the dielectric constant of the grain.

FIG. 8 of the drawings is a pictorial representation of electron polarizability increasing with a consequent dielectric increase.

Referring then to FIG. 1, rectifier 1 allows electrons to move from the ground to capacitor 3 only, while rectifier 2 allows electrons to flow from capacitor 3 to ground only through resistor 4. Resistor 4 represents any electric work load.

Referring then to FIG. 1a as capacitor 3 opens and reduces its capacitance, electrons are no longer tightly bound to plus charges, but repel each other, moving charge to ground through resistor 4.

In the following FIG. 1b as capacitor 3 increases in capacitance, electrons are attached to condenser plates opposite isolated positive charge. Incoming to 3, they move through 1.

Then in FIG. 1c the total current flow can be seen moving in one direction from ground to ground through 1, 2, and 4 as a result of repeated capacitance changes in 3.

Referring now to FIG. 2 current from source 7 fills and charges capacitor 8 through rectifier 9, and when capacitance of 8 decreases voltage rising on 8 is prevented from returning charge to source 7 by rectifier 9, but rectifier 10 allows current with elevated voltage to continue to work load 6 with increased voltage. The mechanism of FIG. 2, thereby differing from that of FIG. 1 in that the mechanism of FIG. 1 requires merely an isolated charge, while that of FIG. 2 requires a constant source of current.

Referring then to FIG. 3 and the generator using capacitors as reservoirs in place of ground reservoirs. A charge placed on variable capacitor 11 also charges condenser 13 moving through rectifier 12 and this same charge source charges 14 through 12 and through load resistance 16. The dotted line connections from power source 18 are intended to show that 18 is used only occasionally for charging purposes and then removed from the generating circuit. A portion of the total charge of all three condensers moves from 11 to 13 to 14 when the capacitance of 11 decreases and its voltage is thereby caused to rise. For instance, when electrons are on the upper plates of these condensers and the capacitance of 11 is made to decrease, the voltage on 11 and therefore the electron pressure rises forcing electrons through 12 to 13 and through 12 and 16 to 14. Subsequently, when the capacitance of 11 again is made to increase, having lost some of its charge during the period when the voltage was higher, capacitor 11 is at this time left with a voltage lower than and a number of electrons on its top plate less than 13 and 14. Because of 12 rectifying electrons cannot flow from 13 through 12 to 11, but they must come from 14 via 17 to 11. The cycle is repeated the next time the capacitance of 11 is made to decrease and the electron flow in this example will always be in one direction through load resistance 16.

In reference to FIG. 4, condenser 24 and 23 correspond to condensers 14 and 13 respectively of FIG. 3. Similarly, rectifiers 27, 22, of FIG. 4 correspond respectively to rectifiers 17, 22, of FIG. 3 with a similar correspondence between resistors 26 and 16 of FIG. 3. Light or radiation-variable capacitor 21 is shown in FIG. 4 and its dielectric material undergoes an effective dielectric constant change under the influence of radiation when the radiation excites electrons in this material to excited, i.e., metastable states. When electrons in significant numbers populate orbitals farther removed from the nuclei of atoms in the dielectric constant greatly increases, thereby increasing the capacitance of the radiation variable capacitor. When electrons subsequently return to the ground state, the condensers capacitance thereupon decreases to complete one cycle of variation as radiation first impinges upon and then is removed from this variable capacitor. Repeated cycling produces repeated changes. The material of this condenser's dielectric may be composed of any or of any combination of a large number of insulating phosphors or of photoreacting nonconducting ferroelectrics, and the alternation between periods of radiation on the dielectric and periods of absence of radiation is accomplished by means of a shutter periodically interrupting the radiation or a moveable reflector directing a beam of radiation to and from this dielectric, as in copending applications 663,927 and 669,384.

Radiation-variable dielectric material of this present invention which is based upon the exclusion of electrical conductivity from excited state compounds is realized in a number of ways. It is realized when ions of a radiation absorbing nature exist in a solid non-conductive solution such as a glass like borate glass, called crown glass. The neodymium ion produced by the solution and excited by radiation like visible light to a metastable state must be in sufficient concentration in proportion to the total mass of the solution that its (the ion's) contribution to the total dielectric constant will be significant. Mole concentrations of up to six percent are known to be used in glass lasers for example, and the use of glasses desolving this and higher proportions are desirable.

Likewise Yttrium aluminum garnet $Y_3Al_5O_{12}$ in which 1.5% or more of neodymium oxide is dissolved provides a light sensitive insulating dielectric for a light variable capacitor as does a 2% or more solution of neodymium oxide in calcium tungstenate. Again neodymium ions can be formed in calcium lithium borate glass called Calibo and by a similar dissolving of their oxides any or any combination of the ions of Neodymium, Yttebium, Gadolinum and Holmium can be sources of metastable-excited states when in solution in lithium silicate glasses such as Li_2O—Mgo—AL_2O_3—SiO_2.

Ruby crystals in which 0.5 percent of Chromium oxide or more is dissolved into AL_2O_3 may be used as a light variable dielectric of highly insulating qualities. The oxides of Uranium, Neodymium, Samarium, Dysprosium, Thulium and combinations of these may all be dissolved in a gram mole percent of 0.5 percent and more into Calcium Fluoride, CaF_2 to provide radiation varible dielectrics. These same last mentioned oxides may likewise be dissolved into Barium and Strontium Fluorides in similar proportions for the same result namely the production of light variable dielectrics. Nickel and Cobalt excitable ions are similarly provided for light variable dielectric material by dissolving oxides and other salts of these metals in similar small proportions into MgF_2 and/or ZnF_2.

Generally, divalent and trivalent rare earths may be dissolved into glasses and crystals employed in the laser art both according to the proportions of that art as well as with higher concentrations of the rare earth ions to provide electrically non-conductive light and radiation variable dielectrics for capacitors to be used in variable capacitance generators for the provision of electric power.

In a further embodiment of the basic inventive concept sensitized fluorescence is used to broaden the range of radiation frequencies that can be accepted by the phosphor. For instance, active Thulium ions dissolved in crystaline $CaMoO_4$ are made to benefit and be excited by a much broader range of frequencies when combined in this host crystal with a small percentage of Erbium. In the same host crystal Holmium and Erbium perform well together. When Yttrium Aluminum Garnet is employed as the host crystal Erbium and Ytterbium combination of active ions broaden the absorption spectrum as do other combinations. fc instance Thulium and Holmium as well as Neodymium and Ytterbium.

Again the absorption spectrum may be broadened in a dielectric utilizing Holmium and Thulium ions dissolved in Erbium Oxide even though Holmium alone is a very active ion in Erbium Oxide host crystal. Combinations are effective in glass dielectrics as well and while none of the above combinations used as examples is intended to limit the combinations possible they are noted to stress the principle. The combination of ions of Ytterbium, Neodymium and Erbium dissolved together in lithium silicate glass provides a dielectric with a broad band of absorption. Similarly, mixtures of any or all of the ions of Cs, Uo_2, Cu, Mn with Neodymium ions in a lithium silicate or other suitable laser type glass will cause broader absorption and greater activation of the Neodymium ions.

Generally these glasses and crystal matrixes are melted according to standard state of the art technology for lasers and a high concentration of any salt of the active ion of the desired activator/activators is dissolved into melt, the concentration density being the highest possible consistent with strong fluoresence at high excitation levels. These glasses or crystal matrixes are then cooled and ground to a fine powder or frit. The powder is applied to a metalic conductive plate and enameled onto the plate by heating to the fusing point of the enamel. After cooling a conductive layer such as Stannic oxide, Indium or Gold is then vacuum deposited on the dielectric enamel to provide the opposite plate of the condenser. The thickness of the enameled layer of light-variable dielectric must be great enough to prevent electric breakdown of insulation at the particular voltage used in the generating circuit. The dielectric enamel must be thick enough and doped with the active element in sufficient density to absorb and interact with a sufficient quantity of light. Alkali halides such as the salt Potassium chloride activated with Tellurium are nonconducting phosphors based upon metastable state phenomena which undergo dielectric constant change when excited by light or other radiation and therefore provide the dielectric material of this generator's capacitor. Similarly, Rubidium halide phosphors activated with a few percentage parts by weight of Tellurium exhibit a phosphorescence based on electrons being raised to excited states which lie below the conduction band and are therefore nonconductive and provide suitable material for the dielectric of the generator's variable capacitor. Such alkali halide and rubidium halide phosphors are also activated for dielectric constant change by the addition of up to several percentage parts by weight of metals such as lead, tin, gallium, indium, germanium, copper, silver, europium, etc.

Numerous ferroelectric compounds can absorb light energy and are otherwise responsive to radiant energy. This class of materials therefore provides capacitor dielectric changeable by the influence of radiation and useful for application in this generator. Some examples are lithium tantalate, $LiTaO_3$, lithium niobate, $LiNbO_3$, tungsten trioxide, WO_3, etc.

This light or radiation-variable capacitor **21** of FIG. **4** is usually constructed with two condenser plates between which is a very thin (2 to 10 mils in thickness) dielectric material of very high dielectric strength. A transparent electrically conductive material is used for at least one of the condenser's plates. The transparent conductive material must be transparent to the particular frequencies of radiation employed. Any or any combination of the above insulating radiation-variable dielectrics is employed as the dielectric material between the condenser plates. Those dielectrics whose composition depends on solid solution in a glass may be positioned between the condenser plates in the form of glass plates or may be enameled onto the condenser plate according to the technique of fritting. Other powders of the above dielectric materials which mix with glass may be enameled with glass powder onto one of the condenser's plates. Powders of the above dielectric materials may likewise be suspended in plastic insulators as is practiced in the electroluminescent panel art.

Referring then to FIG. **5** exciter power supply **31** places a charge on capacitor bank composed of fixed capacitor **32** and radiation-variable capacitors **33**, **34**, **35**, **36** and **37**. Exciter power supply is removed leaving a charge upon all capacitors which load resistor **38** is not able to remove, since the entire upper assembly composed of all rectifiers, and resistor **38** merely forms a common connection for the upper plates of all capacitors, and cannot discharge the capacitor bank, as no current path is ever formed across the capacitor bank. Even capacitor in the bank has a portion of the total charge depending upon its capacitance value. Light or other radiation (such as U.V., infrared or nuclear radiation) is incidented successively, or at least desperately upon radiation-variable capacitors 33, 34, 35, 36, 37. The light or radiation increases the capacitance of the particular capacitor/capacitors it is impinging at any given instant in time. The particular capacitor/capacitors receive a large portion of the total charge of the entire bank at the time they are receiving radiation. Every charge redistribution caused by any and every capacitance change in the network, must move through a corresponding bridge network and through resistor 38 to make the shares of the total charge correspond to the new capacitive values of each condenser. For instance, if radiation is incident upon radiation-variable capacitor 33, and its capacitance is thereby increasing, it is thereby receiving electrons in the process of redistribution through rectifier 43, but it cannot receive electrons through 45, 47, 49, nor 51, nor 40. It can only receive electrons which come through resistor or load 38. These electrons may be supplied by capacitors 32, 34, 35, 36 and 37, through rectifiers 41, 44, 46, 48 and 50, out all of the electrons to 33 must flow through 38 where electric work can be done.

Similarly, if, instead of 33, radiation were falling upon capacitor 36, all electrons coming to 36 in the redistribution, would flow through only rectifier 49, after flowing through load resistor 38. These electrons would come from the upper plates of 32, 33, 34, 35 and 37 via rectofiers 41, 42, 44, 46, and 50, and each electron would, of necessity, move through 38, where it would be able to do work. In the same way, any condenser, that would be increasing in capacitance at any instance, would receive electrons from a current flow through 38. The same is true of any and all combinations of radiation-variable capacitors, which should receive radiation simultaneously, and be simultaneously increasing in capacitance, i.e., if 33, 34, 35, 36, and 37 were all receiving electrons due to capacitance increase, then rectifiers 43, 45, 47, 49 and 51 would be admitting electrons to all of those capacitors, with all of the electrons coming from fixed capacitor 32 via 41, and all of the electrons flowing through work load resistor 38.

Alternatively, if all radiation-variable capacitors were darkening from the removal of radiation, except 33, which is receiving radiation, then the darkening capacitors, which are thereby undergoing an increase in voltage and a decrease in capacitance, will be impelling electrons to 33 and 32. The electrons must travel through 40 and 43, all of them moving through 38 via 44, 46, 48 and 50. In the event only one was darkening and increasing in voltage, while decreasing in capacitance, the current flow would still, of necessity, be through 38. For instance, if 35 were alone, darkening its rise in voltage would impel electrons through 46 and 38 to 32, 33, 34, 36 and 37 via 40, 43, 49 and 51, all the current still, of necessity, passing through 38.

Referring then to FIG. 6 of the drawings, charges placed on 61 capacitor plates and 62 introduce an electric field in dielectric insulator 63 in which is embedded conductive phosphor grains 65 which are some of many such phosphors within the dielectrics insulating medium 63. (The other phosphor grains are not shown). In that grains 65 are conductors the influence of the field is effectively excluded from electron polarizable ions, molecules and atoms 66 within the grain and recipricall the polarizability contribution of polarizable ions, atoms and molecules to the total dielectric constant is excluded or greatly diminished. Because of this radiation stimulated polarizability changes are prevented from causing dielectric constant changes.

Referring next to FIG. 7 of the drawings charges placed on capacitor plates 71 and 72 introduce an electric field in dielectric insulator 73 in which are embedded non-conductive phosphor grains 75 which are some of many such phosphors within the dielectrics insulating embedding medium. (The other phosphor grains are not shown). In that grains 75 are non-conductors the influence of the electric field is experienced upon polarizable ions, atoms and molecules 76 within the grain thereby enabling the polarizability of atoms, ions and molecules 76 within the grain to make a significant contribution to the total dielectric constant and thereby permitting the dielectric constant to change when polarizability changes.

Referring then to FIG. 8 of the drawings, charges placed on capacitor plates 81 and 82 introduce an electric field on insulating dielectric and insulating grains of phosphor 85 causing an electron polarization across an excitable ion 84 shown diagrammatically by an extension of the electron cloud in the field. The resulting farther extension of this electron cloud when it is subsequently raised to an excited state by means of radiation is shown by dotted lines 86 representing a light induced increase in dielectric constant value of ions, atoms or molecules of the dielectric thereby causing a total dielectric constant change of the dielectric with light or radiation.

I claim:

1. A method of generating direct current electricity from radiant energy by means of radiation variable capacitance by:

periodically directing radiation on a radiation sensitive dielectric material whose effective dielectric constant changes under the influence of incident radiation,

placing an electric charge on said radiation-variable capacitor and removing the source of the charge,

employing said radiation-variable capacitor in an electric circuit comprising two rectifiers, and an electric load resistance and two fixed condensers in such a manner that the initial charge on the variable capacitor is distributed through a rectifier to one fixed condenser as well as through that rectifier and through a load resistance to the other fixed condenser, all three condensers having a common connection on their plates opposite the rectifier connections and,

employing the alternate voltage elevations and depressions from the activated radiation-variable condenser in such a way that, when that condenser's voltage is elevated by having its capacity reduced, the rectifiers connected to its terminal will allow the current flowing from it to move in only one direction as it elevates the voltage on the two fixed capacitors, one rectifier functioning to conduct current at this time with the second rectifier functioning during a subsequent period of depressed voltage on the radiation-variable capacitor to admit current from the fixed condensers which at that time will have higher voltage than the radiation-variable capacitor will have, providing for an isolation of the total distributed charge by insuring that no resistance is connected across any condenser or group of condensers sharing the total charge, periodically restoring any of the isolated charge which may have leaked off of the condensers by occasionally connecting the power supply and then removing it.

utilizing electric power from a one direction current flow through the load resistance from which useful work energy is extracted.

2. A method of generating direct current electricity by means of radiation-variable capacitance as in claim 1 in which the radiation-variable dielectric material of the radiation-variable condenser is an insulating, non-conducting phosphor the photoactivation of which is not based upon photoconductivity and the presence of trapping centers but upon the absorbtion of radiation by an activator element such as an ion, atom or molecule which is excited by the radiation to an energy state below the conduction band.

3. A method of generating electricity as in claim 2 in which the insulating, non-conducting phosphor dielectric is a dielectric selected from the group consisting of alkalai halide phosphors and rubidium halide phosphors activated by one activator selected from the group consisting of tellurium, lead, tin, gallium, indium, germanium, copper, silver, and europium.

4. A method of generating electricity as in claim 2 in which the insulating, non-conducting phosphor dielectric is a dielectric selected from the group of glass laser phosphors in which metalic oxides selected from the group consisting of neodymium, gadolinium, holmium and combinations of these are disolved in lithium silicate glasses thereby providing excitable ions.

5. A method of generating electricity as in claim 2 in which the insulating, non-conducting phosphor dielectric is a dielectric selected from the group of crystal laser phosphors consisting of phosphors in which the oxides of metals selected from a group of metals consisting of uranium, neodymium, samarium, dysporsium, thulium, are disolved into fluoride salts selected from the group of fluoride salts consisting of calcium fluoride, barium fluoride and strontium fluoride.

6. A method of generating electricity as in claim 2 in which the insulating, non-conducting phosphor dielectric is a dielectric selected from a group consisting of crystal laser phosphors in which chromium oxide is disolved into aluminum oxide.

7. A method of generating electricity as in claim 2 in which the insulating, non-conducting phosphor dielectric is a dielectric selected from a group consisting of neodymium oxide disolved in yttrium aluminum garnet and neodymium oxide disolved in calcium tunstenate.

8. A method of generating direct current electricity from radiant energy by means of radiation-variable capacitance by:

forming a capacitor bank of many radiation-variable capacitors and one fixed capacitor having one set of plates from each capacitor connected to one common terminal, each single condenser's opposite plate being connected to its own set of two rectifiers, one rectifier of each set of two enabeling negative current flow outward and away from each single condenser and the other rectifier of each set of two enabeling current flow to the single condenser to which it belongs, those terminals of all rectifiers able to carry only a negative charge from their respective capacitor all being connected to a common terminal, this terminal being the negative output terminal of the generator, the other rectifiers of each set of two that is connected to each capacitor thereby enabeling current flow inward and each said single capacitor and each of said rectifiers having a terminal through which current can only flow to its capacitor, said terminals being connected to a common terminal forming the generators positive terminal and, charging this capacitor bank with a power source and removing the power source thereby providing a bank of charged condensers isolated from the power source and, alternately providing periods of radiation and non-radiation on the radiation sensitive dielectric of each condenser and, extracting useful electric power from an electric load connected across the output terminals.

* * * * *

United States Patent [19]

Spence

[11] Patent Number: 4,772,816

[45] Date of Patent: Sep. 20, 1988

[54] **ENERGY CONVERSION SYSTEM**

[75] Inventor: Geoffrey M. Spence, Crowborough, United Kingdom

[73] Assignee: Energy Conversion Trust, Crowborough, United Kingdom

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§ 371 Date: Oct. 14, 1986

§ 102(e) Date: Oct. 14, 1986

[87] PCT Pub. No.: WO86/04748

PCT Pub. Date: Aug. 14, 1986

[30] **Foreign Application Priority Data**

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[51] Int. Cl.⁴ H02N 7/00; H02K 44/00

[52] U.S. Cl. 310/306; 310/11

[58] Field of Search 310/306, 10, 11

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Primary Examiner—Mark O. Budd

Attorney, Agent, or Firm—Charles E. Pfund

[57] **ABSTRACT**

The apparatus uses a magnetic field (80) to accelerate a charged particle radially towards a target electrode (10). The increased kinetic energy of the particles enables the particle to give up more electrical energy to the target electrode (10) than was initially given to it. This charges the target electrode (10), and the increased energy is extracted from the apparatus by connecting an electrical load between the target electrode and a point of lower or higher potential.

29 Claims, 5 Drawing Sheets

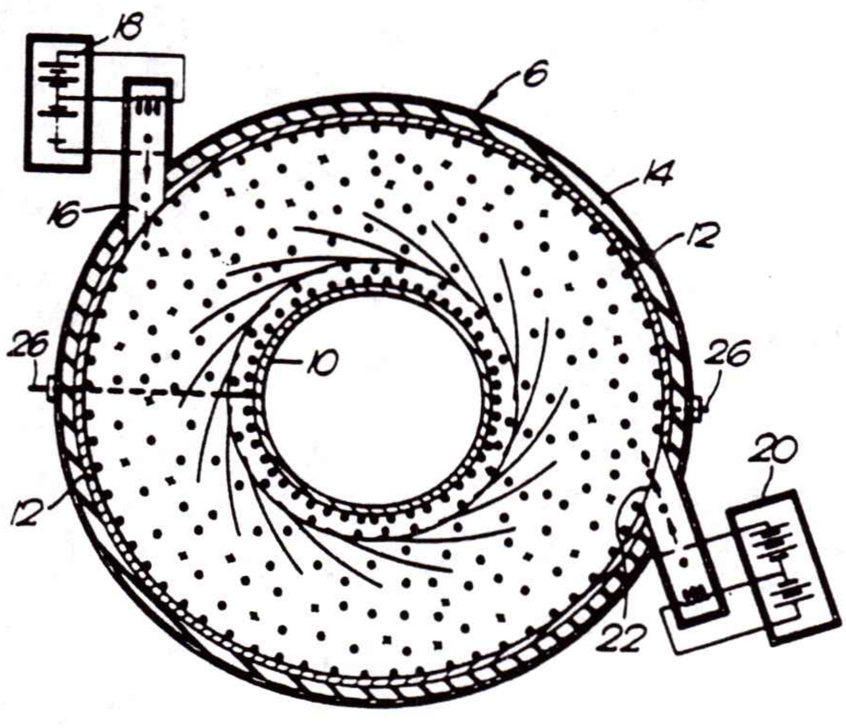


Fig. 1.

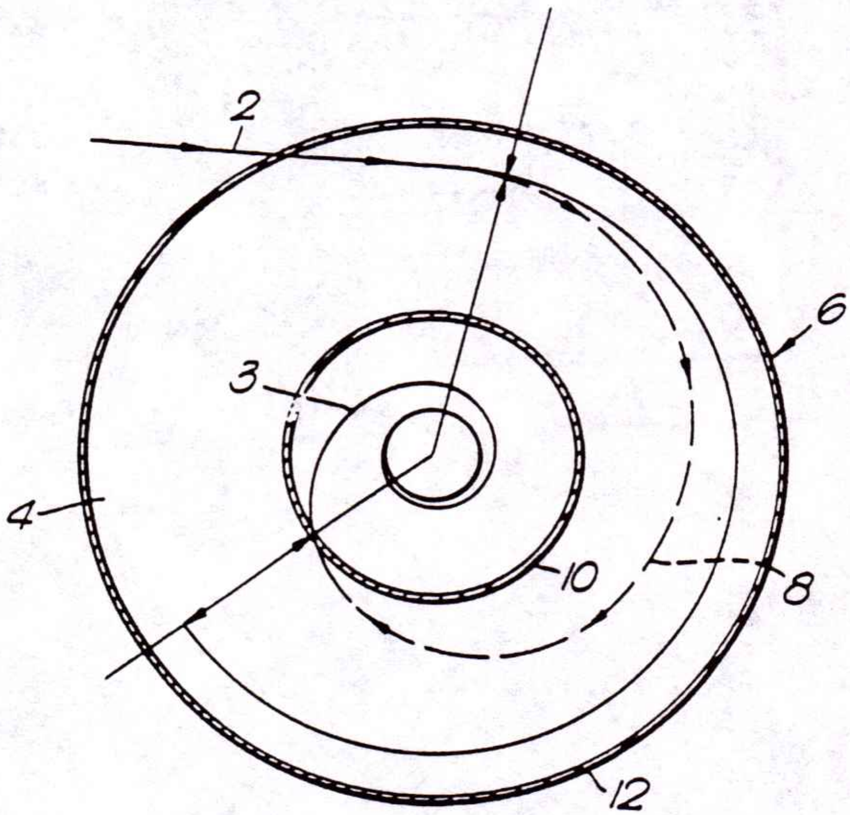


Fig. 2.

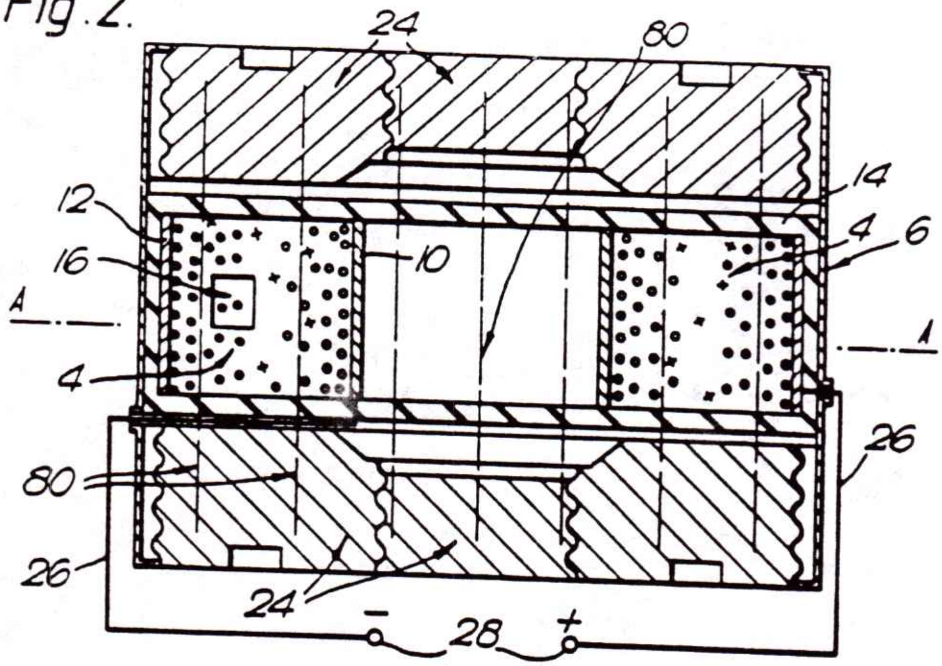


Fig. 3.

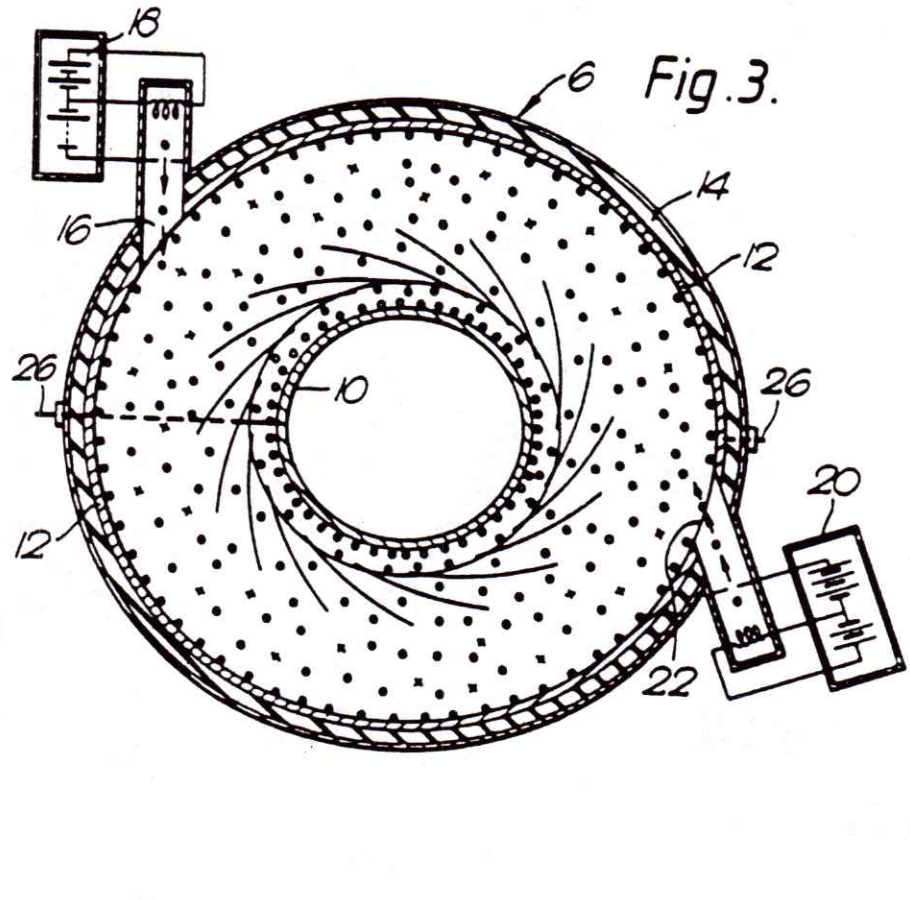


Fig. 4.

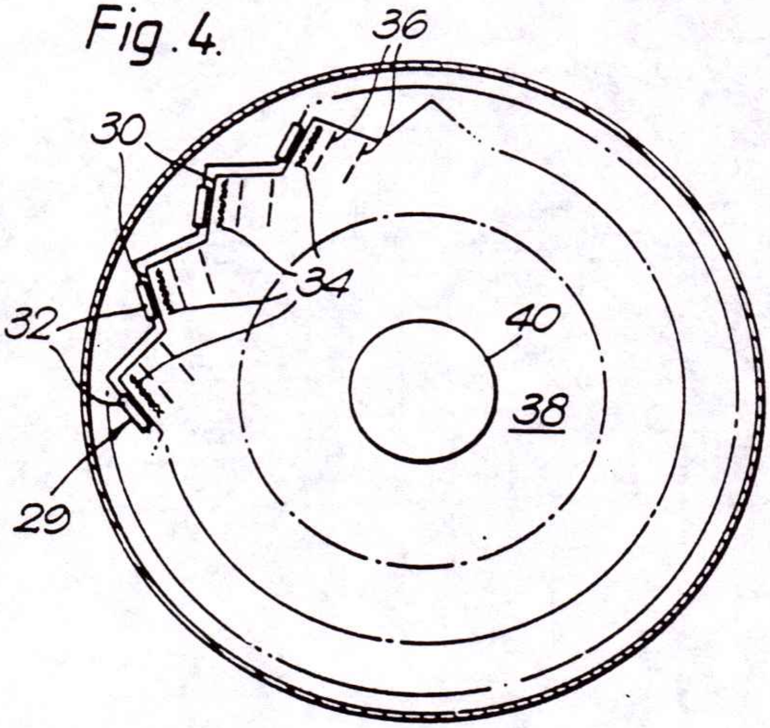


Fig. 9.

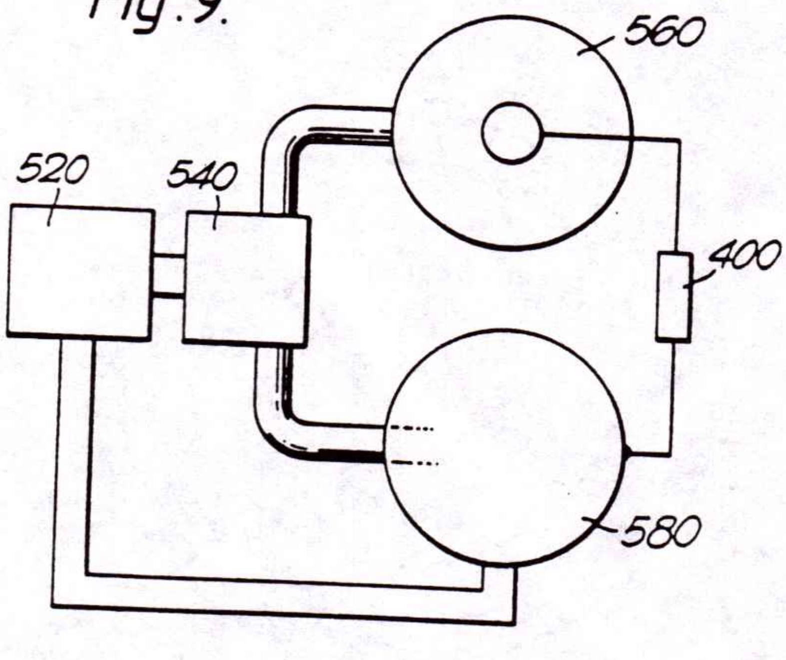


Fig. 5.

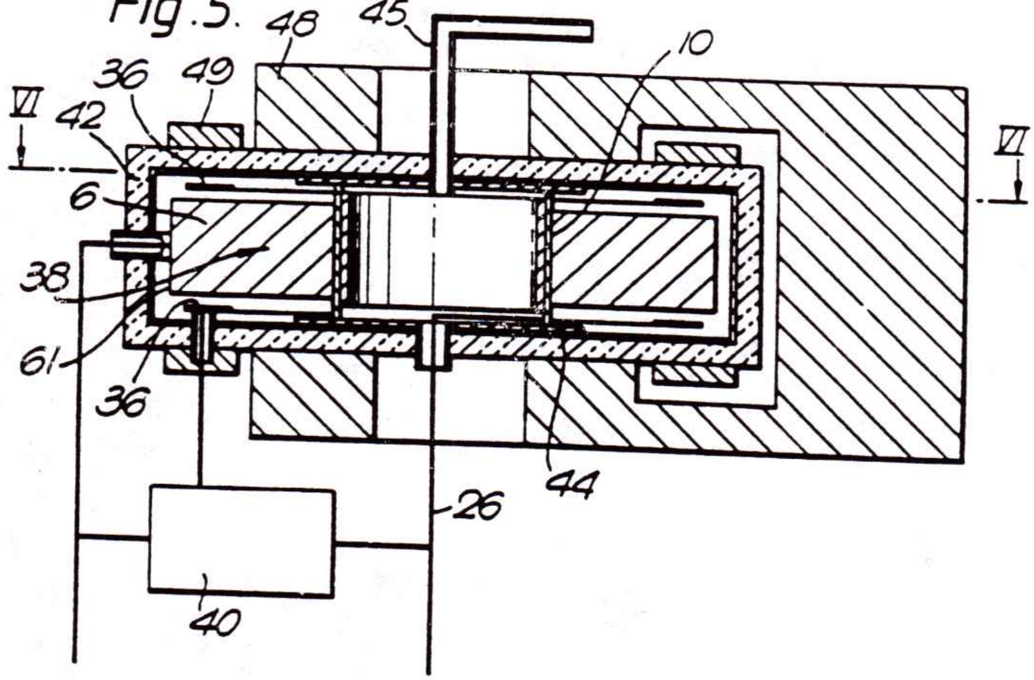


Fig. 6.

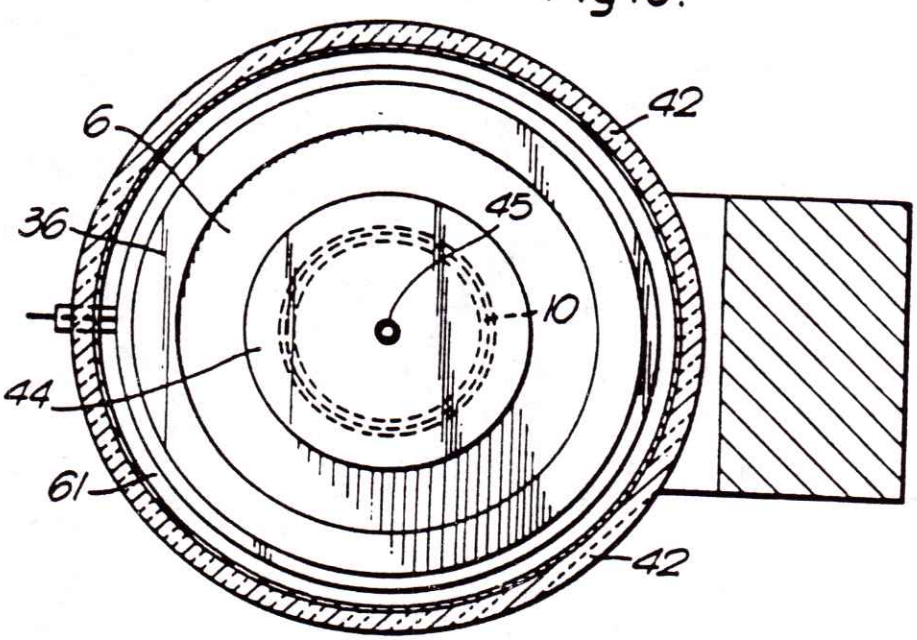


Fig. 7.

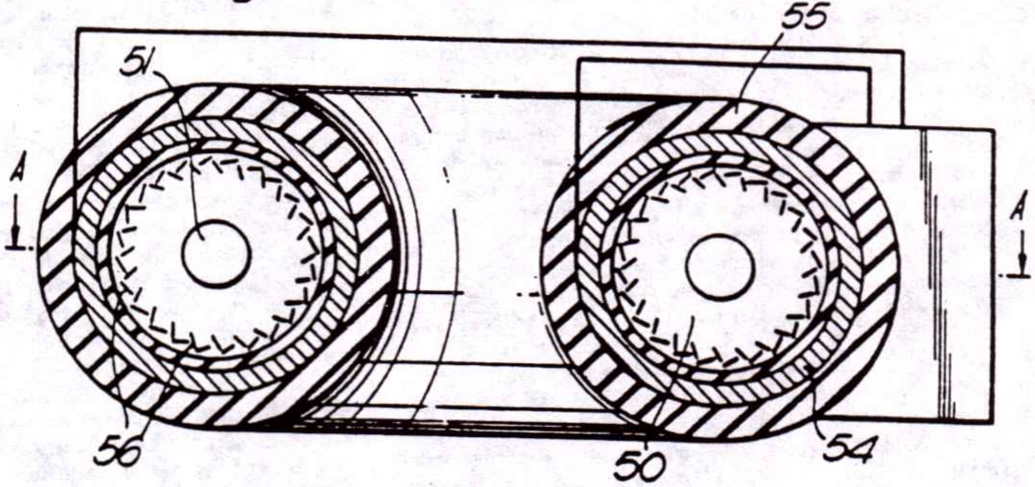
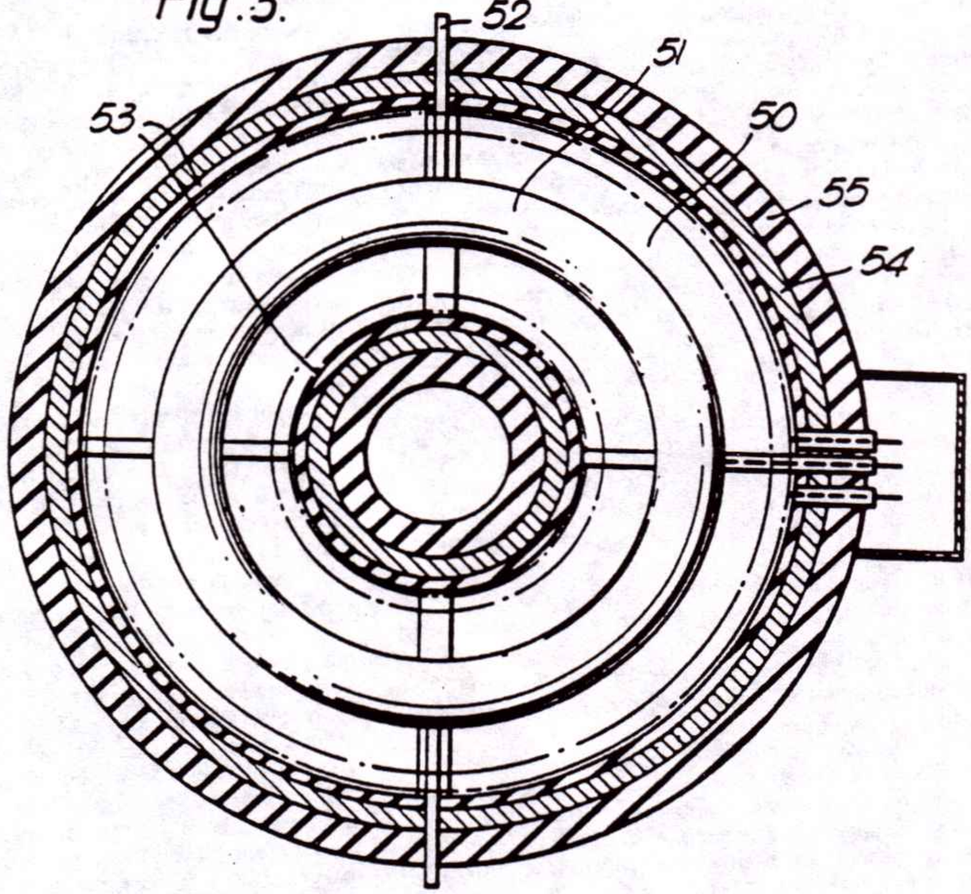


Fig. 3.



ENERGY CONVERSION SYSTEM

This invention relates to a process and apparatus for generating a potential difference between two or more electrodes and using charged particles as energy carriers.

Electrical power is usually generated by burning a fossil fuel and converting the energy released into rotary motion which drives electrical generators. This is cost-effective only if carried out on a large scale, the conversion process being inefficient; utilising natural resources, and producing waste products which can cause serious environmental pollution. An additional disadvantage is that the electrical power cannot be supplied directly to road vehicles or ships.

The energy-conversion process of this invention involves no health or pollution hazard and generates electrical power directly by a single-stage process without waste products. The overall energy-conversion factor and power-to-weight ratio are both high, making the apparatus suitable for most fixed and mobile applications.

One known apparatus for doing useful work by operating on electrons with a magnetic field is called the "betatron". This includes a doughnut-shaped vacuum chamber between the poles of a specially-shaped electromagnet. Thermionically-produced electrons are injected into the chamber with an initial electrostatic energy of about 50 keV. As the magnetic field builds up during its positivegoing half-cycle, it induces an electromotive force within the doughnut, which force accelerates the electrons and forces them to move in an arcuate path, by interaction with the magnetic field. An important distinction between the betatron and the energy cnverter of this invention is that in the former the magnetic field has got to be able to increase over a very short period, in order to accelerate the electrons sufficiently, whereas in the latter the magnetic field is virtually constant and the electrons fall inwardly to give up both their kinetic energy and electric charge to a central electrode.

The present invention aims at providing an energy converter which may be mobile and which has a permanent magnet or an energised source of magnetic radiation associated with it in order to amplify the electrical energy initially imparted to charge particles fed to, or produced in, a so-called "vacuum" chamber forming part of the generator, which increased energy is extracted from the target electrode on which the particles are incident.

Accordingly the present invention provides an energy converter which is as claimed in the appended claims.

While the invention is not to be limited to any particular theory of operation, it is based on the fact that, when a charged particle is constrained to move through a radial distance d (irrespective of the path which it actually follows) through a magnetic field of intensity H, the work done on the particle is H.d. For an electron carrying a charge e, and moving at a speed v over distance d, the total force on the electron is the centripetal force $\Sigma H.e.v$, less the force exerted on the electron in the opposite direction by the centrifugal force, which is Σmv^2r^{-1}. By making the radius of the centre electrode appreciably greater than the orbit of equilibrium, the centrifugal force can be minimised, thus maximising the

centripetal force, and hence the work done in bringing the charge to the electrode.

The process by which the converter of this invention works uses, as a source of charge, electrically-charged particles, for example electrons and/or ions. Two or more electrodes are housed in a low-pressure chamber. A magnetic field as specified below traverses the chamber: it emanates from a permanent magnet, electromagnet or a source of magnetic radiation. An external source of energy is used to give the charge particles initial kinetic energy, for example by heating, acceleration through an electric field, or from nuclear radiation. The energy-conversion process uses the magnetic field to transfer the charged particles along a desired orbit until they impinge on a central electrode (cathode). The work done on the particles (therefore the electrical potential attained by the cathode) is proportional to the resultant magnetic force times the distance over which the force acts. As the particles move within the chamber they cross the magnetic field. This produces a force acting on the particles, the force being proportional to the field strength, speed and electrical charge of the particles, and the sine of the angle of incidence between the path of the particle and the magnetic lines of force. This force has an angular component and a centripetal one, which forces the particles to travel along a spiral orbit.

An opposing centrifugal force also acts on the particles in opposition to the centripetal magnetic force. The electrode potential is proportional to the work required to be done on the charged particles to overcome both the centrifugal force and the electric field around the cathode as the charges accumulate and the potential difference between the electrodes increases. Maximum electrode potential is reached when the centrifugal and repulsive forces are equal to the centripetal force, after which no further charged particles reach the electrode. The radius of the electrode determines the minimal value voltage between the central and an outer electrode: as the central electrode radius is reduced (by sputtering or erosion) the centrifugal force increases, reducing the number of charged particles which can reach the central electrode and therefore the electrode potential, for a given field strength and particle speed. The difference in mass between ions and lighter charged particles, such as electrons, results in different centrifugal forces for given particle kinetic energies. The generator output and efficiency are optimised when the generator uses the maximum magnetic field to minimise the centrifugal force and to maximise the radial distance over which the force acts for a given field strength. Particles having the highest charge-to-mass ratio should be used.

Low pressure gases can be used as a charge source when ionised by particle collision and excitation within the chamber. Doped gases can minimise the energy level for ionising gas atoms/molecules thereby improving efficiency. However, the resultant magnetic force is lower for the heavier ions due to their lower velocity so that the electric field radiated by the high voltage electrode (cathode) can attract oppositely charged particles (+ ions) and subsequently discharge the electrode reducing the output voltage. Various methods can be used to overcome or reduce this effect. For example one method would be to separate the opposite charges and/or to use electrical biased grids to control the flow of opposite charges to the high voltage electrode.

Gaseous systems are generally more complex than single charge systems, providing higher currents at lower voltages, whereas single charge systems, for example electrons used in high vacuum chambers, can generate higher voltages.

The magnetic field can be from one or more permanent magnets and/or from one or more electromagnets; a static magnetic field produces a constant output voltage, while a varying field produces a varying voltage for particles with equal mass and velocity.

An external source is used to accelerate the charged particles to give them initial kinetic energy, which is released as heat when the particles collide with the electrode. When the energy represented by the increased voltage between the electrodes is greater than the energy required to provide the charged particles; and accelerate them, the conversion process is self-sustaining, the output energy being the difference between the sum of the kinetic energy lost and the energy generated. Charge flows from the central electrode via an external load to another electrode. The electrical energy (work) released is a function of the current (sum of charges that flow per second) times the potential difference. Electrical and thermal output can be controlled by varying: the field strength; the particle speed; the particle density (mean free path), and/or by incorporating a grid to control the rate at which particles reach the central electrode. The output is also proportional to the heat lost or gained, since the translational energy of the particle is proportional to its temperature. Heat liberated at the electrode can be returned to the particles to maintain their energy, or be utilised in a heat exchanger for external use. The generator normally uses non-reacting conductive material to prevent chemical reaction by gases, coolants etc. with the electrodes, container walls or other components. Various particle trajectories, directional movements and positioning of the orbiting particles can be used with appropriate magnetic fields. The low-pressure gas can be ionised by any suitable means: one method would be to use an electron-/ion gun where the plane and direction of the injected particles is correct for the applied magnetic field. In gas apparatus, the electrons flowing through the external circuit, on reaching the anode, recombine with a gaseous ion to form a neutral gas atom/molecule. This atomic particle is duly re-ionised by collision and/or the electric fields, the energy being directly or indirectly derived from the work done by the resultant force acting on the charged particles.

In order that the invention may be better understood, it will now be described with reference to the accompanying schematic drawings, which are given by way of example, and in which:

FIG. 1 shows schematically a cross-section of the generator; and the path followed by a particle during the energy-conversion process;

FIG. 2 shows an axial cross-section of one type of apparatus for the invention, using permanent magnets; and a grid controlling ion migration to the cathode.

FIG. 3 shows a cross-section of the apparatus of FIG. 2 along the line A—A;

FIG. 4 is a diagrammatic section through one form of converter using electrons, showing a circular series of electron sources;

FIG. 5 is an axial cross-section through a more practical embodiment of the FIG. 4 converter;

FIG. 6 is a section along the line VI—VI of FIG. 5;

FIG. 7 is a cross-section along a diameter of a doughnutshaped (toroidal) high-power converter;

FIG. 8 is a section on line A—A of FIG. 7 and

FIG. 9 is a scheme of a two-stage converter using both forms of charged particles concurrently.

As shown in FIG. 1, a charged particle is injected along a trajectory 2 into a magnetic field extending normal to the plane of the drawing. The field permeates the space 4 of the annular cross-section within a cylindrical chamber 6. The magnetic field produces on the particle a force extending normally to both its direction of motion and the magnetic field. The resultant centripetal force causes the particle to follow a spiral path 8 ending on the central electrode 10 spaced radially inwards from the outer cylindrical electrode 12. The extra energy acquired by the particle is a function of the radial distance travelled and the strength of the magnetic field between the electrodes. This energy is given up on impact with the central electrode, in the form of heat and/or work done in bringing the charge against the opposing electric field to the electrode. In the absence of the central electrode 10, the electrons would follow the orbit of equilibrium 3, this being the orbit followed by a particle when the centrifugal and centripetal forces balance, resulting in no work being done on the particle.

As shown more particularly in FIGS. 2 and 3, the energy converter 1 consists basically of a annular chamber 6 having an outer cylindrical electrode 12; an inner cylindrical electrode 10, and two gas-tight walls 14 of electrical insulation material. In the electrode 12 is a port 22 through which an electron gun 20 can inject electrons into space 4. Additionally or alternatively, an ion gun 18 can inject positively-charged particles through port 16.

Seated on the major flat surfaces of chamber 6 are magnetic pole-pieces 24 giving rise to a uniform magnetic field 80 which traverses the space 4 parallel with the axis of chamber 6. The magnets may be ceramic permanent magnets, or they may be electromagnets. In either case, means (not shown) may be provided for adjusting the magnetic field strength.

Heavy conductors 26 connect the two electrodes to terminals 28 across which a resistive load can be placed to dissipate the generator output.

A vacuum pump (not shown) has its inlet in communication with the interior of chamber 6 so that the gas pressure in the generator can be reduced to, and kept at, a desired sub-atmospheric value. Associated with the pump, or separate therefrom, may be means for ensuring that the gas in the generator is of a desired composition, for instance, one which enhances the possibility of ionising collisions between the charged particles and gas atoms or molecules. One such suitable gas would be neon containing 0.1% argon by volume.

In order to cause the generator to start working, it is necessary to start the vacuum pump and to energise the or each particle source. The latter involves heating a filament from an external source of power until the required internal energy level (temperature) is reached which in turn causes a piece of thermo-emissive material to emit electrons. If the electrons are to be the charge carriers, they are accelerated by a suitable electric field and projected into the space 4. Here they are further accelerated by the radial electric field between the electrodes, and at the same time have a deflecting force applied to them by the axial magnetic field through which they pass.

For an ion source, the electrons are accelerated until they impact some atoms or molecules, to produce a stream of ions which likewise pass into the space 4. With the polarities shown, the electrons are attracted to the central electrode, while the ions are pulled towards the outer electrode, which accounts for the different orientations of sources 18 and 20.

Any gas molecule which pass close to, or between, the electrodes are ionised by collision and/or the electrostatic field. Output current can then be taken through a load impedance connected across terminals 28. The impedance is matched to prevent the internal process energy dropping below a value which would prevent the reionisation of the gaseous atoms. As each ion is deionised at the anode, the gas atoms will tend to continue to circulate until reionised, the resultant force drawing both the ions (shown by solid circles) and electrons (shown by hollow circles) back into their respective orbits.

It is envisaged that, in the case of a converter using electrons, the chamber could be evacuated to a chosen subatmospheric pressure and sealed.

In that form of the invention shown in FIG. 4, each electron source forming one of a circular series 29 of sources has a body 30 of electroemissive material, such as molybdenum coated by caesium, heated by an electric filament 32 connected in series or parallel across a source of electric power (not shown). Immediately in front of each emitter 30 is a grid 34 of fine wires, all the grids being connected with a source of adjustable voltage so as to control the flow of electrons from the emitter. These electrons are projected through one or more acceleration electrodes 36 across which a potential difference is established along the electron path, so that each incremental electron source injects a stream of electrons having known kinetic energy into a space 38, indicated by the circle shown in a broken line, traversed by the deflection magnetic field, within which is the central, target, electrode 40. The stream of electrons injected into the magnetic field may be focussed by electric and/or magnetic fields.

In the remaining Figs, those parts already referred to will retain the same references.

In the "flat disc" configuration shown in FIG. 5, the annular chamber 6 is enclosed in a body 42 of thermal insulation material. The central electrode 10 is seated on insulators 44 which are pierced by conduits 45 for the passage of a coolant fluid and by an output lead 26, which may extend along the conduit so that it too is cooled.

FIG. 5 shows how the deflection magnet is generally U-shaped, and has two annular pole-pieces 48, so that the magnetic field is uniform between the surface of electrode 10 and the region 38 radially innermost of the circular electron source, the electric field between the electrode 36 and emission surface 61 providing the electrons initial accelerations (kinetic energy).

FIG. 5 also shows how a voltage is tapped off the resistive load 40 (which thus functions as a potentiometer) and is fed through to the acceleration electrode 36.

Chamber 6 is also provided with two annular magnets 49 (or a circular series of incremental magnets) designed to influence the direction along which the electrons pass into space 38. The magnets provide local magnetic fields to ensure that the electrons meet the boundary of space 38 tangentially, i.e. with zero radial velocity.

In that form of the invention shown in FIGS. 7 and 8 the individual "flat disc" converters of FIGS. 5 and 6 are arranged in a type of "circular" construction such that the magnetic fields extend along the axis of the resulting toroidal space 50 penetrated by a single toroidal target electrode 51 through which a coolant fluid may pass, along conduits 52. The cross-section of FIG. 8 shows that the magnetic fields are supplemented by an electric field produced by windings 53 wound on a magnetic core 54 bounded by insulation 55.

Apart from the fact that the electrodes are common to all converters, each functions individually as described above. Obviously the power source driving the heaters for the electron guns 56; the electromagnets (if any); the acceleration electrodes and the control grids, have to be of sufficient capacity to supply the greater power needed to drive this "toroidal" configuration. Concomitant changes would need to be made to the physical dimensioning and positioning of the relatively-complex construction, but as all these are within the purview of a competent engineer, they are not further described in this specification.

As already mentioned, the converters of this invention are of two types, i.e. electronic and ionic. FIG. 9 shows diagrammatically how they may be combined to take advantage of their differences. In the two-stage power generation apparatus shown in FIG. 9 the first stage consists of an ioniser 520 supplying a mixture of charged particles, i.e. ions and electrons, to a separator 540, which supplies electrons to a second stage consisting of a sealed electronic converter 560 in parallel with a gaseous ionic converter 580.

The separator 540 may use the different particle masses to separate them centrifugally using, for example, the energy conversion system of FIG. 1 (without the target electrode), or it may use electromagnetic deflection fields, or a physical diffusion process, either alone or in combination. As this is not part of the subject-matter of this invention, it will not be described herein in any further detail.

In the generators of FIGS. 6 and 8, the respective particles are deflected magnetically and accelerated radially, to function as already described above.

Because each generator is designed to operate most effectively with its particular form of charge carrier, it can be designed optimally, thus reducing the energy absorption caused by ions and electrons recombining before each has fallen on its respective target electrode. Because the electronic converter would finish up with a negatively-charged electrode, whereas the converse is true for the ionic converter, the load 400 extracting energy from the apparatus is connected across the two target electrodes. The other two electrodes of the converters may be held at the same potential, as by being connected together, or their potentials may float.

The generator can be designed to produce a wide range of output voltages and currents. The lower-energy generators are light enough to be mobile, so that they can power vehicles or act as stand-by generators. Various electrode and magnet configurations can be used, and the generators can be connected in series or parallel. Cooling jackets are fitted to prevent over-heating in high-powered apparatus, and the generator is enclosed within a thermally-insulating jacket to reduce heat losses thereby increasing particle velocities. For high-energy generators, it may be necessary to provide for forced cooling of the inner electrode, as by [illegible] projecting therefrom into a high-speed stream of suitable coolant.

Although the process according to this invention is particularly suited to using external electrical energy, it must be understood that other sources can be used to provide the initial energy input, e.g. solar and waste-processed heat are some of the varied energy sources which could be utilised. Control of the charge-generation process can be achieved by other means, including one or more electrically-biased grids, as used in thermionic valves.

I claim:

1. An energy conversion process for generating an electric potential, the process comprising; providing a source of electric charge carriers of predetermined polarity, accelerating the carriers away from the source, introducing the carriers into a magnetic field transverse to the path of the carriers in a process chamber, the field bounding an inner electrode within the chamber such that the carriers orbit the electrode while accelerating radially toward the electrode; and converting the resulting increased kinetic energy of the carriers into an electric potential at the electrode before the carriers reach an orbit of equilibrium in which the centripetal force is balanced by the centrifugal force on the carriers.

2. A process according to claim 1 in which the electric potential is created between the inner electrode and an outer electrode radially spaced from the inner electrode.

3. A process according to claim 2 in which the outer electrode provides the said source of the charge carriers.

4. A process according to claim 1 or claim 2 in which the chamber is maintained at a sub-atmospheric pressure.

5. A process according to claim 1 in which the electric potential drives a load connected between the inner electrode and a point remote from the electrode.

6. A process according to claim 1 or claim 2 in which the electric charge carriers comprise electrons or ions.

7. A process according to claim 1 in which further charge carriers of the opposite polarity traverse the magnetic field and accumulate at a second electrode to increase the potential difference between the two electrodes.

8. A process according to claim 1 in which electrically biased grids control the flow of the charge carriers from the source.

9. A process according to claim 1 in which the charge carriers are separated from charge carriers of the opposite polarity before being introduced into the magnetic field.

10. A process according to claim 9 in which the charge carriers of opposite polarity are introduced into a corresponding second magnetic field, whereby a potential difference is produced between respective electrodes in each field.

11. A process according to claim 1 in which the carriers are injected into the magnetic field.

12. A process according to claim 11 in which the injection energy is produced by accelerating the carriers through an electric field.

13. A process according to claim 11 in which the injection energy is produced by accelerating the carriers through a magnetic field.

14. A process according to claim 1 in which the injection energy of the carriers is produced by nuclear emission.

15. A process according to claim 1 in which the injection energy of the carriers is produced by heat.

16. A process according to claim 1 in which the generated electric potential is directly or indirectly used to maintain the generation of charge carriers or the internal temperature of the space traversed by the magnetic field, or the applied magnetic field.

17. A process according to claim 1 in which the generated electric potential is directly or indirectly used to maintain the generation of charge carriers and the internal temperature of the space traversed by the magnetic field and the applied magnetic field.

18. An energy converter including a source of electric charge carriers of a predetermined polarity, a process chamber having an inner electrode, means for accelerating the carriers away from the source and for introducing the carriers into the chamber, means for applying a magnetic field transverse to the path of the carriers and bounding the inner electrode of the chamber such that the carriers orbit the electrode while accelerating radially toward the electrode, the electrode being located at a radius which exceeds the equilibrium radius for the carrier mean velocity and applied field strength and intercepting the carriers such that the increased kinetic energy of the carriers due to centripetal acceleration is converted to an electric potential at the electrode.

19. An energy converter according to claim 18 in which the chamber includes an outer electrode spaced radially from the inner electrode, and means for injecting the charge carriers into the space between the electrodes.

20. An energy converter according to claim 19 in which the outer electrode provides the said source of charge carriers.

21. An energy converter according to claim 19 further comprising an insulating wall bounding the outer electrode.

22. A converter according to claim 18 further comprising means for maintaining the chamber at a predetermined sub-atmospheric pressure.

23. A converter according to claim 19 in which the outer electrode has at least one port through which the charge carriers can be injected into the chamber along a desired trajectory.

24. A converter according to claim 23 in which the outer electrode has plural ports and each port communicates with a thermionic source of the respective carriers.

25. A converter according to claim 18 in which the chamber is a vacuum chamber.

26. A converter according to claim 18 further comprising electrically biased grids for controlling the flow of charge carriers from the source.

27. A converter according to claim 22 or claim 25 in which the evacuated chamber comprises a sealed unit.

28. A converter according to claim 18 further comprising means for adjusting the strength of the applied magnetic field.

29. A converter according to claim 18 in which the chamber is filled with low pressure gas.

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