



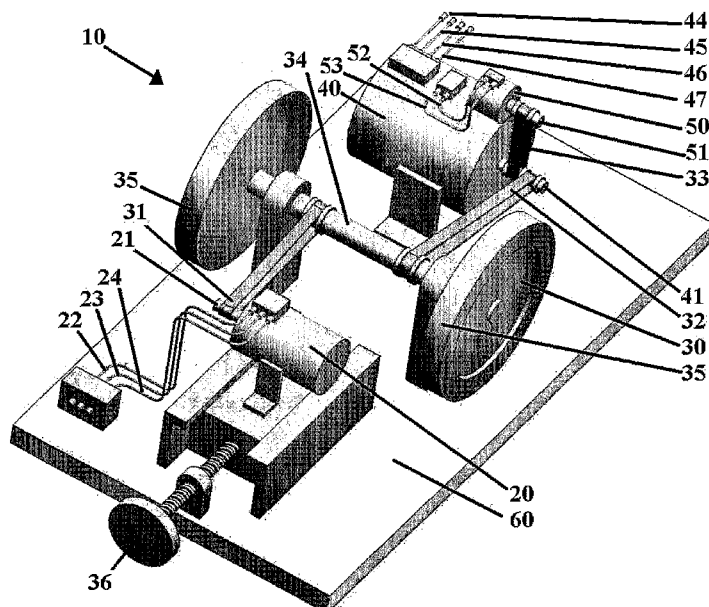
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(54) Title: ELECTRICAL GENERATOR AND ELECTRICITY GENERATION SYSTEM



(57) Abstract: The present invention relates to an electrical generator (40) and an electricity generation system (10 or 11 or 12) incorporating the generator. The generator comprises a stationary part (42) and a movable part (43), one of which (43) is deployed with magnetising means and the other (42) with coil means, such that movement of the movable part relative to the stationary part induces electrical current flow in the coil, the stationary part and the movable part metamagnetically interact to increase the electrical current flow.

FIG. 1

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# ELECTRICAL GENERATOR AND ELECTRICITY GENERATION SYSTEM

## Field of the Invention

The present invention relates to an electrical generator and an electricity generation system. More particularly, the present invention relates to an electrical generator that  
5 utilises inherent magnetic properties of its component parts to efficiently increase the quantity of generated electrical current.

## Background of the Invention

In this specification, where a document, act or item of knowledge is referred to or  
10 discussed, this reference or discussion is not an admission that the document, act or item of knowledge or any combination thereof was at the priority date:

- (i) part of common general knowledge; or
- (ii) known to be relevant to an attempt to solve any problem with which this  
specification is concerned.

15 Electromagnetic energy is an efficient mode of power transmission, due to the near light-speed velocity of the constituent electric and magnetic fields. Electricity is commonly generated at a power plant and transmitted to consumers via combinations of one or more of: step-up transformers; tie lines (being the interconnecting lines between power plants); transmission lines; step-down transformers; sub-transmission lines; high voltage primary  
20 distribution feeders and distribution transformers; and low voltage transmission lines.

Excess energy generated at the plant or during the course of transmission, typically cannot be effectively stored and is therefore normally loss as heat. It would be advantageous for electricity generation systems to service varying demands for electrical energy whilst  
25 maintaining quality and reliability standards and minimizing the generation of excess energy.

Moreover, the bulk of electrical power is currently generated from fossil fuel (including natural gas, coal, crude oil etc) combustion. Fossil fuel supplies are of course limited and the release of carbon dioxide into the atmosphere during combustion is known to contribute to global warming.

30 Therefore, it would also be advantageous to improve the efficiency of power generation to lessen the reliance on fossil fuel combustion.

Further, many power plants are connected together by tie lines into a transmission grid formation. Power stability is crucial in transmission grids, to ensure that additional demand from one location does not destabilise the grid in other locations. It is therefore also desirable for electrical generators to maintain a terminal voltage and load frequency  
5 notwithstanding varying demands for electrical power.

The choice of load frequency of either 50 Hz or 60 Hz is dependent on the standards adopted for different grids. Generators, motors, and transformers in 50 Hz systems tend to be bigger than comparable components of a 60 Hz system, whereas transmission lines and transformers for 50 Hz systems tend to achieve lower impedance ratings than 60 Hz  
10 systems.

The present invention aims to overcome or at least ameliorate one or more of the deficiencies of the prior art discusses above.

### **Summary of the Invention**

According to a first aspect of the present invention there is provided an electrical generator  
15 comprising a stator composed at least partly of a material having metamagnetic properties and having coil means connected to an external electrical load, and a rotor having an electromagnet for generating a magnetic field therein, movement of the rotor and magnetic field relative to the stator inducing electrical current flow in the coil means, the electromagnet configured to generate a magnetic field of sufficient strength to interact with  
20 a magnetic field associated with the external electrical load and induce metamagnetism within the metamagnetic material of the stator to increase electrical current flow within the coil means.

Metamagnetism is a physical state of matter characterised by a superlinear increase of magnetisation over a narrow range of magnetic field. The present invention utilises the  
25 metamagnetic properties of certain materials to increase the efficiency of electricity generation, and thereby overcomes one or more of the deficiencies of the prior art noted above.

Moreover, an electromagnet is deployed as a magnetising means on the rotor, the magnetic flux of which is controllable and adjustable to enable metamagnetic interaction to take  
30 place between the rotor and stator. Permanent magnets are not used for this purpose on the

rotor, as their magnetic flux is fixed and tends to not be strong enough to induce metamagnetism in the metamagnetic material of the stator.

Preferably, the rotor is composed at least partly of another material having non-metamagnetic properties. This is necessary in order to isolate the remainder of the rotor  
5 from the profound metamagnetic interaction occurring between the electromagnet and the stator. Typically, the other material has a higher magnetic permeability than the metamagnetic material for these purposes.

Similarly, the other material may have a fully saturated magnetic flux density irrespective of whether or not the metamagnetic material of the stator has metamagnetism induced  
10 therein. This also serves to provide additional magnetic isolation between the rotor and stator.

Materials including Permalloy, Silicon Iron, Pure Iron, Relay Steel or an iron equivalent are suitable for this purpose.

Optimally, the magnetic flux density and magnetic field strength of the metamagnetic  
15 material of the stator increases superlinearly when metamagnetism is induced therein.

According to preferred embodiments the metamagnetic material is a magnetic material that enters a metamagnetic state responsive to an applied magnetic field.

Materials such as Alnico V, Stelloy, or a Stelloy equivalent are suitable for this purpose.

Typically, the other material and metamagnetic material respectively comprise a pair  
20 selected from the group comprising: Permalloy and Alnico V; Permalloy and Stelloy; Silicon Iron and Alnico V; Silicon Iron and Stelloy; Pure Iron and Alnico V; Pure Iron and Stelloy; Relay Steel and Alnico V; Relay Steel and Stelloy; and an iron equivalent and a Stelloy equivalent.

The electromagnet may comprise first and second diametrically opposed pairs of poles.  
25 According to preferred embodiments, the poles have a cross-sectional area that applies a uniform beam of magnetic flux from each pole when the rotor is viewed in plan, and a uniform plane beam when the rotor is viewed in elevation.

The stator may take the form of a substantially hollow cylinder, with the coil means provided at selected location(s) on the interior wall thereof. The coil means may also be  
30 provided in longitudinally extending slot(s) formed in the interior wall of the hollow

cylinder. The stator may enclose the rotor so as to minimise magnetic flux leakage between the two. An outer casing may also enclose the stator.

According to preferred embodiments, the coil means comprises parallel, insulated, untwisted, thin, and circular cross-sectional multi-strand wires located within the  
5 longitudinally extending slots in a manner that each wire is subjected to a uniform magnetic flux.

Typically, the coil means are operatively connected so as to generate alternating current of a selected phase such that the part with coil means provide an overall three-phase Alternating Current (AC) output.

10 In particularly preferred embodiments, the angular velocity of the rotor, and thereby the frequency of the generated electrical current, remains substantially constant notwithstanding the metamagnetic interaction between the rotor and the stator. These embodiments are particularly suitable for addressing the power stability issues in transmission grids referred to above.

15 According to a second aspect of the present invention there is provided an electricity generation system comprising:

an electrical generator according to the first aspect of the invention;

energy supply means for supplying magnetic energy to the electromagnet and  
mechanical energy to the rotor, said magnetic energy and mechanical energy being  
20 supplied to the generator independently of the electrical current generated by the generator.

The energy supply means may comprise:

a motor; and

a belt assembly operatively connecting the rotor to the motor, rotating motion of the motor being transferred to the rotor via the belt assembly.

25 Alternatively, the energy supply means may comprise:

a motor; and

a transmission assembly operatively connecting the rotor to the motor, rotating motion of the motor being transferred to the rotor part via the transmission assembly .

Alternatively, the energy supply means may comprise:

a motor;

a gear train assembly operatively connecting the rotor to the motor, rotating motion of the motor being transferred to the rotor via the gear train assembly;

5 a DC power source driven by the gear train assembly; and

a relay switch or a Switchgear operatively connecting the electromagnet to the DC power source.

The electricity generation system may further include an adjuster for connecting the belt assembly, gear train or transmission assembly to the motor so as to overcome inertia of  
10 movable parts during system start-up.

According to preferred embodiments, the adjuster is a clutch that is configured to selectively engage or disengage the motor to and from the belt assembly, gear train or transmission assembly.

The electricity generation system may further include a counterweight in the belt assembly,  
15 gear train or transmission assembly for ensuring that movable parts are in static and dynamic balance and to smooth out any jerk or slack encountered during motion of movable parts.

Typically, the motor is an AC motor rather than a diesel engine or the like. This enables the electricity generation system to be cascaded. Use of a belt assembly or a transmission  
20 assembly ensures the motor is not connected directly to the electrical generator. An indirect connection enables the motor to gain a desired rotational speed and power before it is coupled to the electrical generator.

In other words, during system start-up, the electrical generator is mechanically and electrically isolated from the motor. Once coupled, the gear-ratio in the belt assembly or  
25 transmission assembly provides a means to allow the motor to rotate at high speed and also to enable the electrical generator to turn at either 25 Hz or 30 Hz (due to the use of a four-pole rotor that provides two cycles of voltage per revolution).

The counterweight of the belt assembly and the gear train of the transmission assembly each provide a dynamic balance between the motor and the electrical generator. At steady  
30 state, conservation of angular momentum enables the counterweight of the belt assembly

and the gear train of the transmission assembly to smooth out any jerk or slack that may be encountered from the movable parts.

Embodiments of the electricity generation system that include a gear train assembly, the gears are typically threaded firmly and secured by lock nuts on the motor shaft. In turn  
5 these gears mesh with other gears that are also threaded and secured by lock nuts onto the shaft of the electrical generator.

The motor can be seen as being in direct mechanical connection with the electrical generator via the gear train.

Alternatively, a single plate clutch can be adopted to connect the motor shaft and the  
10 respective gears, to allow a time delay in the form of limited slip, to enable the motor to build up speed during system start-up.

When the relay switch (or Switchgear) is inactive, no electrical supply is provided for the electromagnet of the electrical generator, and Faraday's Law of electromagnetic induction therefore cannot take place. The inactive state of the relay switch (or Switchgear) ensures  
15 that the electrical generator is electrically isolated at system start-up, such that the motor need only overcome the inertia of the rotor inside the electrical generator.

When the rotor has attained a desired rotational speed, the relay switch (or Switchgear) is activated to produce three-phase AC output via Faraday's Law of electromagnetic induction.

20 The gear train also provides a dynamic balance between the motor and the electrical generator. At steady state, conservation of angular momentum enables the gear train to smooth out any jerk or slack associated with the various moving parts.

According to a third aspect of the present invention there is provided an integrated electricity generation system comprising two or more operatively connected electricity  
25 generation systems according to the second aspect of the invention, so as to increase the electrical output of a single unit.

The electricity generation systems may be connected in series, parallel or in a combination of the two.

According to a fourth aspect of the present invention, there is provided an electrical  
30 distribution network including one or more electricity generation systems according to the

second aspect of the invention configured so as to provide power stability to selected parts of the electrical distribution network.

According to a fifth aspect of the present invention, there is provided an automotive engine including one or more electrical generators according to the first aspect of the invention.

- 5 According to a sixth aspect of the invention there is provided a marine vessel including an automotive engine according to the fifth aspect of the invention.

According to a seventh aspect of the invention, there is provided an electricity generation system comprising two or more operatively connected electrical generators according to the first aspect of the invention.

## 10 **Brief Description of the Drawings**

The present invention will now be further explained and illustrated by reference to the accompanying drawings in which:

Figure 1 is a perspective view of an electricity generation system according to a first embodiment of the present invention;

- 15 Figure 2 is a cross-sectional schematic view of the electrical generator component of the system illustrated in Figure 1;

Figure 3 is a schematic illustration of the stator coils of the generator generation, shown connected in a Y-connection;

- 20 Figure 4 is a close up view of the electrical generator illustrated in Figures 1 and 2 running at no or negligible load;

Figure 5 is a close up view of the electrical generator illustrated in Figures 1 and 2 the flux created when the stator runs at full load;

Figure 6 is a close up view of the flux distribution during metamagnetic interaction between the stator and rotor of the electrical generator;

- 25 Figure 7 is a schematic illustration of stimulated emission of magnetic fields within the stator's magnetic material;

Figure 8 is an isometric view, partly in cross section, of a rotor turning inside a cylindrical stator, wherein both the rotor and stator include thin, insulated laminations of magnetic material.

Figure 9 shows the saturation curves of a particular conjugate pair of a non-metamagnetic material and a metamagnetic material.

Figure 10 shows the presence of large eddy currents induced in the magnetic structures of the electrical generator without thin, insulated laminations.

5 Figure 11 shows the reduction in eddy currents when the magnetic structures of the electrical generator are split into thin, insulated laminations.

Figure 12 is an elevation view, partly in cross section, of an electricity generation system according to a second embodiment of the present invention;

10 Figure 13 is a flow chart showing the operation of a control unit with touch-screen display suitable for use with the electricity generation system according to the second embodiment of the present invention.

Figure 14 is a perspective view of an electricity generation system according to a third embodiment of the present invention.

15 Figure 15 is an elevation view of a single plate clutch that connects a shaft of a Prime Mover to a respective gear of a gear train.

Figure 16 is a pictorial sectional view of a friction plate used inside the single plate clutch illustrated in Figure 15.

20 Figure 17 is a flow chart showing the operation of a control unit with touch-screen display suitable for use with the electricity generation system according to the third embodiment of the present invention.

### **Detailed Description of the Drawings**

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout several views and more particularly to Fig. 1, wherein the electricity generation system 10, according to the present invention includes Prime Mover  
25 20, Conveyor-belt System 30, Electrical generator 40, Exciter 50, and Platform 60.

The electrical generator 40 takes the form of a Meta-magnetic Effect Dynamo.

30 Prime Mover 20 is an AC (Alternating Current) Motor. The alternating current (AC) provided from an external power source is used to generate mechanical torque to rotate a magnet in a coil of wire, or rotate a coil of wire inside a powerful magnet. In either case, the generated mechanical torque is used to rotate the Shaft 21 of Prime Mover 20. While

only one type of Prime Mover 20 is shown, the Prime Mover 20 could also be a single-phase Alternating Current (AC) Motor, or a DC (Direct Current) Motor with a DC to AC Converter for its electrical input power.

Adoption of an AC Motor for Prime Mover 20 enables the entire electricity generation system of the present invention to be cascaded.

The input power cables 22, 23, 24 of Prime Mover 20 can be connected to an external generator such as a fossil fuel-fired steam turbine, a natural gas-fired steam turbine, a hydro-generator, a diesel engine, a petrol engine, a steam engine, a Fuel-cell Generator, an AC or DC generator that uses alternative sources of energy (such as solar, wind, hydro-electric, wave energy, or biomass), and any electricity generation unit that can provide the required AC or DC power to drive Prime Mover 20 used in the present invention.

Conveyor-belt System 30 uses conveyor belts to transfer the rotational energy from Prime Mover 20 to Meta-magnetic Effect Dynamo 40 and Exciter 50. Conveyor-belt 31 connects Shaft 21 of Prime Mover 20 to the Intermediate Shaft 34. Conveyor-belt 32 connects the Intermediate Shaft 34 to the Shaft 41 of Meta-magnetic Effect Dynamo 40. Conveyor-belt 33 connects the Shaft 41 of Meta-magnetic Effect Dynamo 40 to the Shaft 51 of Exciter 50. Intermediate Shaft 34 ensures the Shaft 41 of Meta-magnetic Effect Dynamo 40 turns at either 25 Hz or 30 Hz (due to the use of a four-pole Rotor that provides two cycles of voltage per revolution) when driven by Shaft 21 of Prime Mover 20.

Counter-weight 35 ensures the operation of the Conveyor-belt system 30 is both statically and dynamically balanced. Adjuster 36 serves as a Clutch. It is loosened to disengage Prime Mover 20 from Conveyor-belt system 30 in order for Prime Mover 20 to attain the required idling rotational speed when it is first started. It is tightened to engage Prime Mover 20 to Conveyor-belt system 30 when the required idling rotational speed is established.

Exciter 50 is an Alternator that generates the DC power needed by Meta-magnetic Effect Dynamo 40. It consists of three major components: the rotor, the stator, and the rectifier bridge with regulator. The principle of AC generation in Alternator is motion between magnetic lines of force, and conductors will induce electrical pressure (AC Voltage). In the Alternator, the rotor will supply the magnetic lines of force, and the Conveyor-belt 33 spinning the rotor will supply the motion. The generated AC power is converted into DC power by the rectifier bridge with regulator. DC Power generated by Exciter 50 is

supplied to Meta-magnetic Effect Dynamo 40 via Output Power Cable 53 (Positive DC Voltage) and Output Power Cable 52 (Ground).

While only one type of Exciter 50 is shown, Exciter 50 can be any DC power source including a battery or a fuel cell.

- 5 Meta-magnetic Effect Dynamo 40 is a synchronous machine that is driven by Conveyor-belt 32. It uses a metamagnetic effect to generate power from within the magnetic structure of its Stator 42.

Fig. 2 illustrates the Meta-magnetic Effect Dynamo 40. Two principal parts of a synchronous machine are magnetic structures. The stationary part that is essentially a  
 10 hollow cylinder, called the Stator 42, has longitudinal slots in which there are coils of Stator windings. These windings carry the current supplied to an electrical load. Rotor 43 is the part of the machine that is mounted on the shaft and rotates inside the hollow Stator 42. The winding on Rotor 43, called the field winding, is supplied with DC current from Exciter 50.

- 15 Rotor 43 is a single, longitudinal block with a uniform four-pole cross section area as shown in Fig. 8.

Rotor 43 has four poles and two cycles of voltage are generated in each coil per revolution. Since the number of cycles per revolution equals the number of pairs of poles, the frequency of the generated voltage is derived from the following equation:

20  $f = (P / 2) * (N/60) = (P/2) * f_m \text{ Hz}$

where,

$f$  = electrical frequency in Hz

$P$  = number of poles

$N$  = Rotor speed in revolutions per minutes (rpm)

- 25  $f_m = N/60$ , the mechanical frequency in revolutions per second (rps), it is the frequency of Shaft 41 driven by Conveyor-belt 32.

Therefore, when the four-pole Rotor 43 turns at 25 Hz (where  $P = 4$ ,  $N/60 = 25$ ), the electrical frequency  $f$  is:

$$f = 4/2 * 25 = 2 * 25 = 50 \text{ Hz}$$

At 30 Hz, the electrical frequency  $f$  is:

$$f = 4/2 * 30 = 2 * 30 = 60 \text{ Hz}$$

As shown in Fig. 2, opposite sides of Stator 42's Coil, are in  $a$  and  $a'$  180 degree apart.

5 Similar coils are in slots  $b$  and  $b'$  and  $c$  and  $c'$ . Coil sides in slots  $a$ ,  $b$ , and  $c$  are 60 degree apart. The two coils of each phase may be connected in series or in parallel. Fig. 3 shows the Y-connection of Stator 42's Windings where two coils of each phase is connected in series. The Y-connection Stator 42's Windings enables three-phase AC Power to be generated as output. The conductors shown in the slots indicate a coil of only one turn, but  
10 such a coil may have many turns as shown in Fig. 8.

Whenever a magnetic flux (symbol  $\Phi$ ) exists in a body or a component, it is due to the presence of a magnetic field strength (symbol  $H$ ), given by

$$H = U / l$$

15 Where

$H$  = magnetic field strength [A/m]

$U$  = magnetomotive force (mmf) acting on the component [A] or [ampere turn]

$l$  = length of the component [m]

The resulting magnetic flux density (symbol  $B$ ) is given by

$$20 \quad B = \Phi / A$$

Where

$B$  = magnetic flux density [T]

$\Phi$  = flux in the component [Wb]

$A$  = cross section of the component [m<sup>2</sup>]

25 There is a definite relationship between the magnetic flux density (symbol  $B$ ) and the magnetic field strength (symbol  $H$ ) of any material. This relationship is usually expressed graphically by the B-H curve of the material as shown in Fig. 9.

In Fig.4, Meta-magnetic Effect Dynamo 40 runs at no load. The small current induced in the Stator 42's Windings does not appreciably affect the flux  $\Phi_1$  coming from the pole.

In the presence of an electrical load or loads, the Stator 42 carries its normal current. It produces a strong magneto-motive force that, if it acted alone, would create flux  $\Phi_2$  as shown in Fig 5.

By superimposing  $\Phi_1$  and  $\Phi_2$ , the resulting flux  $\Phi_3$  is obtained as shown in Fig. 6. The flux density of flux  $\Phi_3$  increases at region A and decreases at region B. Thus, a strong resultant magnetic flux (or Magnetic Flux Density with symbol B) is established at region A.

There are five stages associated with the spontaneous magnetic field emission in Electrical Generator 40. Stage 1 is a typical Faraday Law of electromagnetic induction from the Rotor 43 to Stator 42 and the magnetic flux is directed from Rotor 43 to Stator 42 as shown in Fig 4. In Stage 2, additional magnetic flux from current flow (due to the presence of an external load) in the coil means of Stator 42 is directed from Stator 42 to Rotor 43 as shown in Fig 5. In Stage 3, the magnetic flux from Stage 1 interacts with the additional flux from Stage 2 to form a strong resultant magnetic flux (or magnetic flux density with symbol B) that is directed from Rotor 43 to Stator 42 as shown in Figure 6. As the strong magnetic flux penetrates the metamagnetic materials in Stator 42, the definite relationship between magnetic flux density and magnetic field strength causes a very strong magnetic field strength (with symbol H) to be present inside the metamagnetic material of Stator 42. In Stage 4, as shown in Fig 7, this incident magnetic field (symbol H) causes transitions between two energy levels in a magnetic atom where the transition is from E1 to E0 with additional identical and coherent magnetic fields radiated to trigger other magnetic atoms. The discrete energy level between E1 and E0 means that a magnetic atom can only absorb or emit energy in definite amounts and not continuously. This explains why the external applied magnetic field must be of a certain and narrow range. In Stage 5, these coherent magnetic fields within Stator 42 are transformed instantaneously into a strong current flow in the coil means of Stator 42. The relationship between the strong current in Stator 42's windings and these coherent magnetic fields can be established via the application of Ampere's law. Ampere's Law states that magnetomotive force (symbol U) around a closed path of a component is given by the following line integral:

$$\oint_c H \cdot dl = i$$

Where

$i$  = induced current passes through the area bounded by the closed path

$H$  = magnetic field strength

- 5  $H \cdot dl$  = product of the tangential component of  $H$  and the incremental distance  $dl$  along the path

In other words, the magnetic energy associated with the enhanced magnetic field is being absorbed and converted into electrical energy by the Stator 42's windings, resulting in more electrical power being generated (in the presence of electrical loads) as compared  
10 with the input power supplied to the Prime Mover 20. As the stimulated magnetic fields are coherent to each other, the "extra" AC power generated is in phase with each other and is of the same frequency (50 Hz or 60 Hz). Thus, the generated AC output power is clean and not noisy.

Besides, the strong magnetic flux (generated in Stage 3) from each pole of Rotor 43 is a  
15 thin beam when view from the cross-sectional side of Electrical Generator 40 and as a uniform plane beam when view from the elongated side of Electrical Generator 40. As the coil means of Stator 42 are subjected to such a strong and uniform magnetic flux, multi-stranded copper wires that are small, untwisted and parallel to each other are used as shown in Fig. 8. Besides, the use of small and circular cross-sectional wire as compared  
20 with a single circular wire or a single flat wire has the advantage of having more surface area for AC current transmission. Each wire is insulated via enamel coating.

In this present prevention, Stator 42 is made of magnetic material or any alloy that can be stimulated by metamagnetic effect relative to the magnetic material used in Rotor 43. Metamagnetic effect is a physical state of matter (such as the magnetic material of Stator  
25 42) characterized by a super-linear increase of magnetization (stimulated emission of magnetic fields within that matter) over a narrow range of an external applied magnetic field (brought about by Magnetic Flux  $\Phi_3$  at region A in Fig. 6).

The characteristic feature of Stator 42's magnetic material is due to the presence of magnetic domains. A magnetic domain is a region of crystalline matter, whose volume  
30 may be between  $10^{-12}$  and  $10^{-8} \text{ m}^3$ , which contains atoms whose magnetic moments are

aligned in the same direction. The magnetic moment of a magnetic atom results from the spin of electrons in an unfilled inner shell of the atom. The formation of a magnetic domain depends upon the strong inter-atomic forces (exchange forces) that are effective in a crystal lattice containing magnetic atoms.

- 5 In unmagnetized volume of a Stator 42's specimen, the magnetic domains are arranged in a random fashion with their magnetic axes pointing in all directions so that the specimen has no resultant magnetic moment.

Under the influence of a magnetic field, those magnetic domains whose magnetic axes have directions near to that of the field grow at the expense of their neighbours. In this  
10 process, the atoms of neighbouring magnetic domains tend to be aligned in the direction of the field but the strong influence of the growing magnetic domains causes their axes to align parallel to its magnetic axis. The growth of these magnetic domains leads to a resultant magnetic moment and hence magnetization of the specimen in the direction of the field.

- 15 However, a very strong applied magnetic field triggers stimulated emission within the Stator 42's specimen. Fig. 7 shows the transitions between two energy levels in a magnetic atom by stimulated emission, in which an incident magnetic field (symbol H) causes a transition from E1 to E0. In stimulated emission, the radiated magnetic fields are exactly in phase with the incident ones, so the result is an enhanced beam of coherent magnetic fields  
20 and these coherent magnetic fields are converted instantaneously into a strong current flow in Stator 42's windings via the application of Ampere's law.

In other words, the magnetic energy associated with the enhanced magnetic field is being absorbed and converted into electrical energy by the Stator 42's windings, resulting in more electrical power is being generated (in the presence of electrical loads) as compared  
25 with the input power supplied to the Prime Mover 20.

The enhanced beam of coherent magnetic field enables the present invention to be used as a device for power stability in an electrical distribution network or in a national grid. When there is a larger load demand, the coherent nature of enhanced magnetic field enables additional electrical power to be generated with no change in phase angle or frequency (50  
30 Hz or 60 Hz). In this way, unanticipated output can be catered for and at the same time, unexpected power trip due to power instability can be avoided.

Law of Conservation of Energy is preserved in this present invention as the “excess” electrical energy with respect to the input energy at Prime Mover 20 is generated from within the Stator 42’s magnetic material. The electric attraction between an electron and a proton is in the order of 1039 times greater than the gravitational attraction between them.

5 Thus, a small change in the character of these forces due to relative motion, which is what magnetic forces represent in this present invention, can have large consequences in term of electrical output power. Besides, the coherent magnetic flux means that the “excess” AC power generated is in phase with each other and at the same frequency (50Hz or 60 Hz).

In this present invention, Rotor 43 is made of magnetic material that is invariant to  
10 metamagnetic effect. The enhanced magnetic flux in Stator 42 causes saturation to set in pole tip of region A. The increase of flux under the left side of the pole, region A, is only slightly more than the flux when the Meta-magnetic Effect does not take place. Consequently, the magneto-motive force does not increase appreciably in the presence of strong magnetic flux within the Stator 42 at region A, resulting in a constant rotating speed  
15 of Rotor 43 that does not increase with electrical loads.

Fig. 9 shows the characteristics of a particular conjugate pair of magnetic material that is applicable for the Electrical Generator 40. The magnetic material used in the magnetising means must be non-metamagnetic relative to the regions entering the metamagnetic state. Non-metamagnetic material is characterized by adoption of magnetic material such as  
20 “Permalloy” with high relative permeability (with curve originated more to the left of Fig 9) and its magnetic flux density must be saturated prior and during the regions of the other part with coil means (that uses “Alnico V”) entering a metamagnetic state.

When the resultant magnetic flux in Stage 3 (as shown in Fig 6) brings about an incident magnetic field of strength at Point C, it will trigger Metatmagnetic Effect. Between Point C  
25 and Point D is the range (or amount) of magnetic field strength that can be stimulated via Metamagnetic interaction. As the emitted magnetic fields are converted into current instantaneously, the amount of magnetic field to be stimulated from the range (between Point C and Point D) will be dependent upon the amount of current needed by the external load.

30 As “Permalloy” reaches saturation at between Point C and Point D, the spontaneous and super-linear increase in Magnetic Fields within Stator 42 does not affect Rotor 43, resulting in a constant rotating speed of Rotor 43 that does not increase with electrical

loads. Rotor 43 is said to be "isolated" from the excessive magnetic flux across the narrow air gap between each pole and its adjacent Stator's region. Other conjugate pairs such as "Permalloy and Stelloy", "Silcon Iron and Alnico V", "Silicon Iron and Stelloy", "Pure Iron and Alnico V", "Pure Iron and Stelloy" are applicable in this regard.

5 Reducing eddy current is an important consideration for Electrical Generator 40. In Fig. 10, the magnetic structures in both Rotor 43 and Stator 42 are constructed as a single solid magnetic block. When a magnetic flux  $\Phi$  passes through this magnetic block, it is basically equivalent to a densely packed set of rectangular conductors touching each other. Eddy currents swirl back and forth inside the block, following the paths shown in the figure.

10 These eddy currents can be very large due to the low resistance of the block. These eddy currents produce large  $I^2R$  (where symbol I is the induced eddy current and symbol R is the resistance of the magnetic block) losses that are immediately converted into heat. The power loss is proportional to the square of the rotational speed and the square of the magnetic flux density (symbol B). Consequently, the large magnetic block that is  
15 penetrated by magnetic flux  $\Phi$  can become very hot (even at a frequency of 50 Hz or 60 Hz), resulting in overheating (also known as eddy-current losses).

Eddy currents can be reduced tremendously by splitting the magnetic block into thin and insulated laminations as shown in Fig. 11. As the section in each lamination is a fraction of the entire uncut block, the voltage induced is also a fraction of that induced in the entire  
20 block, with the result that the eddy currents and the corresponding losses are considerably reduced. For a given magnetic block, the eddy-current losses decrease in proportion to the square of the number of laminations. In the present invention, the magnetic structures of both Rotor 43 and Stator 42 are composed of stacked laminations with a fraction of a millimetre thick. Epoxy/resin is the insulating material used by these laminations.

25 Turning to Fig. 1, conveyor-Belt System 30 as a whole ensures the input power of the present invention is electrically isolated from its output power. Exciter 50 is driven mechanically by Conveyor-belt 33 from Shaft 41 of Meta-magnetic Effect Dynamo 40. Shaft 41 of Meta-magnetic Effect Dynamo 40 is in turn driven mechanically by Conveyor-belt 32. Exciter 50 does not use the electrical output power of Stator 42. The fact that  
30 magnetic saturation sets in at the tip of each pole during Meta-magnetic Effect means that apart from the magneto-motive force needed to turn the Rotor 43, Rotor 43 is "isolated" from excess magnetic flux across the narrow air gap between the each pole and its adjacent

Stator 42's region. Therefore, two electrical reference frames are established, one is DC Circuit (that includes Exciter 50 and Rotor 43) for generating the Magneto-motive Force needed by Rotor 43, and the other is the three-phase AC Circuit (that includes the Stator 42's windings and external loads) for generating the Electric Output Power needed by external electrical loads. The establishment of two Electrical Reference Frames in this present invention ensures Conservation of Electric Charge is preserved in each frame. Otherwise, discrepancy occurs when the electric charges in Rotor 43's field windings are less than (that is, not equal) to the electric charges in Stator 42's windings.

Another important feature for the electrical isolation brought about by the establishment of two electrical reference frames enables the Electrical Output via output power cables 44 (Live L1), 45 (Live L2), 46 (Live L3), and 47 (Neutral) of this present invention to be increased further by cascading a group of present inventions in series to increase the output voltage, by connecting a group of present inventions in parallel to increase the output current, or adopting an integrated configuration as a mixture of series and parallel connections to increase the overall voltage and current as needed by an electrical distribution network.

The electrical isolation brought about by the establishment of two electrical reference frames also enables a plurality of single systems or integrated systems to increase the power or to provide power stability in each part of an electrical distribution network or a national grid.

Table 1 illustrates a set of measurement data of an electricity generation system according to this first embodiment of the present invention. Steps 1 to 4 are the initialisation steps needed to power up the electricity generation system. Steps 4 to 8 illustrate the "Power Stability Zone" of Generator 40. In this zone, the angular velocity of the rotor 43 and thereby the frequency of the generated electrical current remains substantially constant under different load conditions. It is important to note that in this zone, there is no need to control the speed of Prime Mover 20 to match the variations in external electrical load connected to the output cables of Electrical Generator 40. In fact, no external control is needed in this zone, the metamagnetic interaction within Stator 42 responds to the variations of external electrical load directly. Besides, further cooling is not needed when operating in Power Stability Zone as both the Prime Mover 20 and Rotor 43 of Electrical Generator 40 are running at their normal and steady speed

Step 9 to 11 illustrates the “Power Enhancement Zone” of Generator 40. In this zone, additional power is needed by Prime Mover 20 in order to maintain the angular velocity of the rotor 43 with respect to increasing load at output of Generator 40.

As shown in Fig. 9, the saturation curve of any magnetic material becomes asymptotic to the B-H curve of vacuum where H is high. The B-H curve of vacuum is a straight line. A vacuum never saturates, no matter how great the flux density may be. Nonmagnetic materials such as copper, paper, rubber, and air have B-H curves almost identical to that of vacuum. Therefore, Prime Mover 20 needs additional power in “Power Enhancement Zone” to produce additional H needed as the magnetic materials used in Electrical Generator 40 approaching the characteristics of vacuum in this particular zone.

Step	Description	Input Power to rated 5 HP Prime Mover 20 according to a first embodiment of the present invention.	Output Power from Generator 40 according to a first embodiment of the present invention.
1.	Activation of Prime Mover 20 with Exciter 40 off and Adjuster 36 fully loosened.	1.65 KW	0 KW
2.	Gradual Tightening of Adjuster 36 to turn Intermediate Shaft 34 and Counterweight 35 from 0 rpm to just before 1500 rpm. Exciter 40 is still OFF.	1.65 KW to 2.8 KW	0 KW
3.	Stop tightening of Adjuster 36 when Intermediate Shaft 34 and Counterweight 35 attain 1500 rpm. Exciter 40 is still OFF.	1.65 KW	0 KW
4.	ON Exciter 40.	1.65 KW	0 KW -- “No Load” condition
5.	5 KW Load to output terminals of Generator 40.	1.65 KW to 1.7 KW	5 KW
6.	10 KW Load to output terminals of Generator 40.	1.65 KW to 1.7 KW	10 KW
7.	15 KW Load to output terminals of Generator 40.	1.65 KW to 1.7 KW	15 KW
8.	20 KW Load to output terminals of Generator 40.	1.65 KW to 1.7 KW	20 KW
9.	25 KW Load to output terminals of	2.5 KW to 2.6 KW	25 KW

	Generator 40.		
10.	30 KW Load to output terminals of Generator 40.	3.2 KW to 3.5 KW	30 KW
11.	35 KW Load to output terminals of Generator 40	3.7 to 3.8 KW	35 KW

Table 1

Turning to Fig. 12, wherein the electricity generation system 11, according to another embodiment of the present invention is shown. The system includes Prime Mover 20, Transmission Assembly 70, Electrical Generator in the form of a Meta-magnetic Effect  
 5 Dynamo 40, Exciter 50, Platform 60, and a Control Unit with touch-screen display 80.

Prime Mover 20 is an AC (Alternating Current) Motor. The alternating current (AC) provided from an external power source is used to generate a mechanical torque by means of a rotating magnet in a coil of wire, or by a rotating coil of wire inside a powerful magnet. In either case, the generated mechanical torque is used to rotate the Shaft 21 of  
 10 Prime Mover 20. Prime Mover 20 receives its AC input power via Input Power Cables 22 (Live L1), 23 (Live L2) and 24 (Live L3). While only one type of Prime Mover 20 is shown, in reality, the Prime Mover 20 can be a single phase Alternating Current (AC) Motor or a DC (Direct Current) Motor with a DC to AC Converter for its electrical input power.

15 The Input Power Cables 22 (Live L1), 23 (Live L2) and 24 (Live L3) of Prime Mover 20 can be connected to an external generator such as a fossil fuel-fired steam turbine, natural gas-fired steam turbine, a hydro-generator, a diesel engine, a petrol engine, a steam engine, a Fuel-cell Generator, an AC or DC generator that uses alternative sources of energy (such as solar, wind, hydro-electric, wave energy, or biomass), and any electricity generation unit  
 20 that can provide the required AC or DC power to drive Prime Mover 20 used in the present invention.

Prime Mover 20 does not develop its full power when it is running slowly. It has to be rotating fairly fast before it develops its maximum power and torque. Thus, the Transmission Assembly 70 provides a mean to allow the Shaft 21 of Prime Mover 20 to  
 25 revolve at high speed to produce the desired power on one hand and allow its Output Shaft 74 to turn at slower speed on the other hand to ensure Shaft 41 of Meta-magnetic Effect Dynamo 40 turns at 25 Hz or 30 Hz (due to the use of a four-pole Rotor that provides two

cycles of voltage per revolution). The speed reduction is achieved via the Planetary Gear Set 73. Shaft 21 of Prime Mover 20 is connected to Shaft 72 of Torque Converter 71.

Torque Converter 71 serves as a fluid coupling device and it offers the following advantages: [a] Absence of direct mechanical contact between the driving and driven members minimizes the transmission of shock and torsional vibration between Prime Mover 20 and Transmission Assembly 70; [b] no positive disengagement or engagement of drive allows smoother starting characteristic; [c] protects against harmful labouring of Prime Mover 20 at low speed, since the fluid coupling will merely slip and allow Prime Mover 20 to increase speed when overloaded.

10 The Output Shaft 74 is coupled to Shaft 41 of Meta-magnetic Effect Dynamo 40. Power Take Off (PTO) 75 is coupled to Shaft 51 of Exciter 50.

Electronic Assembly (EA) 77, also known as Transmission Control Unit, is the brain of Transmission Assembly 70. It is connected to Transmission Assembly 70 via a Signal Cable 76. While only one type of Transmission Assembly 70 is shown, in reality,

15 Transmission Assembly 70 can be manual, semi-automatic, or fully automatic.

Transmission Assembly 70 also includes system that uses Frictional Clutch instead of Torque Converter 71. Transmission Assembly 70 can also have two or more PTOs 75 in its construction.

Exciter 50 is an Alternator that generates the DC power needed by Meta-magnetic Effect Dynamo 40. It consists of three major components: the rotor, the stator, and the rectifier bridge with regulator. The principle of AC generation in Alternator is motion between magnetic lines of force, and conductors will induce electrical pressure (AC Voltage). In the Alternator, the rotor will supply the magnetic lines of force, and PTO 75 spinning the rotor will supply the motion. The generated AC power is converted into DC power by the rectifier bridge with regulator. DC Power generated is supplied to Meta-magnetic Effect Dynamo 40 via Output Power Cable 53 (Positive DC Voltage) and Output Power Cable 52 (Ground). While only one type of Exciter 50 is shown, in reality, Exciter 50 can be any DC Power Source such as a battery or a fuel cell.

Meta-magnetic Effect Dynamo 40 is a synchronous machine that is driven by Output Shaft 74 of Transmission Assembly 70. It uses Meta-magnetic Effect to generate power from within the magnetic structure of its Stator 42.

Fig. 2 shows a perspective cross-sectional schematic view of Meta-magnetic Effect Dynamo 40. Two principal parts of a synchronous machine are magnetic structures. The stationary part that is essentially a hollow cylinder, called the Stator 42, has longitudinal slots in which there are coils of Stator 42's windings. These windings carry the current supplied to an electrical load. Rotor 43 is the part of the machine that is mounted on the shaft and rotates inside the hollow Stator 42. The winding on Rotor 43, called the field winding, is supplied with DC current from Exciter 50 via Output Power Cable 53 (Positive Voltage) and Output Power Cable 52 (Ground). In the present invention, Rotor 43 is a single, longitudinal block with a uniform four-pole cross section area as shown in Fig. 8.

Rotor 43 has four poles and two cycles of voltage are generated in each coil per revolution. Since the number of cycles per revolution equals the number of pairs of poles, the frequency of the generated voltage is derived from the following equation:

$$f = (P / 2) * (N/60) = (P/2) * f_m \text{ Hz}$$

where,

f = electrical frequency in Hz (50 Hz or 60Hz)

P = number of poles

N = Rotor speed in revolutions per minutes (rpm)

$f_m = N/60$ , the mechanical frequency in revolutions per second (rps), it is the frequency of Shaft 41 driven by Output Shaft 74 of Transmission Assembly 70.

The enhanced beam of coherent Magnetic Field generated via metamagnetic interaction is converted into a strong current flow in Stator 42's Windings instantaneously. This strong instantaneous current flow enables the present invention to be used as a device for power stability in an electrical distribution network or in a national grid. When there is a larger load demand, the coherent nature of enhanced Magnetic Field enables additional electrical power to be generated with no change in phase angle or frequency (50 Hz or 60 Hz) and no change in output voltage. In this way, unanticipated output can be catered for and at the same time, unexpected power trip due to power instability can be avoided.

In the present invention, three-phase AC power is being generated and can be supplied to external loads via Output Power Cable 44 (Live L1), Output Power Cable 45 (Live L2), Output Power Cable 46 (Live L3), and Output Power Cable 47 (Neutral).

Control Unit with a touch-screen display 80 is the main brain for the electricity generation system 11. It is used for controlling the operations of the present invention such as the powering up sequence, and the shutting down sequence. The Control Unit has two communication ports with each support either RS-232C or RS-485 communication protocol. One port is used to input control sequence by connecting it to a Personal Computer or Laptop. The other is used to communicate with Electronic Assembly 77 of Transmission 70 via additional communication protocols such as SAE J1708, SAE J1587, SAE J1939, and CAN-bus Protocol.

Fig. 13 shows a flow chart of the operation of the Control Unit with a touch-screen display 80. Upon power up, in step S100, Control Unit 80 performs an initialization in step S110 and waits for button click from its touch screen in step S120. Upon receiving a Power-ON button click from its touch-screen display in step S120, it sends a request command to Electronic Assembly 77 in step 130 to shift Transmission Assembly 70 to Neutral Mode. It waits for EA response message for successful neutral engagement in step S140. When valid response is received in S140, it issues a discrete signal to activate a Relay or a Switchgear in order to power up Prime Mover 20 in step S150. It waits for the required rpm value to attain in step S160. When required RPM is verified in step S160, Control Unit 80 sends a request command to Electronic Assembly 77 in step S170 to shift Transmission Assembly 70 to Drive Mode. It waits for Output Shaft 74 to attain the required rpm value (25 Hz or 30 Hz due to the use of a four-pole Rotor that provides two cycles of voltage per revolution) in step S180. When the required rpm value for Output Shaft 74 is verified, it sends a request command to Electronic Assembly 77 in step 190 to engage PTO 75 in order to drive the Exciter 50. The Meta-magnetic Effect Generator 11 is fully functional after this step.

Upon receiving a Power-OFF button click from its touch-screen display in step S120, Control Unit 80 sends a request command to Electronic Assembly 77 in step S200 to disengage PTO 75 in order to stop Exciter 50 from operating. It waits for EA response message for successful PTO disengagement in step S210. When valid response is received in step S210, it sends request command to EA 77 in step S220 to shift Transmission

Assembly 70 to Neutral Mode and waits for valid response in step S230. When valid response is received in step S230, it issues a discrete signal to deactivate a Relay or a Switchgear to cut-off input power supply to Prime Mover 20 in step S240.

5 A more efficient approach for Power-OFF is to insert a Relay or Switchgear between Output Power cable 53 and Output Power Cable 52 (not shown in diagram) as well as to include in step S200 an additional task of sending a discrete signal to disengage the Relay or Switchgear prior to the request command for disengaging PTO 75. In this manner, instantaneous power cut-off can be achieved in this present invention.

Control Unit 80 is mainly used for system start-up and shut down. It can also be used to  
10 match variations in external load when the system is not operating in Power Stability Zone. Control Unit 80 monitors variations in external load via changes in the required Drive Mode rpm value for Output Shaft 74. Upon receiving a Load-variation button click from its touch-screen display in step S120, it sends a request command to Electronic Assembly 77 in step S300 for the Drive Mode rpm value of Output Shaft 74. It waits for EA response  
15 message for Drive Mode rpm value in step S310. If valid rpm value is obtained in S310, it returns to step S120 to check whether Load-variation is still activated. If Load-variation button is still activated, steps S120, S300, and S310 are repeated for ongoing monitoring of Drive Mode rpm value. When variation is detected in S310, it enters step S320 to issue a discrete signal, an analog signal, or a command to the AC Power Source that is connected  
20 to the input power cables of Prime Mover 20 and instructs the AC Power Source to either increase or reduce the power supply to Prime Mover 20 in response to the load variations. It then returns to step S120 to check whether Load-variation button is still activated. If Load-variation button is still activated, steps S120, S300, S310, and S320 are repeated until the required Drive Mode rpm value for Output Shaft 74 is established and maintained.

25 Transmission Assembly 70 as a whole ensures the input power of the present invention is electrically isolated from its output power. Exciter 50 is driven mechanically by PTO 75. Shaft 41 of Meta-magnetic Effect Dynamo 40 is in turn driven mechanically by Output Shaft 74. Exciter 50 does not use the electrical output power of Stator 42. The fact that magnetic saturation sets in at the tip of each pole during Meta-magnetic Effect means that  
30 apart from the magneto-motive force needed to turn the Rotor 43, Rotor 43 is “isolated” from excess magnetic flux across the narrow air gap between the each pole and its adjacent Stator 42’s region. Therefore, two electrical reference frames are established, one is DC

Circuit (that includes Exciter 50 and Rotor 43) for generating the Magneto-motive Force needed by Rotor 43, and the other is the three-phase AC Circuit (that includes the Stator 42's windings and external loads) for generating the Electric Output Power needed by external electrical loads. The establishment of two Electrical Reference Frames in this present invention ensures Conservation of Electric Charge is preserved in each frame. Otherwise, discrepancy occurs when the electric charges in Rotor 43's field windings are less than (that is, not equal) to the electric charges in Stator 42's windings.

Turning to Fig.14, wherein the electricity generation system 12, according to a further embodiment of the present invention is shown. The system includes Prime Mover 20, Gear Train Assembly 90 (with three Gears 91, 92, and 93), Electrical Generator in the form of a Meta-magnetic Effect Dynamo 40, Exciter 50, Platform 60, and a Control Unit with touch-screen display 80.

Prime Mover 20 is an AC (Alternating Current) Motor. The alternating current (AC) provided from an external power source is used to generate a mechanical torque by means of a rotating magnet in a coil of wire, or by a rotating coil of wire inside a powerful magnet. In either case, the generated mechanical torque is used to rotate the Shaft 21 of Prime Mover 20. Prime Mover 20 receives its AC input power via Input Power Cables 22 (Live L1), 23 (Live L2) and 24 (Live L3). While only one type of Prime Mover 20 is shown, in reality, the Prime Mover 20 can be a single-phase Alternating Current (AC) Motor or a DC (Direct Current) Motor with a DC to AC Converter for its electrical input power.

The Input Power Cables 22 (Live L1), 23 (Live L2) and 24 (Live L3) of Prime Mover 20 can be connected via an AC Input Power Switch Box 25 to an external generator such as a fossil-fired steam turbine, natural gas-fired steam turbine, a hydro-generator, a diesel engine, a petrol engine, a steam engine, a Fuel-cell Generator, an AC or DC generator that uses alternative sources of energy (such as solar, wind, hydro-electric, wave energy, or biomass), and any electricity generation unit that can provide the required AC or DC power to drive Prime Mover 20 used in the present invention.

Gear Train Assembly 90 provides a mechanical mean to connect Shaft 21 of Prime Mover 20 to Shaft 41 of Meta-magnetic Effect Dynamo 40. Its gear ratio enables Shaft 21 of Prime Mover 20 to revolve at high speed to produce the desired power on one hand and

allow Shaft 41 of Meta-magnetic Effect Dynamo 40 to turn at slower speed at 25 Hz or 30 Hz (due to the use of a four-pole Rotor that provides two cycles of voltage per revolution).

In this embodiment, Gear 92 is threaded firmly and secured by a lock nut to the Shaft 21 of Prime Mover 20. Therefore, at system start-up, Prime Mover 20 and its Shaft 21 must be strong enough to overcome the inertia of Gear Train 90, inertia of Shaft 51 of Exciter 50, and inertia of Shaft 41 of Meta-magnetic Effect Dynamo 40 directly without slip. To prevent Shaft 21 of Prime Mover 20 from being twisted or breaking at start-up, Single Plate Clutch 100 may be deployed to connect Shaft 21 to Gear 92.

As shown in Fig. 15, Single Plate Clutch 100 is a device used to engage Shaft 21 and Gear 92 smoothly in relative motion during system start-up. It comprises a Friction Plate 101, a Pressure Plate 102, a Spring 103, and two Guards 104a and 104b. Both Guards are attached and secured firmly to the Shaft 21. Guard 104a is used to hold the Spring 103 in place and Guard 104b is used to hold Gear 92 in place. Shaft 21 serves as the driving member that is driven permanently by Prime Mover 20. Pressure Plate 102 rotates permanently with Shaft 21. It supplies the other unlined friction contact surface, and conveys the clamping force of Spring 103 to Shaft 21. Friction Plate 101 is the driven member. To accommodate wearing of the friction-lined Friction Plate 101 and the slip during system start-up, a certain amount of axial freedom must be provided for Gear 92. This axial freedom is achieved by attaching Gear 92, Friction Plate 101, and Pressure Plate 102 to Shaft 21 with Bush Bearing 105c, 105b, and 105a respectively so that they can float along Shaft 21 between the two Guards 104b and 104a. Pressure Plate 102 is produced from cast iron and is intentionally of rugged construction, it must neither distort under the loading of Spring 103 nor be unable to absorb and conduct away the heat generated during clutch engagement. Spring 103 is compressed between Pressure Plate 102 and Guard 104a. Its purpose is to maintain a sufficient clamping force between the friction surfaces of the Single Plate Clutch so that maximum torque from Shaft 21 can be transmitted to Gear 92 without slip occurring. Insulation washers (not shown in Fig. 15) may be used to reduce heat transmission from Pressure Plate 102 to Spring 103. Friction Plate 101 is sandwiched between the friction contact surfaces of Gear 92 and Pressure Plate 102.

Fig. 16 shows the construction of Friction Plate 101. Each side of Friction Plate 101 is faced with a ring of friction material, known as Friction Lining 101c, which is secured by

riveting to Borglite Segment 101a. Torsional Damper-springs 101b are provided to permit smooth, gradual engagement.

Turning to Fig. 15, the purpose of fitting a Single Plate Clutch provides the following benefits: [a] Better engagement at system start-up, slight delay in the form of slip before full engagement enables Prime Mover 20 to have sufficient time to build up its speed, thereby, allowing shock-free connection between Shaft 21 and Gear 92; [b] the friction linings 101c enables maximum torque transmission from Shaft 21 to Gear 92 at full engagement.

Turning to Fig. 14, Gear 91 is coupled to Shaft 51 of Exciter 50. Exciter 50 is an Alternator that generates the DC power needed by Meta-magnetic Effect Dynamo 40. It consists of three major components: the rotor, the stator, and the rectifier bridge with regulator. The principle of AC generation in Alternator is motion between magnetic lines of force, and conductors will induce electrical pressure (AC Voltage). In the Alternator, the rotor will supply the magnetic lines of force, and Gear 91 spinning the rotor will supply the motion. The generated AC power is converted into DC power by the rectifier bridge within the regulator. DC Power generated is supplied to Meta-magnetic Effect Dynamo 40 via Output Power Cable 53 (Positive Voltage) and Output Power Cable 52 (Ground). While only one type of Exciter 50 is shown, in reality, Exciter 50 can be any DC Power Source such as a battery or a fuel cell.

Meta-magnetic Effect Dynamo 40 is a synchronous machine that is driven by Gear 93 of Gear Train Assembly 90. It uses Meta-magnetic Effect to generate power from within the magnetic structure of its Stator 42.

Fig. 2 shows a perspective cross-sectional schematic view of Meta-magnetic Effect Dynamo 40. Two principal parts of a synchronous machine are magnetic structures. The stationary part that is essentially a hollow cylinder, called the Stator 42, has longitudinal slots in which there are coils of Stator 42's windings. These windings carry the current supplied to an electrical load. Rotor 43 is the part of the machine that is mounted on the shaft and rotates inside the hollow Stator 42. The winding on Rotor 43, called the field winding, is supplied with DC current from Exciter 50 via Output Power Cable 53 (Positive DC Voltage) and Output Power Cable 52 (Ground). In the present invention, Rotor 43 is a single, longitudinal block with a uniform four-pole cross sectional area as shown in Fig. 8.

Rotor 43 has four poles and two cycles of voltage are generated in each coil per revolution. Since the number of cycles per revolution equals the number of pairs of poles, the frequency of the generated voltage is derived from the following equation:

$$f = (P / 2) * (N/60) = (P/2) * f_m \text{ Hz}$$

5 where,

f = electrical frequency in Hz (50 Hz or 60 Hz)

P = number of poles

N = Rotor speed in revolutions per minutes (rpm)

10  $f_m = N/60$ , the mechanical frequency in revolutions per second (rps), it is the frequency of Shaft 41 driven by Gear 93 of Gear Train Assembly 90 which is either 25 Hz or 30 Hz.

The enhanced beam of coherent Magnetic Fields generated via metamagnetic interaction is converted into a strong current flow in Stator 42's Windings instantaneously. This strong instantaneous current flow enables the present invention to be used as a device for power stability in an electrical distribution network or in a national grid. When there is a larger  
15 load demand, the coherent nature of enhanced Magnetic Field enables additional electrical power to be generated with no change in phase angle or frequency (50 Hz or 60 Hz) and no change in output voltage. In this way, unanticipated output can be catered for and at the same time, unexpected power trip due to power instability can be avoided.

In the present invention, three-phase AC power is being generated and can be supplied to  
20 external loads via Output Power Cable 44 (Live L1), Output Power Cable 45 (Live L2), Output Power Cable 46 (Live L3), and Output Power Cable 47 (Neutral).

Control Unit with a touch-screen display 80 is the main brain for the electricity generation system 12. It is used for controlling the operations of the present invention such as the powering up sequence, and the shutting down sequence. The Control Unit has two  
25 communication ports with each support either RS-232C or RS-485 communication protocol. One port is used to input control sequence by connecting it to a Personal Computer or Laptop. The other is used to communicate with the AC Power Source that is connected to Prime Mover 20. Besides, Control Unit 80 is connected to DC Output Power Switch Box 54 via Signal Cable 81. A Relay switch is installed (not shown in Fig 14)  
30 inside the DC Output Power Switch Box 54. Alternatively, the Signal Cable 81 is

connected to the DC Output Power Switch Box 54 via a Switchgear. Besides, there is an RPM Sensor (not shown in Fig 14) mounted on Exciter 50 to read the rotational speed of Shaft 51. The rpm reading can be accessed from Signal Cable 81 via the DC Output Power Switch Box 54. Control Unit 80 is connected to AC Input Power Switch Box 25 via Signal Cable 82. A Relay Switch (not shown in Fig 14) and an AC to DC power converter (not shown in Fig 14) are installed inside the AC Input Power Switch Box 25. Control Unit 80 also receives DC input power from Signal Cable 82 from the AC to DC Power Converter installed inside the AC Input Power Switch Box 25.

Fig. 17 shows a flow chart of the operation of the Control Unit with a touch-screen display 80. Upon power up, in step S100, Control Unit 80 performs an initialisation in step S110 and waits for button click from its touch screen in step S120.

Upon receiving a Power-ON button click from its touch-screen display in step S120, it sends a discrete signal to energise the Relay Switch in AC Input Power Switch Box 25 in step S130 to supply AC power to Prime Mover 20. It reads the RPM reading of Shaft 51 and derives the speed of Shaft 41 from the received rpm reading via gear-ratio conversion in step S140. It also waits for the desired speed of Shaft 41 to be established in this step. When the desired speed for Shaft 41 is obtained, it issues a discrete signal via Signal Cable 81 in step S150 to energise the Relay Switch in DC Output Power Switch Box 54 (or Switchgear) to supply DC power via Power Cable 53 (Positive DC Voltage) and Power Cable 54 (Ground) to enable Faraday's Law of Electromagnetic Induction to take place inside Meta-magnetic Effect Dynamo 40. The Meta-magnetic Effect Generator 12 is fully functional after this step.

Upon receiving a Power-OFF button click from its touch-screen display in step S120, Control Unit 80 sends a discrete signal via Signal Cable 81 in step S200 to DC Output Power Switch Box 54 to deactivate the Relay Switch (or Switchgear) in order to cut off the DC supply which in turn disables the Meta-magnetic Effect Dynamo instantly as Faraday's Law of Electromagnetic Induction cannot take place immediately after that instance. It then issues a discrete signal via Signal Cable 82 in step S210 to AC Input Power Switch Box 25 to deactivate the Relay Switch in order to power off Prime Mover 20. Control Unit 80 continues to receive its DC power from the AC to DC Converter installed inside the AC Input Power Switch Box 25.

Control Unit 80 is mainly used for system start-up and shut down. It can also be used to match variations in external load when the system is not operating in Power Stability Zone. Control Unit 80 monitors variations in external load via changes in the required rpm value for Output Shaft 93. Upon receiving a Load-variation button click from its touch-screen display in step S120, it reads the RPM reading of Shaft 51 and derives the speed of Shaft 41 from the received rpm reading via gear-ratio conversion in step S300. If valid rpm value is obtained in S300, it returns to step S120 to check whether Load-variation is still activated. If Load-variation button is still activated, steps S120 and S300 are repeated for ongoing monitoring of the rpm value for Shaft 93. When variation is detected in S300, it enters step S310 to issue a discrete signal, an analog signal via an additional Signal Cable (not shown in Fig. 14), or a command via the second serial communication port (not shown in Fig. 14) to an External AC Power Source that is connected to the input power cables of Prime Mover 20 and instructs the AC Power Source to either increase or reduce the power supply to Prime Mover 20 in response to the load variations. It then returns to step S120 to check whether Load-variation button is still activated. If Load-variation button is still activated, steps S120, S300, and S310 are repeated until the required rpm value for Shaft 93 is established and maintained.

Gear Train Assembly 90 as a whole ensures the input power of the present invention is electrically isolated from its output power. Exciter 50 is driven mechanically by Gear 91. Shaft 41 of Meta-magnetic Effect Dynamo 40 is in turn driven mechanically by Gear 93. Exciter 50 does not use the electrical output power of Stator 42. The fact that magnetic saturation sets in at the tip of each pole during Meta-magnetic Effect means that apart from the magneto-motive force needed to turn the Rotor 43, Rotor 43 is "isolated" from excess magnetic flux across the narrow air gap between the each pole and its adjacent Stator 42's region. Therefore, two electrical reference frames are established, one is DC Circuit (that includes Exciter 50 and Rotor 43) for generating the Magneto-motive Force needed by Rotor 43, and the other is the three-phase AC Circuit (that includes the Stator 42's windings and external loads) for generating the Electric Output Power needed by external electrical loads. The establishment of two Electrical Reference Frames in this present invention ensures Conservation of Electric Charge is preserved in each frame. Otherwise, discrepancy occurs when the electric charges in Rotor 43's field windings are less than (that is, not equal) to the electric charges in Stator 42's windings.

In the claims which follow except where the context requires, otherwise due to express language or necessary implication, the word “comprise”, or variations such as “comprises” or “comprising” is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various  
5 embodiments of the invention

Modifications and improvements to the invention will be readily apparent to those skilled in the art. Such modifications and improvements are intended to be within the scope of this invention.

**Claims:**

1. An electrical generator comprising a stator composed at least partly of a material having metamagnetic properties and having coil means connected to an external electrical load, and a rotor having an electromagnet for generating a magnetic field  
5 therein, movement of the rotor and magnetic field relative to the stator, inducing electrical current flow in the coil means, the electromagnet configured to generate a magnetic field of sufficient strength to interact with a magnetic field associated with the external electrical load and induce metamagnetism within the metamagnetic material of the stator to increase electrical current flow within the  
10 coil means.
2. An electrical generator according to claim 1, wherein the rotor is composed at least partly of another material having non-metamagnetic properties.
3. An electrical generator according to claim 2, the other material has a higher magnetic permeability than the metamagnetic material.
- 15 4. An electrical generator according to claim 2 wherein the other material has a fully saturated magnetic flux density irrespective of whether or not the metamagnetic material of the stator has metamagnetism induced therein.
5. An electrical generator according to claim 1 wherein the magnetic flux density and magnetic field strength of the metamagnetic material of the stator increases  
20 superlinearly when metamagnetism is induced therein.
6. An electrical generator according to any one of claims 2 to 5 wherein the other material is any one or more of Permalloy, Silicon Iron, Pure Iron, Relay Steel or an iron equivalent.
7. An electrical generator according to any one of claims 1 to 6 wherein the  
25 metamagnetic material is Alnico V, Stelloy, or a Stelloy equivalent.
8. An electrical generator according to any one of claims 2 to 6 wherein the other material and metamagnetic material respectively comprise a pair selected from the group comprising: Permalloy and Alnico V; Permalloy and Stelloy; Silicon Iron and Alnico V; Silicon Iron and Stelloy; Pure Iron and Alnico V; Pure Iron and  
30 Stelloy; Relay Steel and Alnico V; Relay Steel and Stelloy; and an iron equivalent and a Stelloy equivalent.

9. An electrical generator according to any of claims 1 to 8, wherein the angular velocity of the rotor and thereby the frequency of the generated electrical current, remains substantially constant notwithstanding the induction of metamagnetism within the metamagnetic material of the stator
- 5 10. An electrical generator according to any one of claims 1 to 9, wherein the stator is a substantially hollow cylinder with the coil means provided at selected locations on the interior wall thereof.
11. An electrical generator according to claim 10, wherein the coil means are provided in longitudinally extending slots formed in the interior wall of the hollow cylinder.
- 10 12. An electrical generator according to claim 9, wherein the coil means are operatively connected so as to generate alternating current of a selected phase.
13. An electrical generator according to claim 11 or claim 12, wherein the coil means comprise parallel, insulated, untwisted, thin, and circular cross-sectional multi-strand wires located within the longitudinally extending slots in a manner that each
- 15 wire is subjected to a uniform magnetic flux.
14. An electrical generator according to any one of claims 1 to 13, wherein the electromagnet comprises first and second diametrically opposed pairs of poles.
15. An electrical generator according to claim 14 wherein the poles have a cross-sectional area that applies a uniform beam of magnetic flux from each pole when
- 20 the rotor is viewed in plan, and a uniform plane beam when the rotor is viewed in elevation.
16. An electricity generation system comprising:
- an electrical generator according to any one of claims 1 to 15;
- energy supply means for supplying magnetic energy to the electromagnet
- 25 and mechanical energy to the rotor, said magnetic and mechanical energy being supplied to the generator independently of the electrical current generated by the generator.
17. An electricity generation system according to claim 16, wherein the energy supply means comprises:
- 30 a motor; and

a belt assembly operatively connecting the rotor to the motor, rotating motion of the motor being transferred to the rotor via the belt assembly.

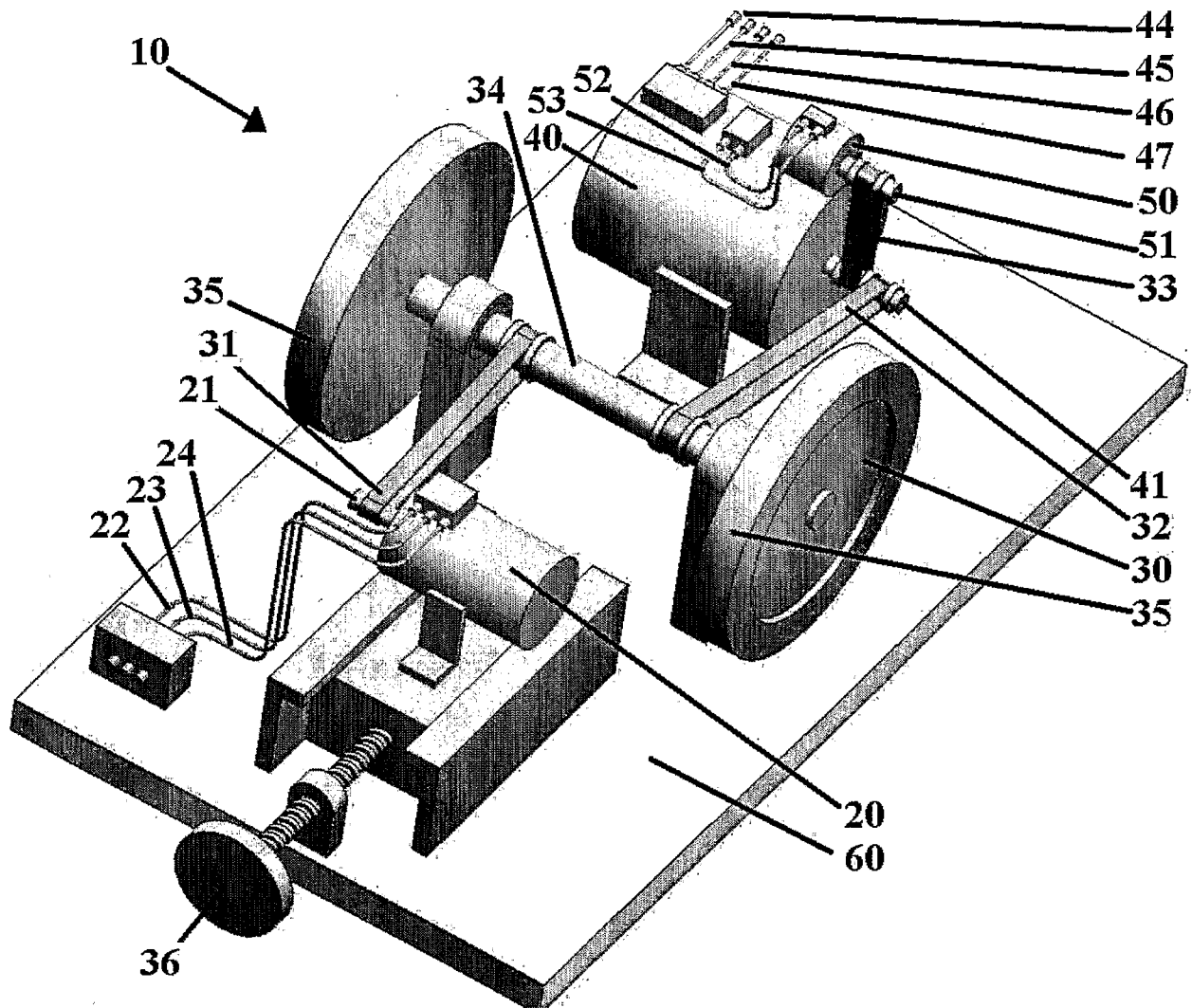
18. An electricity generation system according to claim 16, wherein the energy supply means comprises:
- 5 a motor; and
- a transmission assembly operatively connecting the rotor to the motor, rotating motion of the motor being transferred to the rotor via the transmission assembly .
19. An electricity generation system according to claim 16, wherein the energy supply means comprises:
- 10 a motor;
- a gear train assembly operatively connecting the rotor to the motor, rotating motion of the motor being transferred to the rotor via the gear train assembly;
- 15 a DC power source driven by the gear train assembly; and
- a relay switch or a Switchgear operatively connecting the electromagnet to the DC power source.
20. An electricity generation system according to any one of claims 16 to 19 further including an adjuster for connecting the belt assembly, gear train or transmission assembly, to the motor so as to overcome inertia of movable parts during system start-up.
- 20
21. An electricity generation system according to claim 20 wherein the adjuster is a clutch that is configured to selectively engage or disengage the motor to and from the belt assembly, gear train or transmission assembly.
- 25
22. An electricity generation system according to claim 21 wherein the clutch is a single plate clutch.
23. An electricity generation system according to any one of claims 16 to 19 further including a counterweight in the belt assembly, gear train or transmission assembly for ensuring that movable parts are in static and dynamic balance and to smooth out any jerk or slack encountered during motion of movable parts.
- 30

24. An integrated electricity generation system comprising two or more operatively connected electricity generation systems according to any one of claims 16 to 19, so as to increase the electrical output of a single unit.
25. An integrated electricity generation system according to claim 24 wherein the electricity generation systems are cascaded in series.
26. An integrated electricity generation system according to claim 24 wherein the electricity generation systems are connected in parallel.
27. An integrated electricity generation system according to claim 24 wherein the electricity generation systems are connected in both series and parallel.
28. An electrical distribution network including one or more electricity generation systems according to any one of claims 16 to 19 configured so as to provide power stability to selected parts of the electrical distribution network.
29. An automotive engine including one or more electrical generators according to any one of claims 1 to 15.
30. A marine vessel including an automotive engine according to claim 29.
31. An electrical generator according to any one of claims 1 to 15 wherein the induced metamagnetism within the metamagnetic material of the stator comprises an instantaneous five-stage process to spontaneously and coherently increase electrical current flow within the coil means.
32. An electrical generator according to claim 31, wherein the instantaneous five-stage process comprises:
- a first stage comprising a typical Faraday's Law of Electromagnetic Induction between the rotor and stator wherein magnetic flux is directed from the rotor to the stator;
  - a second stage, wherein additional magnetic flux from current flow in the coil means due to the presence of the external electrical load is directed from the rotor to the stator;
  - a third stage, wherein magnetic flux from the first stage interacts with the additional flux from the second to form a strong resultant magnetic flux that is directed from the rotor to the stator to penetrate the stator;

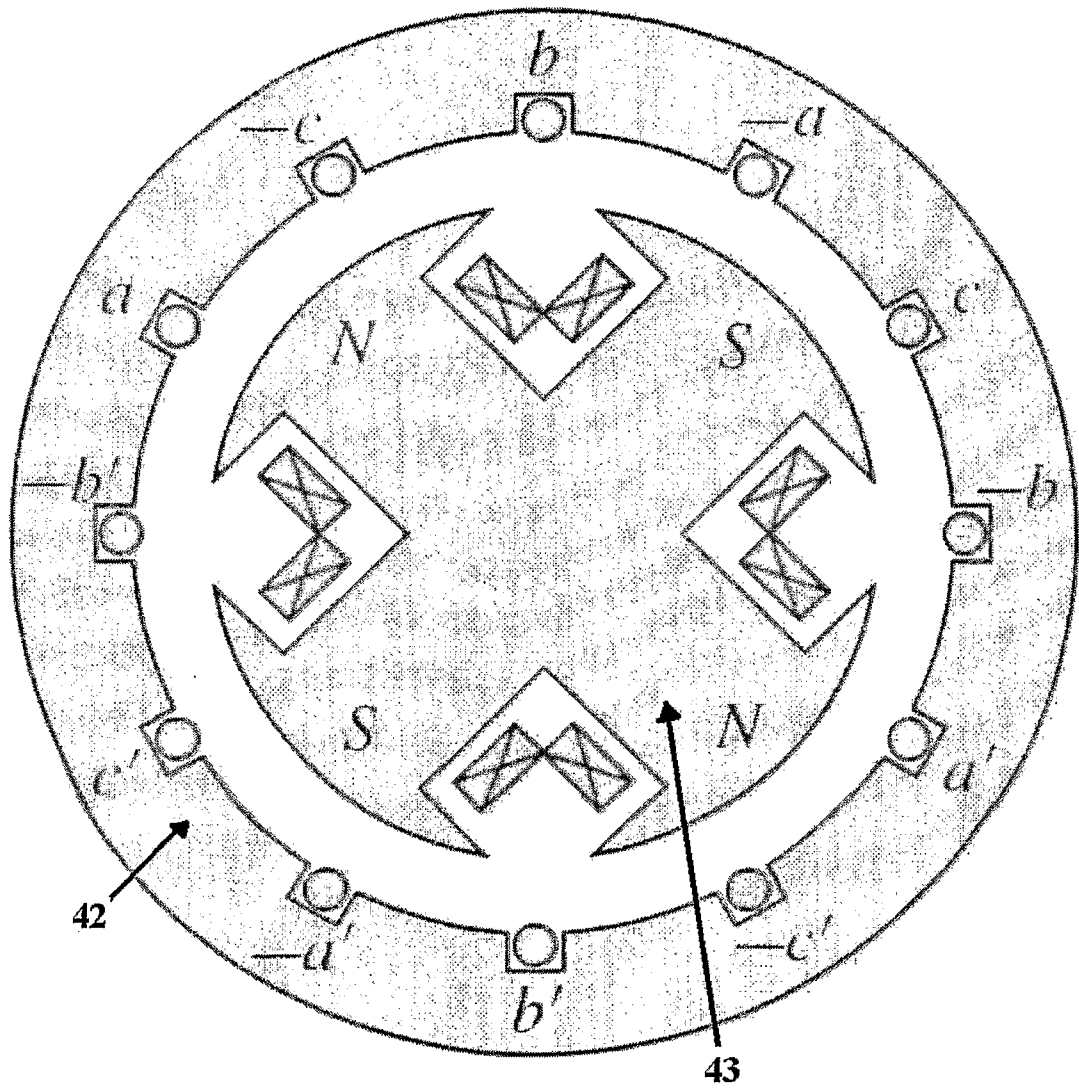
a fourth stage, wherein the resultant magnetic field from the third stage 3 causes the material of the stator having metamagnetic properties to enter a metamagnetic state and release additional coherent magnetic fields that trigger similar emissions in other magnetic atoms within the material, resulting in a strong beam of coherent magnetic fields being generated immediately within the material; and

a fifth stage, wherein the strong beam of coherent magnetic fields generated within the material of the stator in stage 4 is transformed instantaneously into a strong current flow in the coil means of the stator via the application of Ampere's Law.

33. An electrical generator according to claim 12 wherein the coil means are operatively connected so as to independently and simultaneously generate alternating current of two or more selected phases in response to two or more corresponding external electrical loads.
34. An electrical generator according to claim 31 wherein the spontaneous and coherent increase of electrical current flow in the coil means is instantaneously stopped by deactivating a relay or a Switchgear to terminate the electrical supply to the electromagnet notwithstanding ongoing movement of the rotor.
35. An electricity generation system according to any one of claims 16 to 27 further including a control unit for system start-up and shutdown, and for matching variations in external electrical load when the system is not operating in a Power Stability Zone.
36. An electricity generation system according to claims 16 to 27 further including respective additional belts in the belt assembly, additional driveshafts in the transmission assembly, and additional gears in the gear train assembly, enabling the motor to drive two or more electrical generators according to any one of claims 1 to 15.

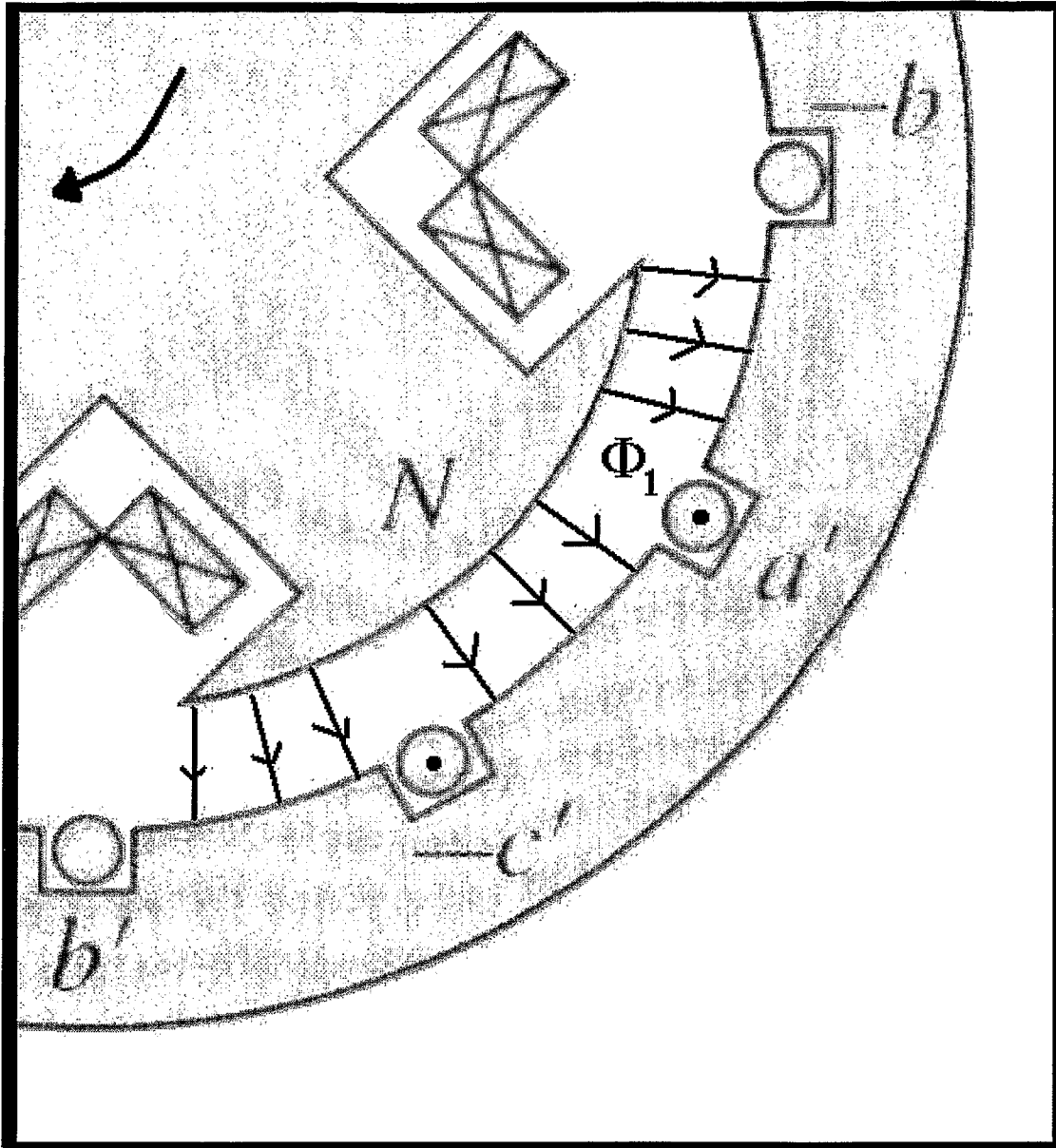


**FIG. 1**

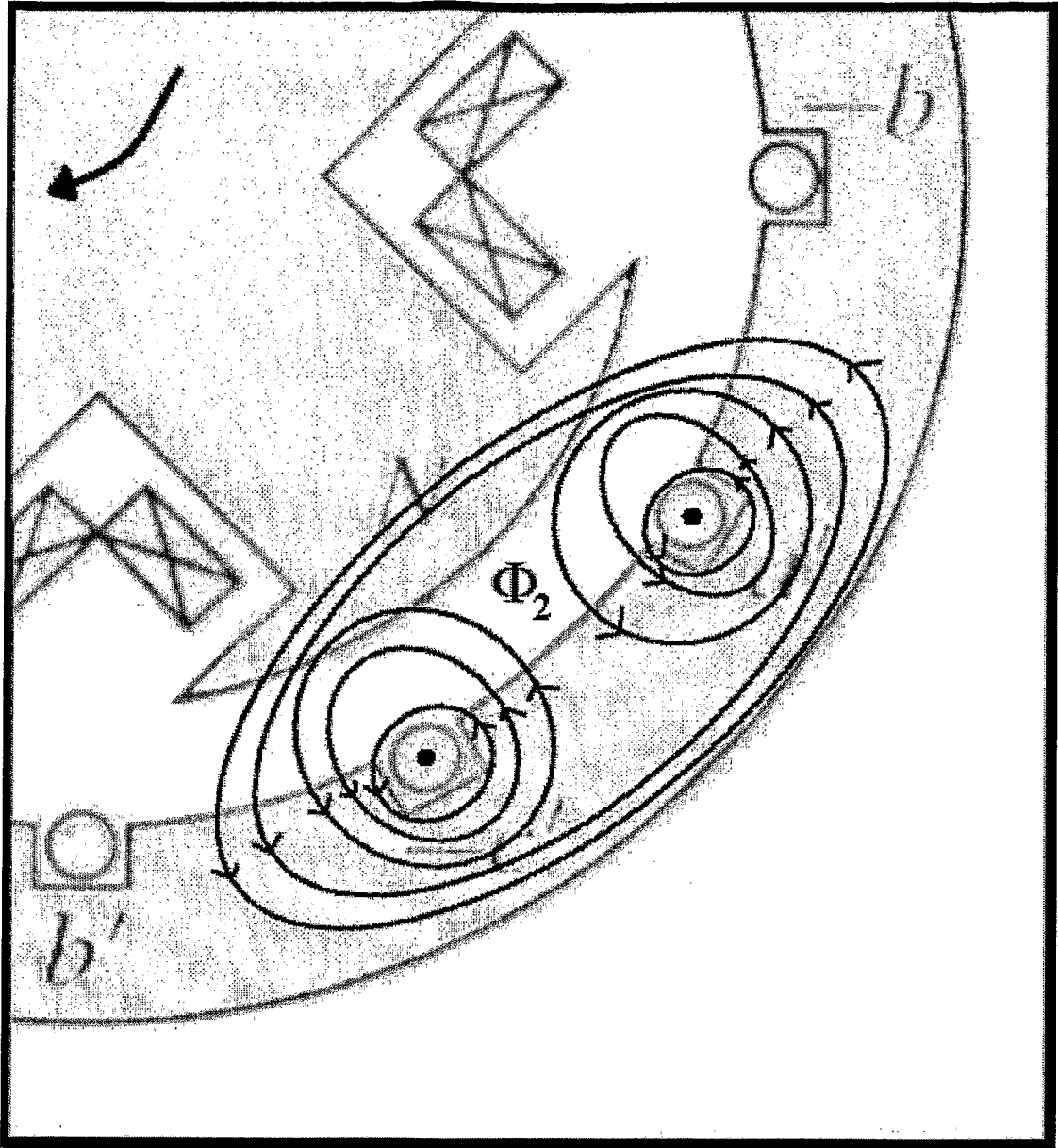


**FIG. 2**

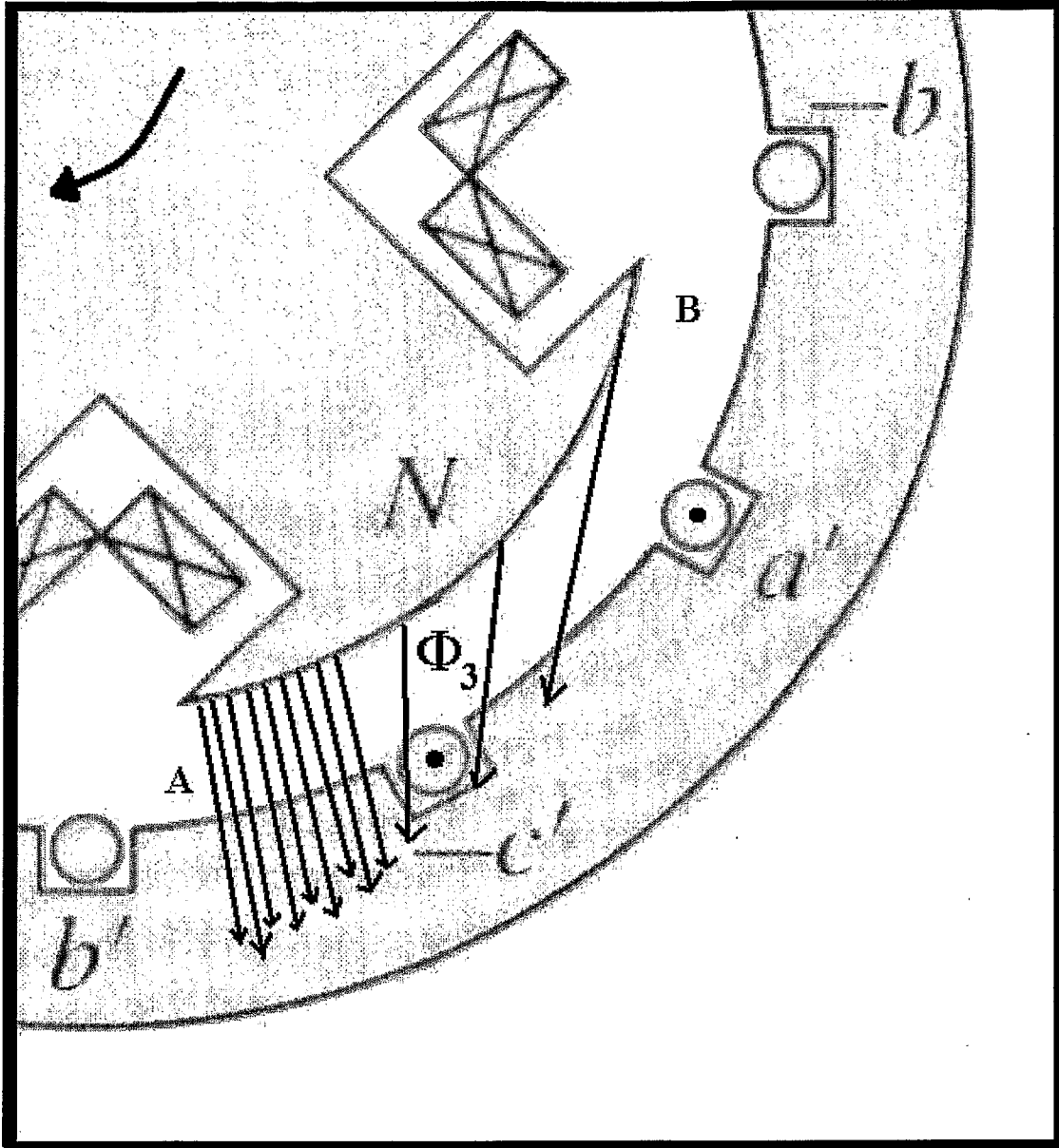




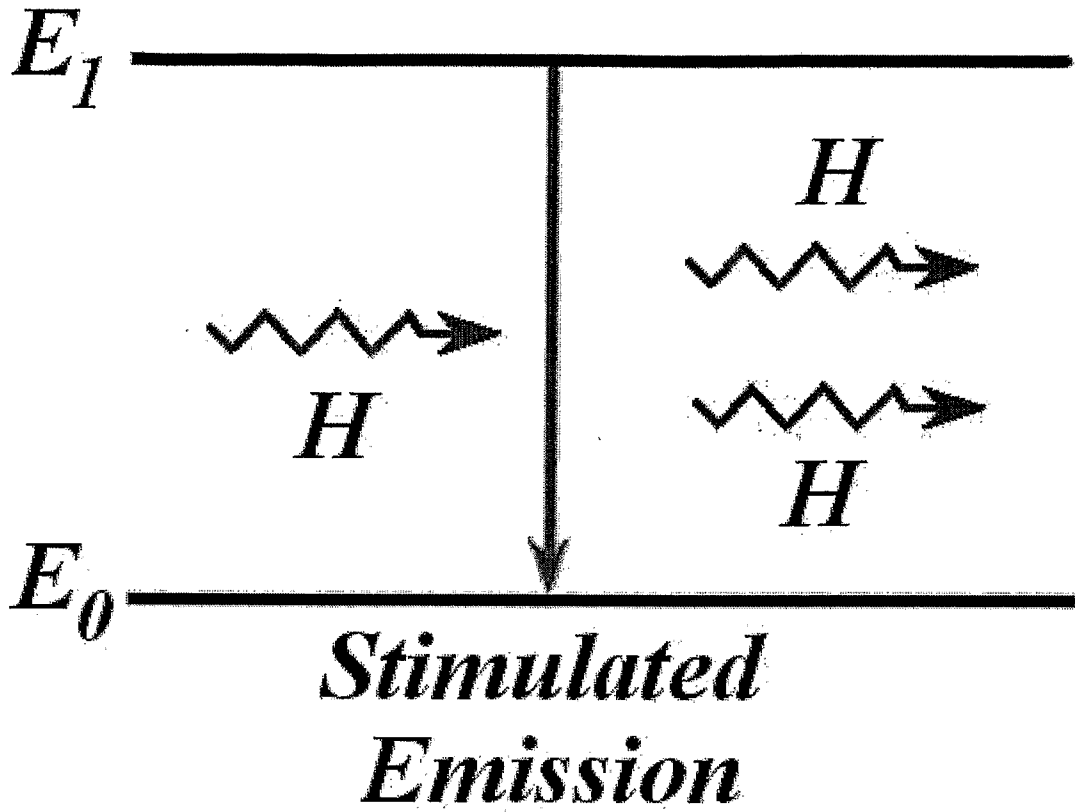
**FIG. 4**



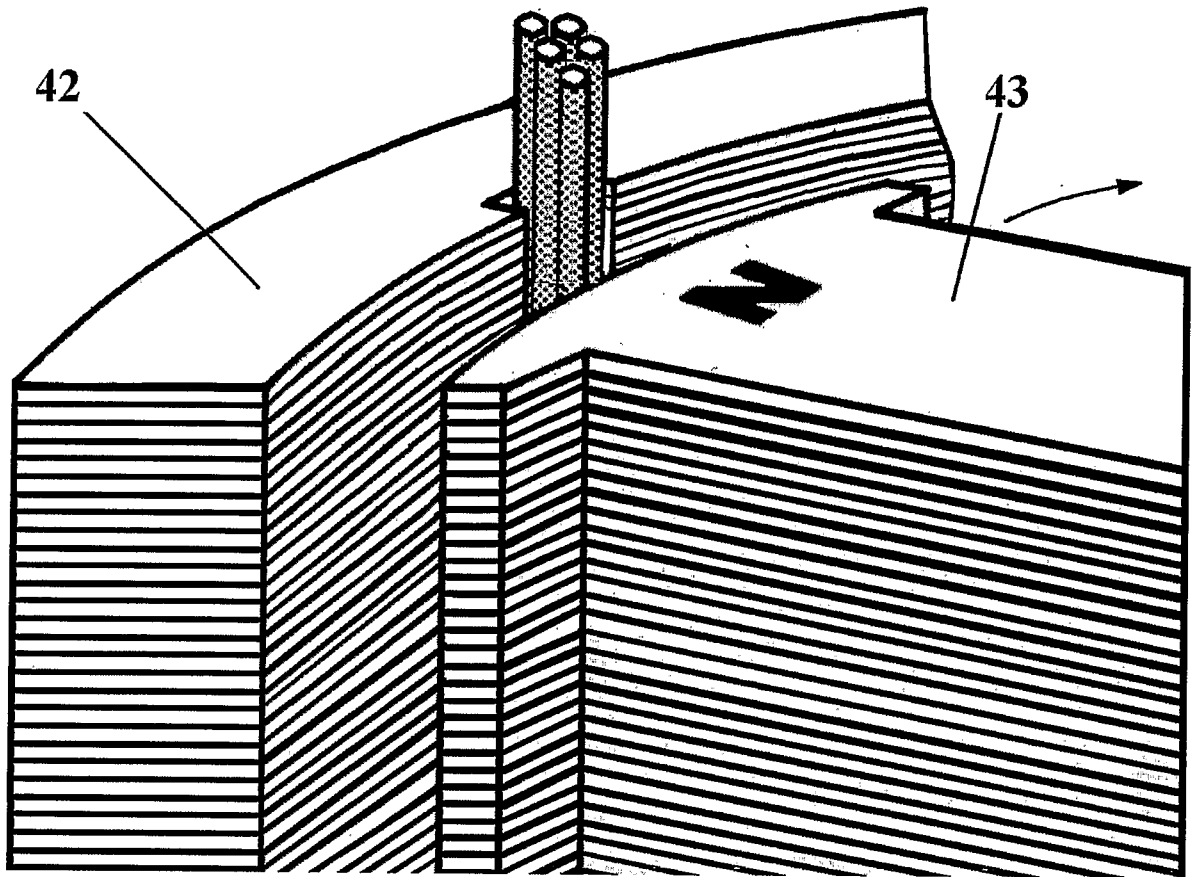
**FIG. 5**



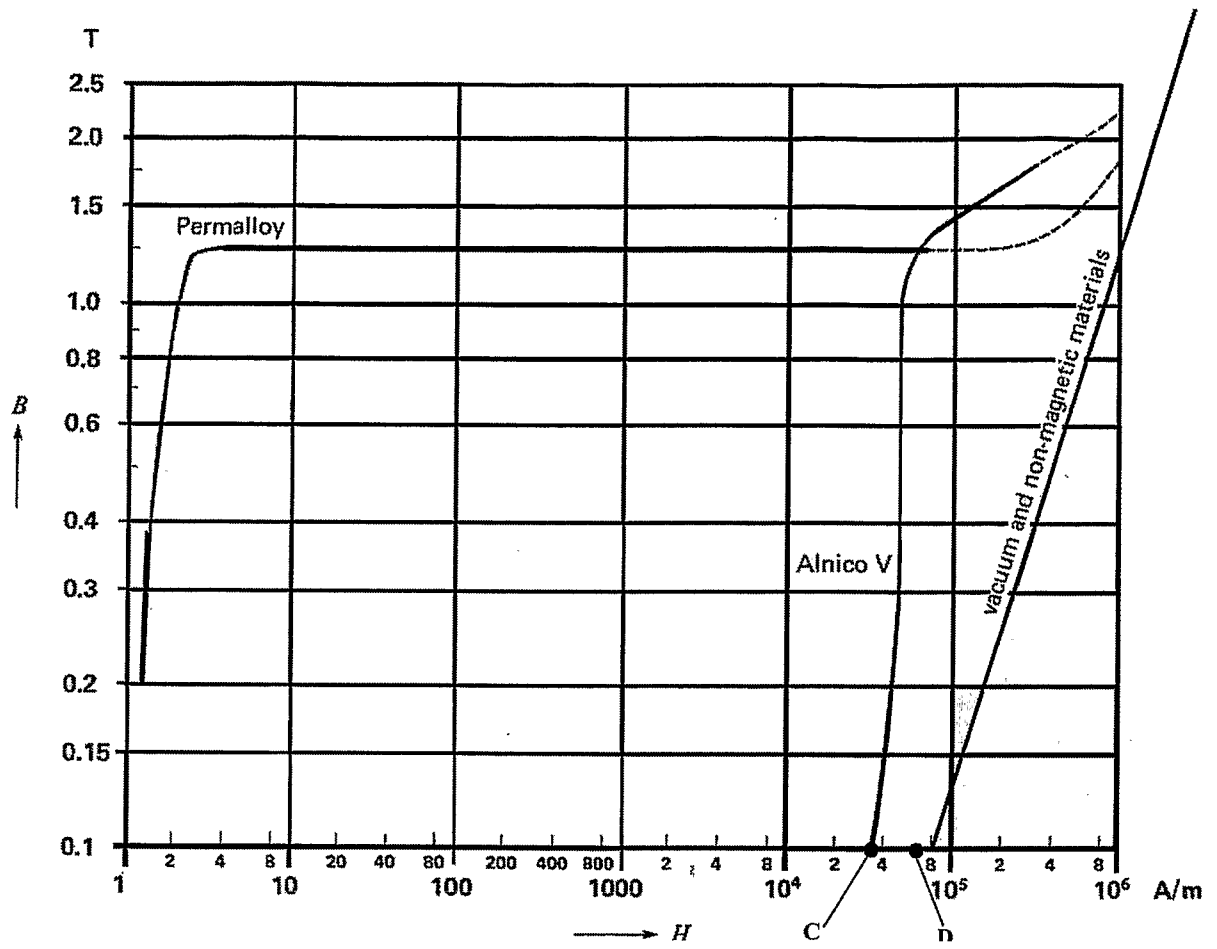
**FIG. 6**



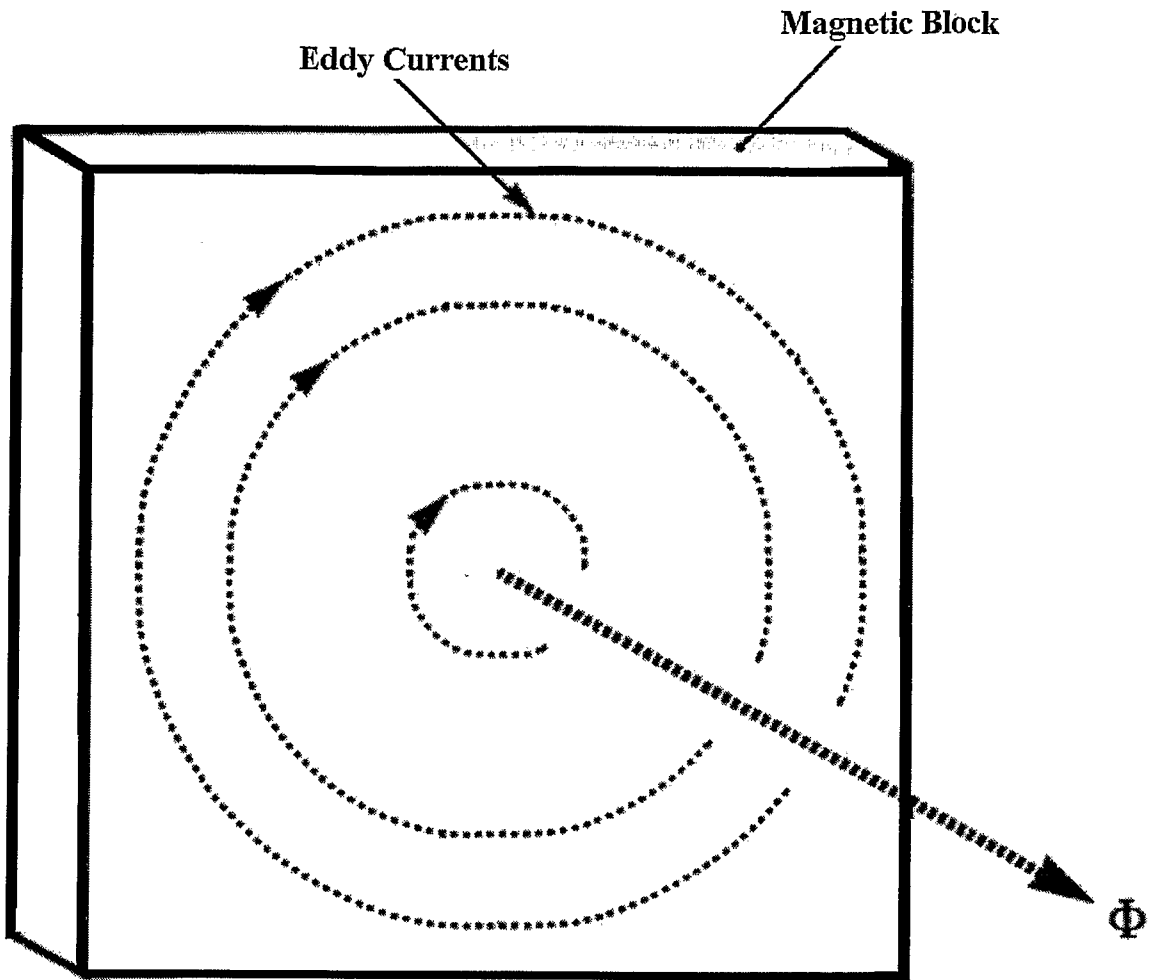
**FIG. 7**



**FIG. 8**



**FIG. 9**



**FIG. 10**

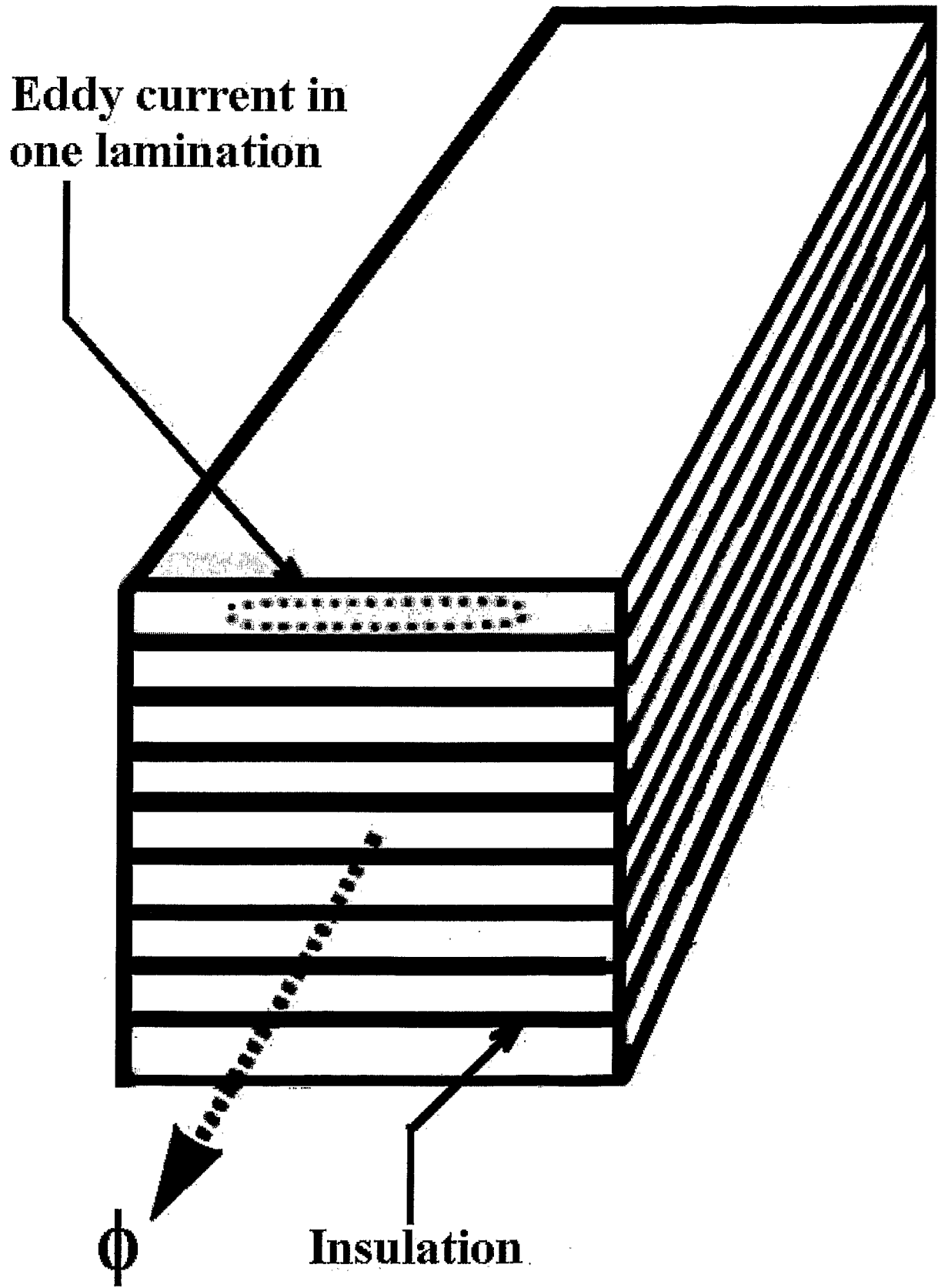


FIG. 11

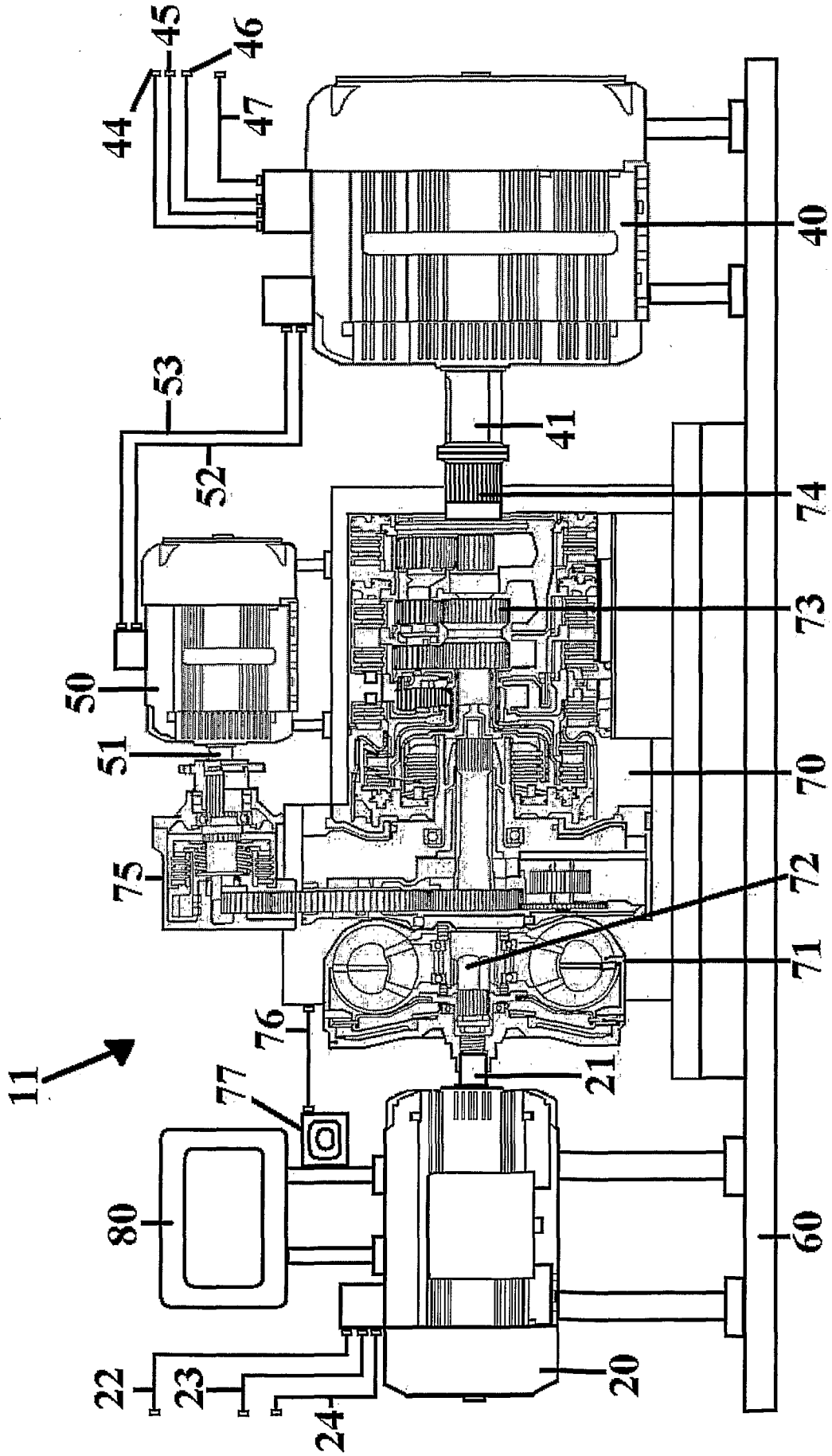


Fig. 12

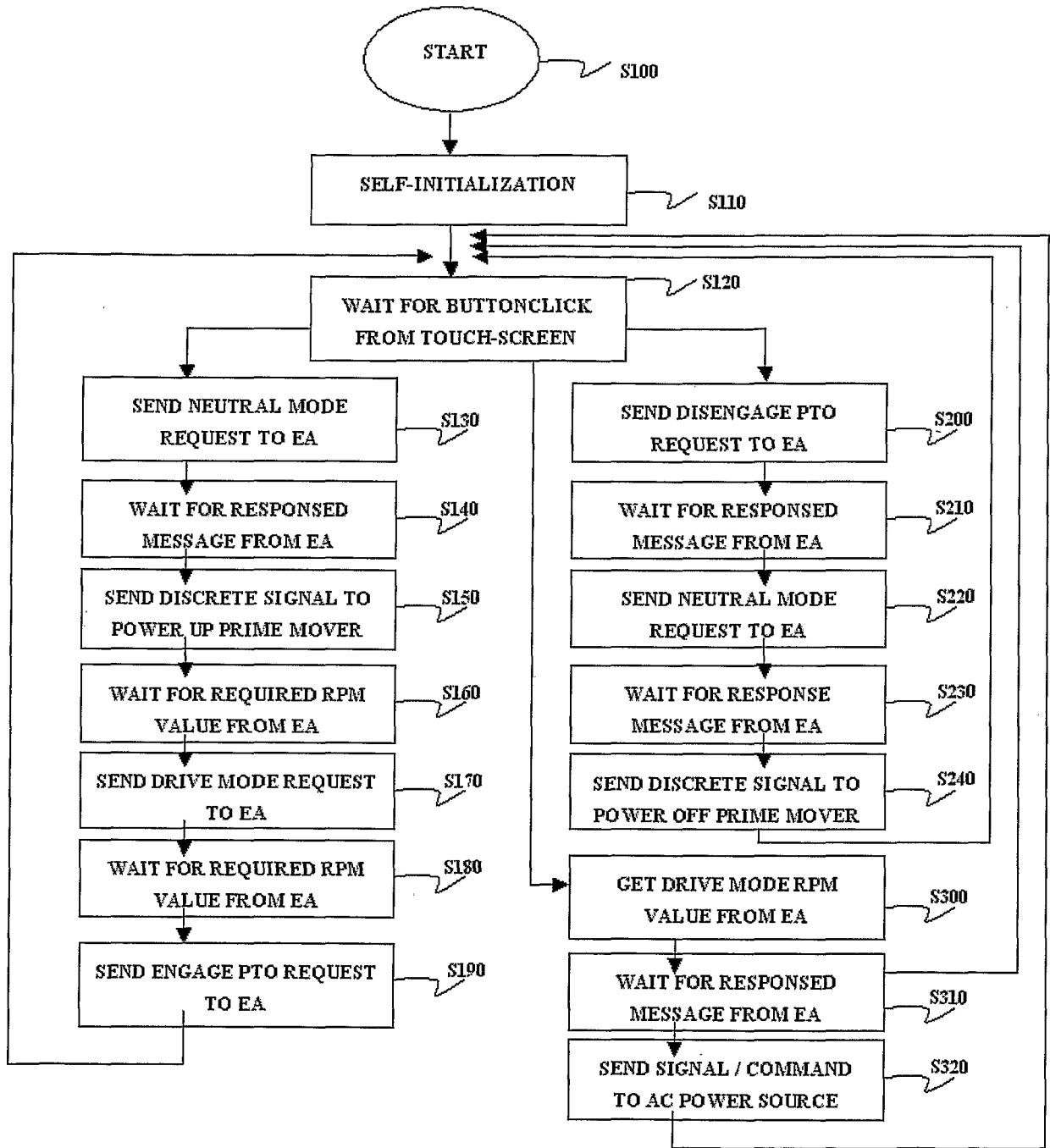
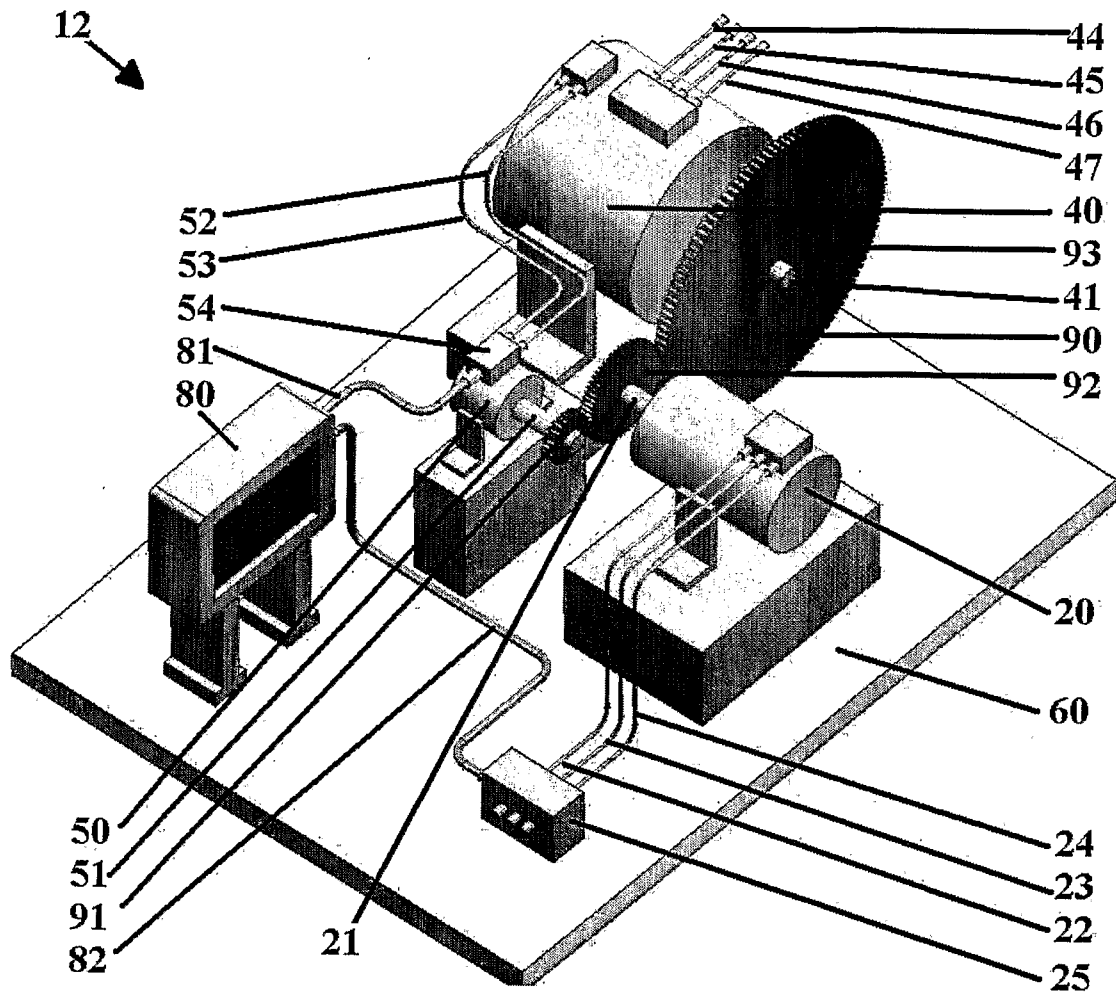
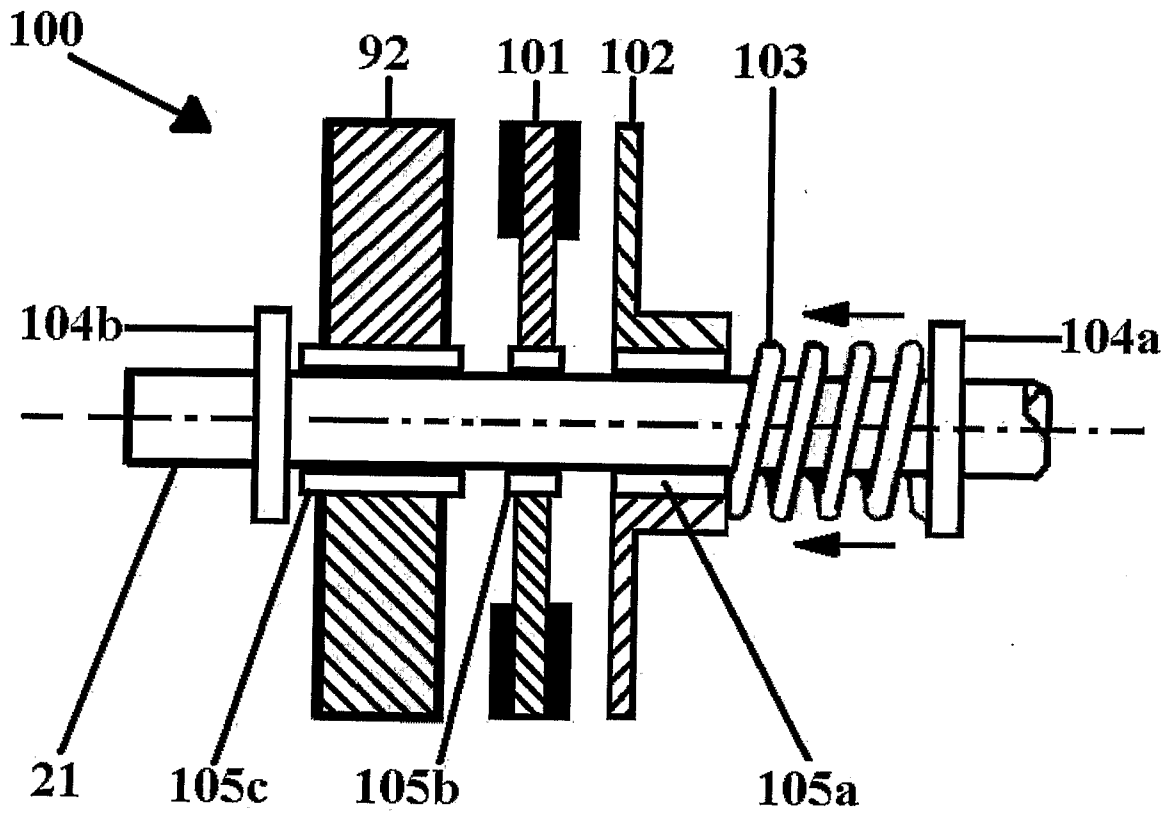


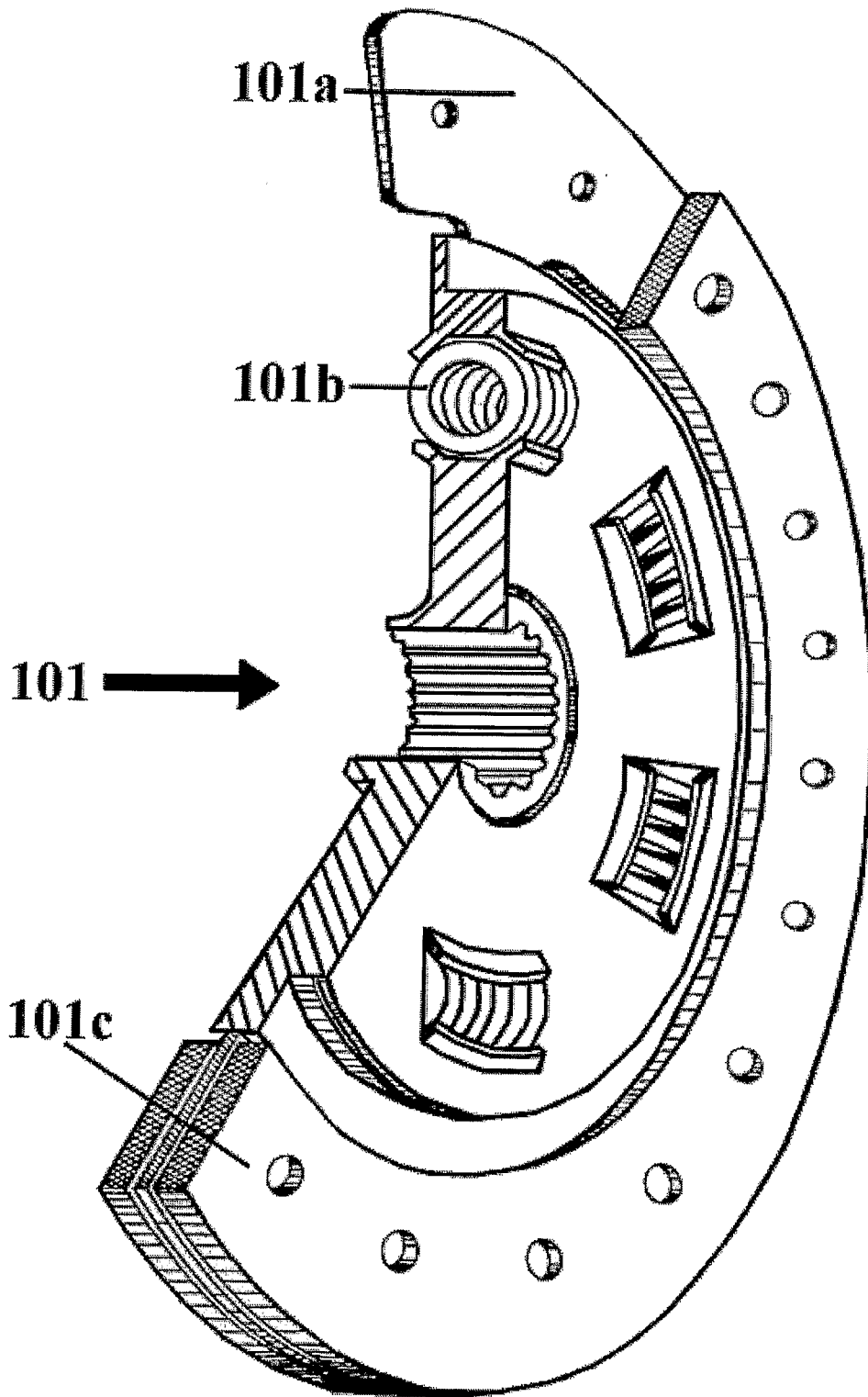
FIG. 13



**FIG. 14**



**FIG. 15**



**FIG. 16**

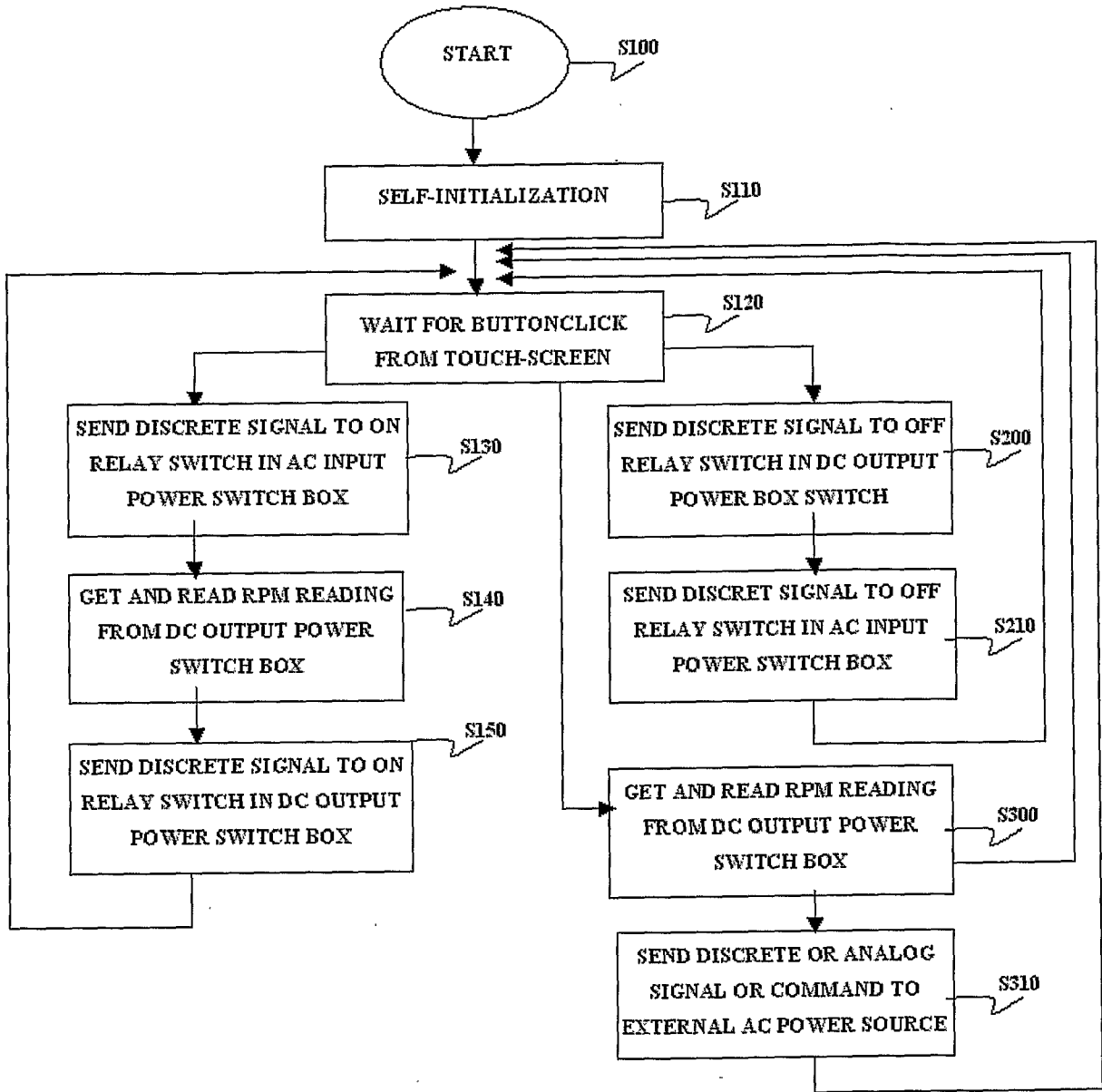


FIG. 17

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SG2009/000028

**A. CLASSIFICATION OF SUBJECT MATTER**

Int. Cl.

**H02K 1/02** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPOQUE FULL TEXT DATABASE CLUSTER: TXTUS0, TXTUS1, TXTUS2, TXTUS3, TXTEP1, TXTGB1, TXTWO1, TXTAU1 and google keywords: METAMAGNETIC, GENERATOR, ELECTRIC MACHINE and other terms and phrases

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4916907 A (MUNK ET AL) 17 April 1990 See whole document, especially abstract and Figs. 1-2B	
A	US 2007/0125094 A1 (IWASAKI ET AL) 7 June 2007 See whole document, especially abstract and Figs. 1-3C	
A	US 2007/0125095 A1 (IWASAKI ET AL) 7 June 2007 See whole document, especially abstract and Figs. 1A-1D	

Further documents are listed in the continuation of Box C

See patent family annex

* Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search  
12 March 2009

Date of mailing of the international search report

**17 MAR 2009**

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

**PCT/SG2009/000028**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member		
US 4916907	DE 3732312 EP 0308611	DE 3800098	DE 3815500
US 2007125094	JP 2007147209		
US 2007125095	JP 2007155237		

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX