The Gravelectric Generator

Conversion of Gravitational Energy directly into Electrical Energy

Fran De Aquino
Maranhao State University, Physics Department, S.Luis/MA, Brazil.

The electrical current arises in a conductor when an outside force acts upon the free electrons of the conductor. This force is called, in a generic way, of *electromotive force* (EMF). Usually, it has *electrical* nature. Here, we show that it can have *gravitational* nature (*Gravitational Electromotive Force*). This fact led us to propose an unprecedented system to convert Gravitational Energy *directly into* Electrical Energy. This system, here called of *Gravelectric Generator*, can have individual outputs powers of several tens of kW or more. It is easy to be built, and can easily be transported from one place to another, on the contrary of the hydroelectric plants, which convert Gravitational Energy into Hydroelectric energy.

Key words: Gravitational Electromotive Force, Gravitational Energy, Electrical Energy, Generation of Electrical Energy.

1. Introduction

The research for generate *Gravitational Electromotive Force* (*Gravelectric Effect*) began with Faraday [1]. He had a strong conviction that there was a correlation between *gravity* and *electricity*, and carried out several experiments trying to detect this *Gravelectric Effect* experimentally. Although he had failed several times, he was still convinced that gravity must be related to electricity. Faraday felt he was on the brink of an *extremely important discovery*. His Diary on August 25, 1849 shows his enthusiastic expectations:

"*It was almost with a feeling of awe that I went to work, for if the hope should prove well founded, how great and mighty and sublime in its hitherto unchangeable character is the force I am trying to deal with, and how large may be the new domain of knowledge that may be opened up to the mind of man.*"

Here we show how to generate *Gravitational Electromotive Force*, converting Gravitational Energy directly into electricity. This theoretical discovery is very important because leads to the possibility to build the *Gravelectric Generator*, which can have individual outputs powers of several tens of kW.

2. Theory

In a previous paper, we have proposed a system to convert *Gravitational Energy* directly into *Electrical Energy* [2]. This system uses Gravity Control Cells (GCCs). These GCCs can be replaced by the recently discovered *Quantum Controllers of Gravity* (QCGs) [3], which can produce similar effect. In this paper, we propose a simplification for this system, without using GCCs or QCGs.

Under these conditions, the system shown in the previously mentioned paper reduces to *a coil with iron core*. Through the coil passes a electrical current i, with frequency f. Thus, there is a magnetic field through the iron core. If the system is subject to a gravity acceleration g (See Fig.1), then the *gravitational forces* acting on *electrons* (F_e), *protons* (F_p) and *neutrons* (F_p) of the Iron core, are respectively expressed by the following relations [4]

$$F_e = m_{ge} a_e = \chi_{Be} m_{e0} g \qquad (1)$$

$$F_p = m_{gp} a_p = \chi_{Bp} m_{p0} g \qquad (2)$$

$$F_n = m_{gn} a_n = \chi_{Bn} m_{n0} g \qquad (3)$$

m_{ge}, m_{gp} and m_{gn} are respectively the *gravitational* masses of the electrons, protons and neutrons; m_{e0}, m_{e0} and m_{e0} are respectively the *inertial* masses at rest of the electrons, protons and neutrons.

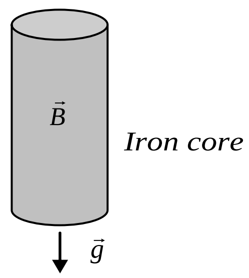

Fig. 1 – An iron core of a coil subjected to a gravity acceleration $\vec{g}$ and magnetic field $\vec{B}$ with frequency f.

The expressions of the *correlation factors* χ_{Be}, χ_{Bp} and χ_{Bn} are deduced in the previously mentioned paper, and are given by

$$\chi_{Be} = \left\{1 - 2\left[\sqrt{1 + \frac{45.56\pi^2 r_e^4 B_{rms}^4}{\mu_0^2 m_e^2 c^2 f^2}} - 1\right]\right\} \qquad (4)$$

$$\chi_{Bp}=\left\{1-2\left[\sqrt{1+\frac{45.56\pi^2 r_p^4 B_{rms}^4}{\mu_0^2 m_p^2 c^2 f^2}}-1\right]\right\} \quad (5)$$

$$\chi_{Bn}=\left\{1-2\left[\sqrt{1+\frac{45.56\pi^2 r_n^4 B_{rms}^4}{\mu_0^2 m_n^2 c^2 f^2}}-1\right]\right\} \quad (6)$$

According to the free-electron model, the electric current is an electrons gas propagating through the conductor (*free electrons Fermi gas)*. If the conductor is made of *Iron*, then the free-electrons density is $N/V \cong 8.4\times10^{28}\,electrons/m^3$ *.

The theory tells us that the total energy of the electrons gas is given by $3NE_F/5$, where $E_F=\hbar^2k_F^2/2m_e$; $k_F=\left(3\pi^2N/V\right)^{\frac{1}{3}}$ (The *Fermi sphere*). Consequently, the electrons gas is subjected to a pressure $\left(-3N/5\right)\left(dE_F/dV\right)=2NE_F/5V$. This gives a pressure of about 37GPa †. This enormous pressure puts the free-electrons very close among them, in such way that if there are $8.4\times10^{28}\,electrons$ inside $1m^3$, then we can conclude that the each electron occupies a volume: $V_e=1.2\times10^{-29}m^3$. Assuming $V_e=\frac{4}{3}\pi r_e^3$, for the electron's volume, then we get

$$r_e\cong1.4\times10^{-10}m \quad (7)$$

It is known that *the electron size depends of the place where the electron is*, and that it can vary from the *Planck length* $10^{-35}m$ ($l_{planck}=\sqrt{\hbar G/c^3}\sim10^{-35}m$) up to $10^{-10}m$, which is the value of the spatial extent of the electron wavefunction, Δx, in the *free electrons Fermi gas* (the electron size in the Fermi gas is $\Delta x\equiv2r_e$). The value of Δx can be obtained from the Uncertainty Principle for position and *momentum*: $\Delta x\Delta p \gtrsim \hbar$, making $\Delta p=m_e v_e$, where v_e is the group velocity of the electrons, which is given by $v_e=\hbar k_F/m_e$. Then, the result is

$$\Delta x\gtrsim\frac{\hbar}{m_e v_e}=\frac{1}{k_F}=\frac{1}{\left(3\pi^2N/V\right)^{\frac{1}{3}}} \quad (8)$$

In the case of *Iron*, ($N/V\cong8.4\times10^{28}\,electrons/m^3$), Eq.(8) gives

$$r_e=\frac{\Delta x}{2}\gtrsim1\times10^{-10}m \quad (9)$$

Comparing with the value given by Eq. (7), we can conclude that $r_e\cong1.4\times10^{-10}m$ is a highly plausible value for the electrons radii, when the electrons are *inside the mentioned free electrons Fermi gas*. On the other hand, the radius of *protons inside the atoms* (nuclei) is $r_p=1.2\times10^{-15}m$, $r_n\cong r_p$. Then, considering these values and assuming $r_e\cong1.4\times10^{-10}m$, we obtain from Eqs. (4) (5) and (6) the following expressions:

$$\chi_{Be}=\left\{1-2\left[\sqrt{1+1.46\times10^{18}\frac{B_{rms}^4}{f^2}}-1\right]\right\} \quad (10)$$

$$\chi_{Bn}\cong\chi_{Bp}=\left\{1-2\left[\sqrt{1+2.35\times10^{-9}\frac{B_{rms}^4}{f^2}}-1\right]\right\} \quad (11)$$

where B_{rms} is the *rms* intensity of the magnetic field through the iron core and f is its oscillating frequency. *Note that χ_{Bn} and χ_{Bp} are negligible in respect to χ_{Be}.*

It is known that, in some materials, called *conductors*, the free electrons are so loosely held by the atom and so close to the neighboring atoms that they tend to drift randomly from one atom to its neighboring atoms. This means that the electrons move in all directions by the same amount. However, if some outside force acts upon the free electrons their movement becomes not random, and they move from atom to atom at the same direction of the applied force. This flow of electrons (their electric charge) through the conductor produces the *electrical current*, which is defined as a flow of electric charge through a medium [6]. This charge is typically carried by moving electrons in a conductor, but it can also be carried by ions in an electrolyte, or by both ions and electrons in a plasma [7].

Thus, the electrical current arises in a conductor when an outside force acts upon its

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* $N/V=N_0\rho_{iron}/A_{iron}$; $N_0=6.02\times10^{26}\,atoms/kmole$ is the Avogadro's number; ρ_{iron} is the matter density of the Iron (7,800 kg/m^3) and A_{iron} is the molar mass of the Iron (55.845*kg/kmole*).

† The artificial production of diamond was first achieved by H.T Hall in 1955. He used a press capable of producing pressures above 10 GPa and temperatures above 2,000 °C [5]. Today, there are several methods to produce synthetic diamond. The more widely utilized method uses high pressure and high temperature (HPHT) of the order of 10 GPa and 2500°C *during many hours* in order to produce a single diamond.

free electrons. This force is called, in a generic way, of *electromotive force* (EMF). Usually, it is of *electrical* nature $(F_e = eE)$. However, if the nature of the electromotive force is *gravitational* $(F_e = m_{ge}g)$ then, as the corresponding force of *electrical* nature is $F_e = eE$, we can write that

$$m_{ge}g = eE \qquad (12)$$

According to Eq. (1) we can rewrite Eq. (12) as follows

$$\chi_{Be}m_{e0}g = eE \qquad (13)$$

Now consider a *wire* with length l; cross-section area S and electrical conductivity σ. When a voltage V is applied on its ends, the electrical current through the wire is i. Electrodynamics tell us that the electric field, E, through the wire is uniform, and correlated with V and l by means of the following expression [8]

$$V = \int \vec{E}d\vec{l} = El \qquad (14)$$

Since the current i and the area S are constants, then the current density $\vec{J}$ is also constant. Therefore, it follows that

$$i = \int \vec{J}.d\vec{S} = \sigma ES = \sigma(V/l)S \qquad (15)$$

By substitution of E, given by Eq.(14), into Eq.(13) yields

$$V = \chi_{Be}(m_{e0}/e)gl \qquad (16)$$

This is the voltage V between the ends of a wire, when the wire with conductivity σ and cross-section area S, is subjected to a uniform magnetic field B with frequency f and a gravity g (as shown in Fig.(2)) (The expression of χ_{Be} is given by Eq. (4)).

Substitution of Eq. (16) into Eq. (15), gives

$$i_{max} = \chi_{Be}(m_{e0}/e)\sigma gS \qquad (17)$$

This is the *maximum output current* of the system for a given value of χ_{Be}.

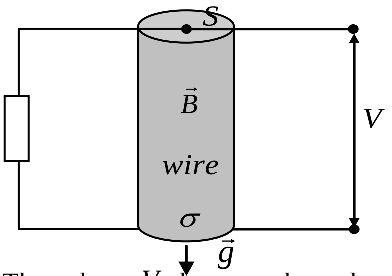

Fig. 2 – The voltage V between the ends of a wire when it is subjected to a uniform magnetic field B with frequency f and gravity g (as shown above).

Now consider the system shown in Fig.3. It is an electricity generator (*Gravelectric Generator*). It was designed to convert a large amount of Gravitational Energy *directly into* electrical energy. Basically, it consists in a Helmholtz coil placed into the core of a *Toroidal coil*. The current i_H through the *Helmholtz coil* has frequency f_H. The wire of the toroidal coil is made of *pure iron* ($\mu_r \cong 4000$) with *insulation paint*. Thus, the nucleus of the Helmholtz coil is filled with *iron* wires, which are subjected to a uniform magnetic field B_H with frequency f_H, produced by the Helmholtz coil. Then, according to Eq. (10), we have that

$$\chi_{Be} = \left\{1 - 2\left[\sqrt{1 + 1.46\times10^{18}\frac{B^4_{H(rms)}}{f^2_H}} - 1\right]\right\} \qquad (18)$$

By substitution of Eq.(18) into Eq.(16), we obtain

$$V = \left\{1 - 2\left[\sqrt{1 + 1.46\times10^{18}\frac{B^4_{H(rms)}}{f^2_H}} - 1\right]\right\}\left(\frac{m_{e0}}{e}\right)gl \qquad (19)$$

If $B_{H(rms)} = 0.8T$ [‡] and $f_H = 0.2Hz$, then Eq. (19) gives

$$V \cong 0.43\, l \qquad (20)$$

In order to obtain $V = 220volts$, the total length l of the iron wire used in the *Toroidal coi*l must have 511.63m. On the other hand, the *maximum output current* of the system (through the *Toroidal coil*) (See Fig.3 (a)) will be given by (Eq.17), i.e.,

$$i_{max} = 0.43\sigma S \qquad (21)$$

Since the electrical conductivity of the iron is $\sigma = 1.04\times10^7 S/m$ and, assuming that the diameter of the iron wire is $\phi_{ironwire} = 4mm$, ($S = \pi\phi^2_{ironwire}/4 = 1.25\times10^{-5}m^2$), then we get

$$i_{max} \cong 56\ Amperes \qquad (22)$$

This is therefore, the *maximum output current* of this Gravelectric Generator. Consequently, the *maximum output* power of the generator is

$$P_{max} = Vi_{max} \cong 12.3kW \qquad (23)$$

Note that, here the Helmholtz coil has *two turns only*, both separated by the distance R (See Fig.3 (a)). By using only 2 turns, both separated by a large distance, it is possible strongly to reduce the *capacitive effect* between the turns. This is highly

[‡] The magnetic field at the midpoint between the coils is $B_H = 0.71\mu_r\mu_0 Ni/R$. Here $\mu_r \cong 4000$ (*pure iron*; commercially called *electrical pure iron* (99.5% of iron and less than 0.5% of impurities.)

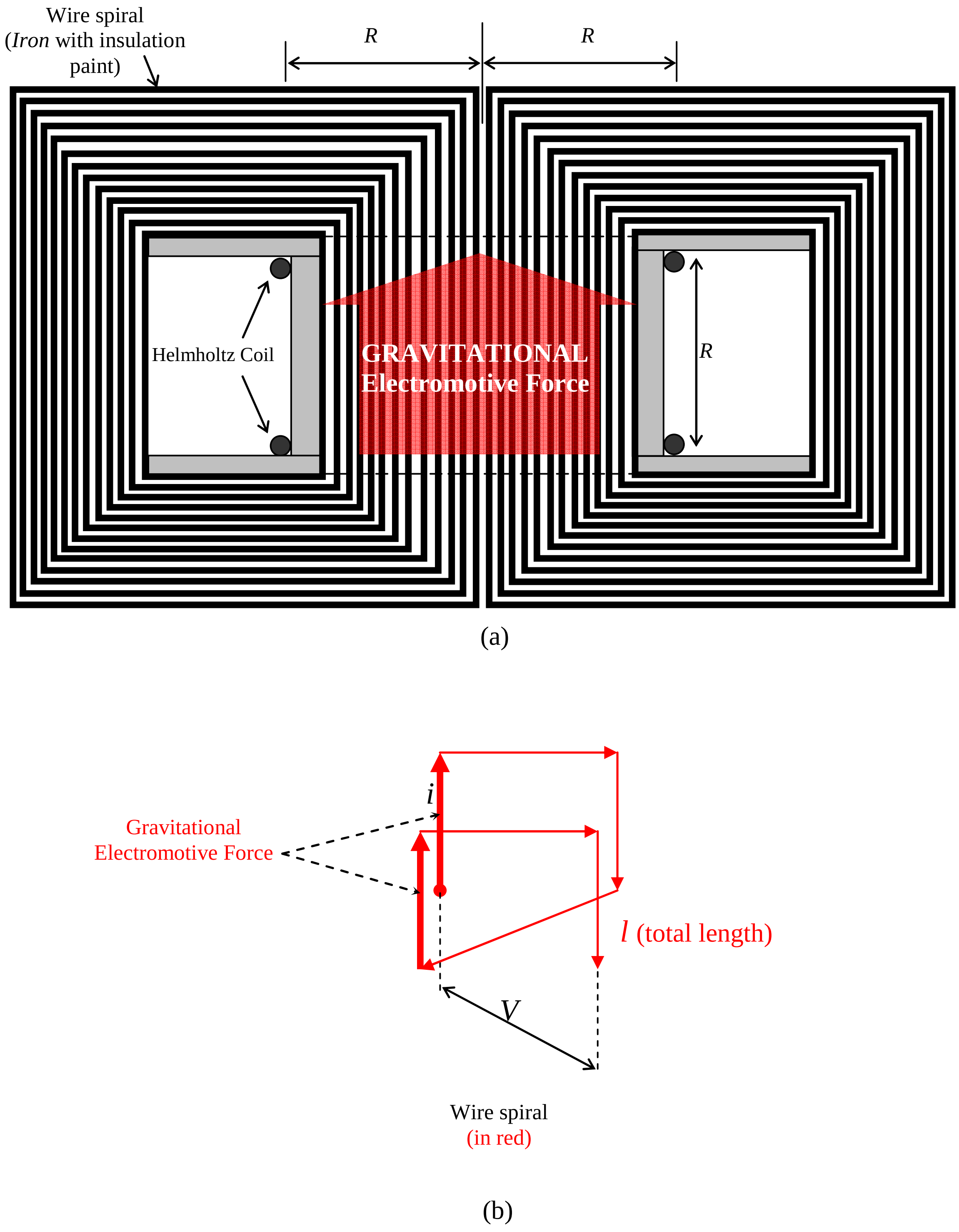

Fig. 3 – Schematic Diagram of the *Gravelectric Generato*r (Based on a gravity control process patented on 2008 (BR Patent number: PI0805046-5, July 31, 2008).

relevant in this case because the extremely-low frequency $f = 0.2Hz$ would strongly increase the capacitive reactance ($X_C = 1/2\pi fC$) associated to the inductor.

Let us now consider a new design for the Gravelectric Generator. It is based on the device shown in Fig. 4 (a). It contains a central pin, which is involved by a *ferromagnetic* tube. When the device is subjected to gravity $\vec{g}$ and a magnetic field with frequency f_H and intensity B_H (as shown in Fig. 4 (a)) the magnetic field lines are concentrated into the *ferromagnetic* tube, and a *Gravitational Electromotive Force* is generated inside the tube, propelling the free electrons through it. The pin is made with *diamagnetic* material (Copper, Silver, etc.,) in order to expel the magnetic field lines from the pin (preventing that be generated a Gravitational Electromotive Force in the pin, *opposite* to that generated in the ferromagnetic tube).

Several similar devices (N devices) are jointed into a cylinder with radius R and height R. The pin, the ferromagnetic tube and the cylinder have length R (See Fig. 4 (a) and (b)). On the external surface of the cylinder there is a Helmholtz coil with two turns only. The current through the Helmholtz coil has frequency f_H in order to generate the magnetic field $\vec{B}_H$. The devices are connected as shown in Fig. 4 (c).

Since the pin and the ferromagnetic tube have length R, then the *total length of the conductor through the Gravelectric Generator*, l, is given by $l = N(2R)$. Equation (20) tells us that in order to obtain $V = 220volts$ (assuming the same value of $\chi_{Be} = 0.43$ given by Eq. (18)) the total length l must have 511.63m. This means that

$$N(2R) = 511.63m \qquad (24)$$

If the area of the cross-section of the cylinder above mentioned is $S = \pi R^2$, and the area of the cross-section of the device is $S_d = \pi r_d^2$, then assuming that $S \cong 1.2NS_d$, we can write that

$$N \cong 0.8(R/r_d)^2 \qquad (25)$$

Substitution of Eq. (25) into Eq. (24) gives

$$r_d = 0.056\,R^{1.5} \qquad (26)$$

Equation (24) tells us that for $N = 640$ *devices*, the cylinder radius must be $R \cong 0.40m$. On the other hand, Eq. (26) tells us that in this case, we must have $r_d = 14.1mm$. Thus, if the ferromagnetic tube is covered with insulation of $1mm$ thickness, then the outer radius of the ferromagnetic tube is $r_{out} = r_d - 1mm = 13.1mm$. The area of the cross-section of the ferromagnetic tube, S_{ft}, must be *equal to* the area of the pin cross-section, i.e.,

$$S_{ft} = \pi\left(r_{out}^2 - r_{inner}^2\right) = \pi r_{pin}^2 \qquad (27)$$

where r_{inner} is the inner radius of the ferromagnetic tube.

Therefore, if the pin is covered with insulation of 0.5mm thickness, then we can conclude that $r_{inner} = r_{pin} + 0.5mm$. Consequently, we obtain from Eq. (27) that

$$r_{pin} = 9mm \qquad (28)$$

Then, the area of the cross-section of the pin is

$$S_{pin} = \pi r_{pin}^2 = 2.5 \times 10^{-4}\,m^2 \qquad (29)$$

On the other hand, the *maximum output current* of the Gravelectric Generator shown in Fig.4, according to Eq. 17, will be given by

$$i_{max} = 0.43\sigma S_{pin} \qquad (30)$$

where σ is the electrical conductivity of the *ferromagnetic tube*. If the ferromagnetic tube is made with *Mumetal*($\sigma = 2.1\times 10^6\,S/m$) §, then we get

$$i_{max} \cong 225.7\ Amperes \qquad (31)$$

This is therefore, the *maximum output current* of this Gravelectric Generator. Consequently, the *maximum output* power of this generator is

$$P_{max} = Vi_{max} \cong 49.6kW \qquad (23)$$

3. Conclusion

These results show that the discovery of the *Gravelectric Generators* is very important, because changes completely the design of the electricity generators, becoming cheaper the electricity generation. They can have individual outputs powers of several tens of kW or more. In addition, they are easy to be built, and can easily be transported.

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§ Note that, if the ferromagnetic tube is made with *electrical pure iron* $\left(\sigma = 1.04\times 10^7\,S/m\right)$, the maximum current increases to $i_{max} = 1117.7A$.

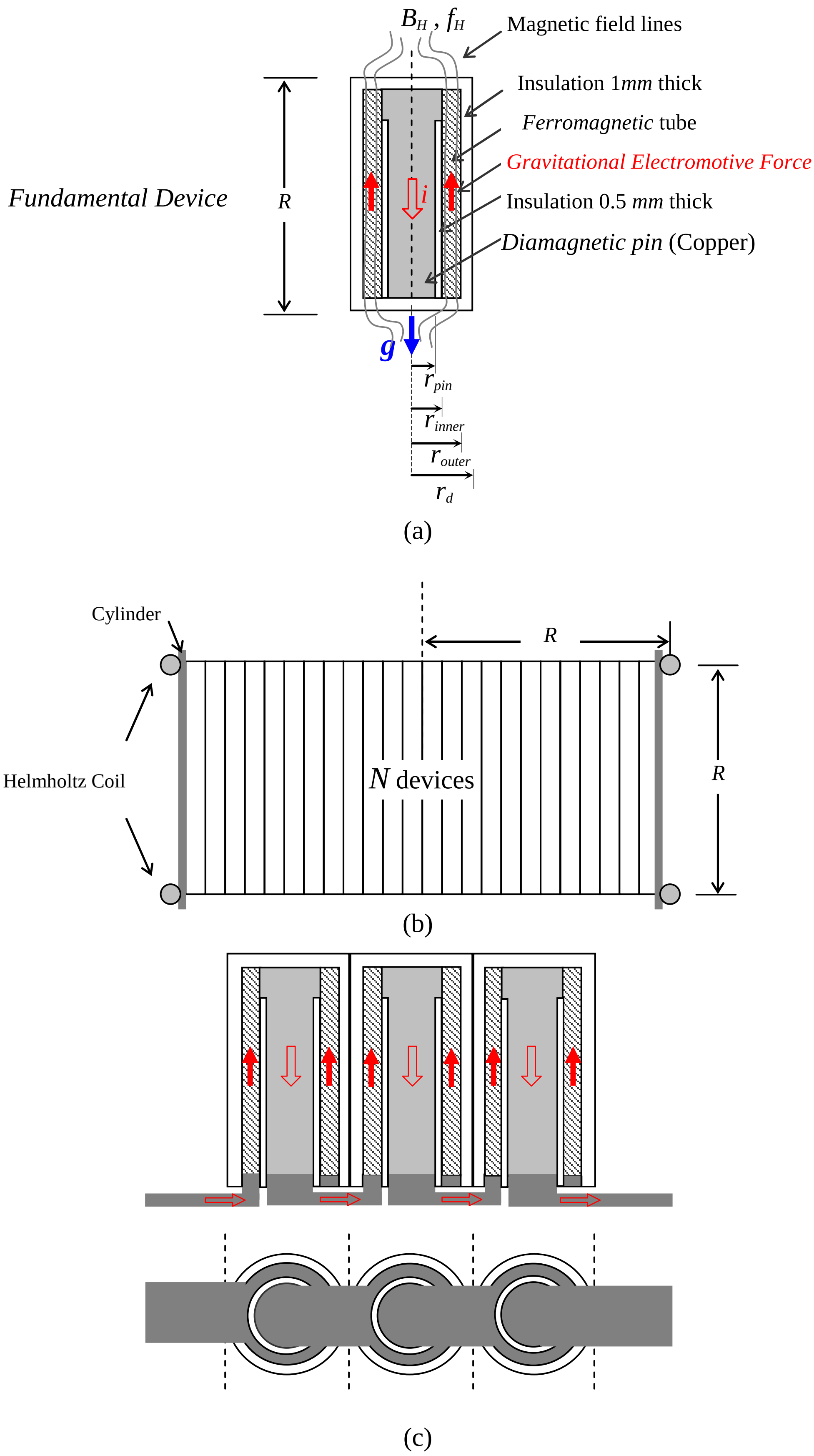

Fig. 4 – Schematic Diagram of another type of *Gravelectric Generator*

APPENDIX

The Eq. (4) of this work is derived from the general equation below (See Eq. (20) of reference [9]).

$$\chi_{Be} = \left\{1-2\left[\sqrt{1+\frac{45.56\pi^2 r_{xe}^{22} B_{rms}^4}{\mu_0^2 m_e^2 c^2 r_e^{18} f^2}}-1\right]\right\} =$$

$$= \left\{1-2\left[\sqrt{1+\frac{45.56\pi^2 k_{xe}^{22} r_e^4 B_{rms}^4}{\mu_0^2 m_e^2 c^2 f^2}}-1\right]\right\} \qquad (I)$$

Therefore, Eq. (4) expresses χ_{Be} in the particular case of $k_{xe} = 1$. However, the values obtained in Eqs. (7) and (8) led us to think that, in the Fermi gas, $k_{xe} > 1$. This conclusion is based on the following: while $r_{xe} \cong 1.4\times10^{-10} m$ (See Eq.(7)), the value of r_e is given by $r_e \cong \Delta x/2 \geq \frac{1}{2}\left(3\pi^2 N/V\right)^{-\frac{1}{3}} \geq 0.37\times10^{-10} m$, which shows that, in the Fermi gas, r_e, *is not smaller than* $0.37\times10^{-10} m$. Therefore, we can write that $r_e^{min} \cong 0.37\times10^{-10} m$. Since $r_{xe} \cong 1.4\times10^{-10} m$, then it follows that $k_{xe}^{max} = r_{xe}/r_e^{min} \cong 3.7$. On the other hand, assuming that $r_e^{max} \cong r_{xe}$, we get $k_{xe}^{min} = r_{xe}/r_e^{max} \cong 1$. Thus, the value of k_{xe} is in the interval $k_{xe}^{min} < k_{xe} < k_{xe}^{max}$. The geometric media for k_{xe}, i.e., $\bar{k}_{xe} = \sqrt{k_{xe}^{min} k_{xe}^{max}} \cong 1.9$, produces a value that possibly should be very close of the real value of k_{xe}. Then, assuming that $k_{xe} \cong \bar{k}_{xe}$ and substituting this value into Eq. (I), we get an approximated value for χ_{Be}, given by

$$\chi_{Be} \cong \left\{1-2\left[\sqrt{1+1.5\times10^{23}\frac{B_{rms}^4}{f^2}}-1\right]\right\} \qquad (II)$$

Note that the numerical coefficient of the term B_{rms}^4/f^2 of this equation is about 1.02×10^5 times greater than the equivalent coefficient of Eq. (10).

Making $B_{rms} = B_{H(rms)}$ and $f = f_H$ (See Eq. (18)), then Eq. (II) can be rewritten as follows

$$\chi_{Be} = \left\{1-2\left[\sqrt{1+1.5\times10^{23}\frac{B_{H(rms)}^4}{f_H^2}}-1\right]\right\} \qquad (III)$$

Substitution of Eq. (III) into Eq. (16), yields

$$V = \left\{1-2\left[\sqrt{1+1.5\times10^{23}\frac{B_{H(rms)}^4}{f_H^2}}-1\right]\right\}\left(\frac{m_{e0}}{e}\right) gl \quad (IV)$$

If $B_{H(rms)} = 0.8T$ and $f_H = 60Hz$, then Eq.(III)gives

$$V \cong 0.46\ l \qquad (V)$$

Note that this equation is approximately equal to Eq. (20). Therefore, the *only change is in the frequency* of the voltage (and current); previously 0.2Hz and now 60Hz (See Fig.5).

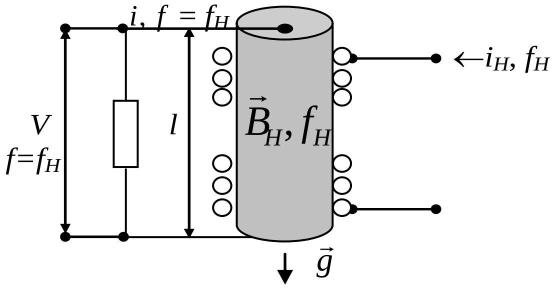

Fig. 5 – The voltage V (and current i) with frequency equal to f_H, now $f_H = 60\,Hz$.

The equations (5) and (6) are also similarly derived from the general expression, i.e.,

$$\chi_{Bp} = \left\{1-2\left[\sqrt{1+\frac{45.56\pi^2 r_{xp}^{22} B_{rms}^4}{\mu_0^2 m_p^2 c^2 r_p^{18} f^2}}-1\right]\right\} =$$

$$= \left\{1-2\left[\sqrt{1+\frac{45.56\pi^2 k_{xp}^{22} r_p^4 B_{rms}^4}{\mu_0^2 m_p^2 c^2 f^2}}-1\right]\right\} \qquad (V)$$

$$\chi_{Bn} = \left\{1-2\left[\sqrt{1+\frac{45.56\pi^2 r_{xn}^{22} B_{rms}^4}{\mu_0^2 m_n^2 c^2 r_n^{18} f^2}}-1\right]\right\} =$$

$$= \left\{1-2\left[\sqrt{1+\frac{45.56\pi^2 k_{xn}^{22} r_n^4 B_{rms}^4}{\mu_0^2 m_n^2 c^2 f^2}}-1\right]\right\} \qquad (VI)$$

With the dimensions previously mentioned the free electrons, if the Fermi gas, have *the size of atoms*, and therefore *they can not cross the atoms of the conductor*. Thus, *passing far from the atoms nuclei*, they practically do not affect the structures of the protons which are in the nuclei of these atoms. In this way, we have that $r_{xp} \cong r_p \rightarrow k_{xp} \cong 1$. Substitution of this value into Eq. (V) leads to Eq. (5).

In the case of the neutrons, due to its *electric charge be null*, we obviously have $k_{xn} = 1$. Substitution of this value into Eq. (VI) leads to Eq. (6).

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