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The Gravelectric Generator

Conversion of Gravitational Energy directly into Electrical Energy

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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.

In a previous paper, we have proposed a system to convert *Gravitational Energy* directly into *Electrical Energy* [1]. This system uses Gravity Control Cells (GCCs). These GCCs can be replaced by the recently discovered *Quantum Controllers of Gravity* (QCGs) [2], 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_n) of the Iron core, are respectively expressed by the following relations [3]

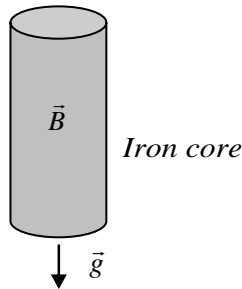


Fig. 1 – An iron core of a coil subjected to a gravity acceleration \vec{g} and magnetic field \vec{B} with frequency f .

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

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

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

m_{ge} , m_{gp} and m_{gn} are respectively the *gravitational* masses of the electrons, protons and neutrons; m_{e0} , m_{p0} and m_{n0} are respectively the *inertial* masses at rest of the electrons, protons and neutrons. The expressions of the *correlations factors* χ_{Be} , χ_{Bp} and χ_{Bn} are deduced in the previously mentioned paper, and are given by

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

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

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

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 $N/V \cong 8.4 \times 10^{28}$ electrons/ m^3 *.

* $N/V = N_0 \rho_{iron} / A_{iron}$; $N_0 = 6.02 \times 10^{26}$ 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 (55.845kg/kmole).

The theory tells us that the total energy of the electrons gas is given by $3NE_F/5$, where $E_F = \hbar^2 k_F^2 / 2m_e$; $k_F = (3\pi^2 N/V)^{1/3}$ (The Fermi sphere). Consequently, the electrons gas is subjected to a pressure $(-3N/5)(dE_F/dV) = 2NE_F/5V$. 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 8.4×10^{28} electrons inside $1m^3$, then we can conclude that the each electron occupies a volume: $V_e = 1.2 \times 10^{-29} m^3$. Assuming $V_e = \frac{4}{3} \pi r_e^3$, for the electron's volume, then we get

$$r_e \cong 1.4 \times 10^{-10} m \quad (7)$$

It is known that *the electron size depends of the place where the electron is*, and that it can vary from the Planck length $10^{-35} m$ ($l_{planck} = \sqrt{\hbar G/c^3} \sim 10^{-35} m$) 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 $\Delta x \cong 2r_e$). 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

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

In the case of *Iron*, ($N/V \cong 8.4 \times 10^{28}$ electrons/ m^3), Eq.(8) gives

$$r_e = \frac{\Delta x}{2} \gtrsim 1 \times 10^{-10} m \quad (9)$$

Comparing with the value given by Eq. (7), we can conclude that $r_e \cong 1.4 \times 10^{-10} m$ 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 $r_p = 1.2 \times 10^{-15} m$, $r_n \cong r_p$. Then, considering these values and assuming $r_e \cong 1.4 \times 10^{-10} m$, we obtain from Eqs. (4) (5) and (6) the following expressions:

$$\chi_{Be} = \left\{ 1 - 2 \left[\sqrt{1 + 1.46 \times 10^8 \frac{B_{rms}^4}{f^2}} - 1 \right] \right\} \quad (10)$$

$$\chi_{Bn} \cong \chi_{Bp} = \left\{ 1 - 2 \left[\sqrt{1 + 2.35 \times 10^{-9} \frac{B_{rms}^4}{f^2}} - 1 \right] \right\} \quad (11)$$

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 [5]. 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 [6].

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

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

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

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

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

[†] 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 [4]. 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.

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 [7]

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

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

$$i = \int \vec{J} \cdot d\vec{S} = \sigma ES = \sigma \left(\frac{V}{l} \right) S \quad (15)$$

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

$$V = \chi_{Be} \left(\frac{m_{e0}}{e} \right) gl \quad (16)$$

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)).

By substitution of Eq. (16) into Eq. (15), we obtain

$$i_{\max} = \chi_{Be} \left(\frac{m_{e0}}{e} \right) \sigma g S \quad (17)$$

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

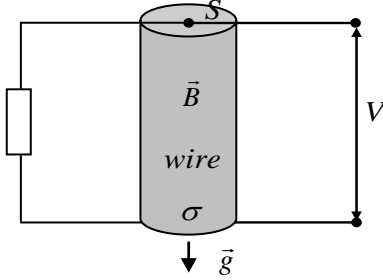


Fig. 2 – The voltage V between the ends of a wire when it is subjected to a uniform magnetic field B with frequency f and gravity g (as shown above).

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

$$\chi_{Be} = \left\{ 1 - 2 \left[\sqrt{1 + 1.46 \times 10^8 \frac{B_H^4(rms)}{f_H^2}} - 1 \right] \right\} \quad (18)$$

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

$$V = \chi_{Be} \left(\frac{m_{e0}}{e} \right) gl = \left\{ 1 - 2 \left[\sqrt{1 + 1.46 \times 10^8 \frac{B_H^4(rms)}{f_H^2}} - 1 \right] \right\} \left(\frac{m_{e0}}{e} \right) gl \quad (19)$$

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

$$V \cong 0.43 l \quad (20)$$

In order to obtain $V = 220volts$, the total length l of the iron wire used in the *Toroidal coil* 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.,

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

Since the electrical conductivity of the iron is $\sigma = 1.04 \times 10^7 S/m$ and, assuming that the diameter of the iron wire is $\phi_{ironwire} = 4mm$, ($S = \pi \phi_{ironwire}^2 / 4 = 1.25 \times 10^{-5} m^2$), then we get

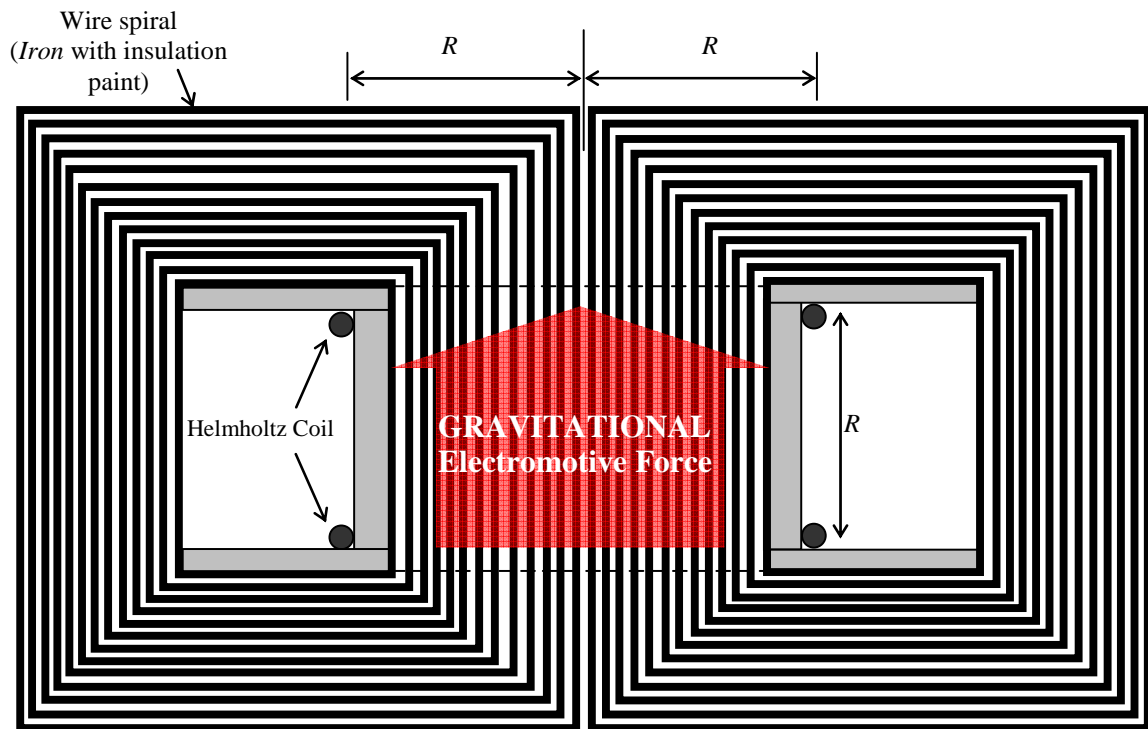
$$i_{\max} \cong 56 \text{ Amperes} \quad (22)$$

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

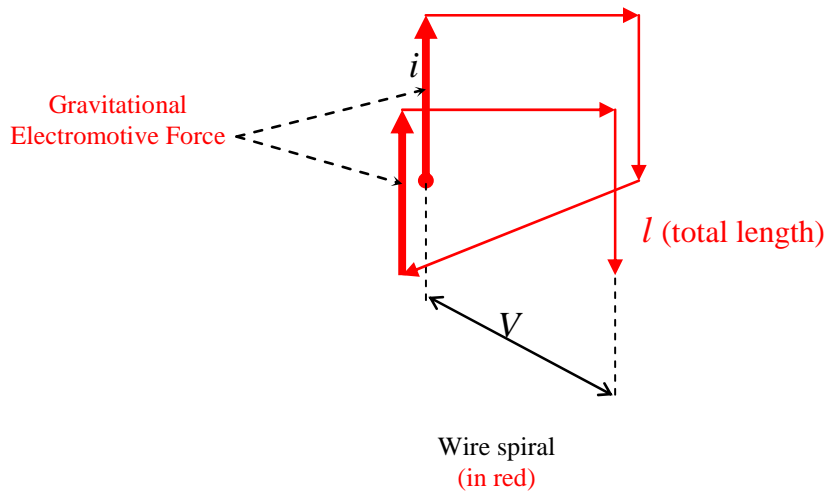
$$P_{\max} = Vi_{\max} \cong 12.3kW \quad (23)$$

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 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.

‡ The magnetic field at the midpoint between the coils is $B_H = 0.7 \mu_r \mu_0 Ni / R$. Here $\mu_r \cong 4000$ (*pure iron*; commercially called *electrical pure iron* (99.5% of iron and less than 0.5% of impurities.)



(a)



(b)

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

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 $V = 220\text{volts}$ (assuming the same value of $\chi_{Be} = 0.43$ given by Eq. (18)) the total length l must have 511.63m . This means that

$$N(2R) = 511.63\text{m} \quad (24)$$

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

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

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

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

Equation (24) tells us that for $N = 640$ devices, the cylinder radius must be

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

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

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 $r_{inner} = r_{pin} + 0.5\text{mm}$. Consequently, we obtain from Eq. (27) that

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

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

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

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

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

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

$$i_{max} \cong 2257 \text{Amperes} \quad (31)$$

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

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

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

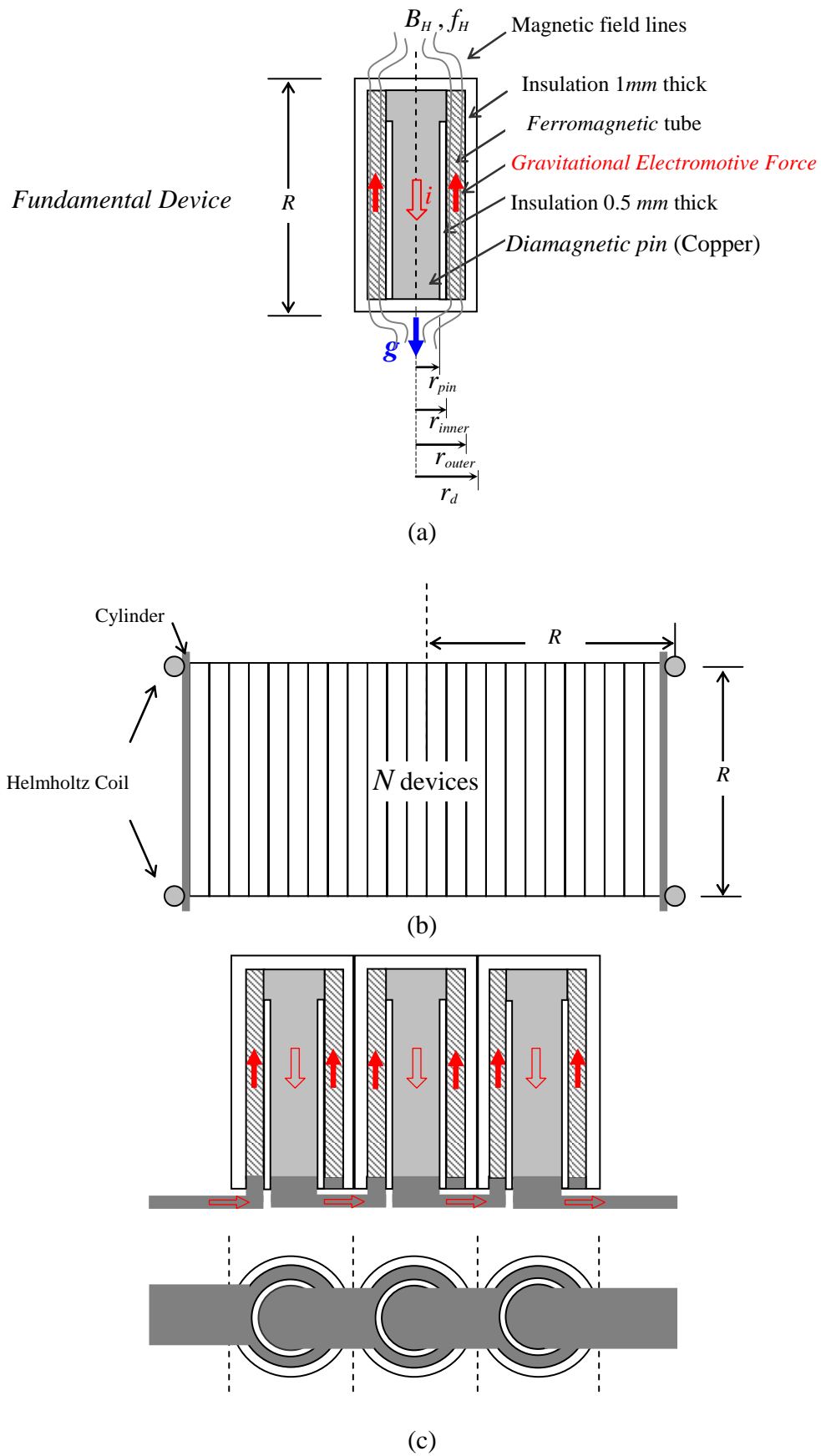


Fig. 4 – Schematic Diagram of another type of *Gravelectric Generator*

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