Usually, the electromotive force (EMF) 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. It was previously called of Gravelectric Generator [1]. Here we show a new design for the Gravelectric Generator. This system can have individual outputs powers of several tens of kW or more.

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

1. **INTRODUCTION**

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. In a previous paper we have shown that this force can have gravitational nature (Gravitational Electromotive Force), and we have proposed a system to produce Gravitational Electromotive Force, called Gravelectric Generator, which converts Gravitational Energy directly into Electrical Energy [1].

A new design for the Gravelectric Generator is shown in this paper. This system can have individual outputs powers of several tens of kW. It is easy to be built, and can easily be transported.

2. **THEORY**

Consider a coil with iron core. Through the coil passes a electrical current \(i\), with frequency \(f_{ct}\). Thus, there is a magnetic field with frequency \(f_{ct}\) through the iron core. If the system is subject to a gravity acceleration \(g\), 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 [2]

\[
F_e = m_{ge}a_e = \chi_{Be}m_{e0}g
\]

\[
F_p = m_{gp}a_p = \chi_{Bp}m_{p0}g
\]

\[
F_n = m_{gn}a_n = \chi_{Bn}m_{n0}g
\]

where \(m_{ge}, m_{gp}\) 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 correlation factors \(\chi_{Be}, \chi_{Bp}\) and \(\chi_{Bn}\) are deduced in the paper [3] and Appendix of [1], and are given by

\[
\chi_{Be} = \left[1 - 2\left\{1 + \frac{45.56 \pi^2 r_{se}^2 e^4 B_{rms}^4}{\mu_0^2 m_e^2 c^2 f^2} - 1\right\}\right]^{1/2} = 1 - 2\left\{1 + 1.5 \times 10^{-35} B_{rms}^4 f^2 - 1\right\}
\]

(4)

\[
\chi_{Bp} = \left[1 - 2\left\{1 + \frac{45.56 \pi^2 r_{sp}^2 e^4 B_{rms}^4}{\mu_0^2 m_p^2 c^2 f^2} - 1\right\}\right]^{1/2}
\]

(5)

\[
\chi_{Bn} = \left[1 - 2\left\{1 + \frac{45.56 \pi^2 r_{sn}^2 e^4 B_{rms}^4}{\mu_0^2 m_n^2 c^2 f^2} - 1\right\}\right]^{1/2}
\]

(6)

where \(k_{se} \approx 1.9\) (See [3] and Appendix of [1]);

\(r_e \approx 1.4 \times 10^{-10}\ m; \quad r_p = 1.2 \times 10^{-15}\ m, r_n \approx r_p\). [1].

Note that \(\chi_{Bn}\) and \(\chi_{Bp}\) are negligible in respect to \(\chi_{Be}\).

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 [4]. 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 [5].

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 \[ m_{ge} g = eE \] (7)

According to Eq. (1) we can rewrite Eq. (7) as follows

\[ \chi_{be} m_{ei} g = eE \] (8)

Now consider a wire with length \( l \); cross-section area \( S \) and electrical conductivity \( \sigma \). 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 [6]

\[ V = \int \vec{E} \cdot d\vec{l} = El \] (9)

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

\[ i = \int \vec{J} \cdot d\vec{S} = \sigma ES = \sigma (V/l)S \] (10)

By substitution of \( E \), given by Eq.(9), into Eq.(8) yields

\[ V = \chi_{be} (m_{ei}/e)gl \] (11)

This is the voltage \( V \) between the ends of a metallic cylinder, when it has conductivity \( \sigma \) and cross-section area \( S \), and it is subjected to a uniform magnetic field \( B_H \) with frequency \( f_H \), and a gravity \( g \) (as shown in Fig.(1)) (The expression of \( \chi_{be} \) is given by Eq. (4)). Substitution of Eq. (11) into Eq. (10), gives

\[ i = \chi_{be} (m_{ei}/e)\sigma gS \] (12)

Substitution of Eq. (4) into Eq. (11) and Eq.(12) yields respectively

\[ V = \left[ 1 - 2 \left( 1 + 1.5 \times 10^{-15} \frac{B_{rms}^4}{f_H^2} - 1 \right) \right] \left( \frac{m_{ei}}{e} \right) gl \] (13)

and

\[ i = \left[ 1 - 2 \left( 1 + 1.5 \times 10^{-15} \frac{B_{rms}^4}{f_H^2} - 1 \right) \right] \left( \frac{m_{ei}}{e} \right) \sigma gS \] (14)

If \( B_{rms} = B_H(rms) = 1.2T \) † and \( f = f_H = 60Hz \), then Eq. (13) and (14) give, respectively

\[ V \simeq 1.03 \ l \] (15)

\[ i = 1.03 \sigma S \] (16)

Thus, for \( l = 215.2m \) \( (l_{pin} = 0.18m) \), \( l_c = 0.46m \), \( l_v = 0.52m \) and \( x = 10mm \). See Fig.2), Eq. (15) gives \( V \approx 220volts \). On the other hand, since \( \sigma_{iron} = 1.03 \times 10^7 S.m^{-1} \), then Eq. (16) gives

\[ i_{max(\text{theoretical})} = 1.06 \times 10^7 x^2 = 1060 \ A \]

However, the maximum current supported by a 10 mm square pin is approximately 300A. Consequently, we can write that

\[ P_{max(\text{theoretical})} = 220 \times 300 = 66kW \approx 88.5HP \] (17)

3. CONCLUSION

Using two of this Gravellectric Generator in parallel it is possible to obtain an output of 220V; 60Hz; 1771HP. This power is sufficient to feed the electric motor of most electric cars.

In the US typical household power consumption is about 1.3 kW per hour. In 2013, the average annual electricity consumption for a U.S. residential utility customer was 10,908KWh [7]. Then, in order to provide the amount energy of 1.3 kWh it is necessary that the electric generator has power \( P = 1300kWh/720h = 1.8kW \). Equation (17) shows that the Gravellectric Generator is able to produce much more than this value.

† This value is based on the well-know fact that, a modern 60 Hz power transformer will probably have a magnetic flux density between 1 and 2T inside the core. Thus, 1.2T can be easily obtained in the device here proposed.
Note that: A modern well-designed 60 Hz power transformer will probably have a magnetic flux density between 1 and 2 T inside the core.

\[ B_{\text{rms}}(\text{rms}) = 1.2 \text{ T} \] (Gravitational Electromotive Force (GEMF); The GEMF produced in the Aluminum pins have opposite direction to the produced in the ferromagnetic pins. But, it is negligible in comparison with this one because \( B_{\text{rms}} \) in the Aluminum pins is \( \ll 1.2 \text{ T} \). See Eqs. (13) and (14)).

Number total of ferromagnetic pins: \( N \approx \frac{l_1}{2\pi} \); Total length of the ferromagnetic pins: \( l = N l_{\text{pin}} = \frac{l_1 l_{\text{pin}}}{2\pi} \)

\( l_{\text{pin}} \) is the length of 1 pin). For \( l_{\text{pin}} = 0.18m, l_x = 0.46m, l_y = 0.52m \) and \( x = 10mm \), we get \( l = 215.2m \).

Fig. 2 - Schematic diagram of a more compact and powerful type of Grav-electric Generator.
References


Appendix: Micro Gravelectric Generator for Mobile Phone

Consider a pure iron disk ($\mu = 20,000$ and $\sigma_{\mu m} = 1.03 \times 10^7 \text{ S.m}^{-1}$), with the following dimensions: $\phi = 3 \text{ mm}$ and $h = 5 \text{ mm}$. This disk is the core of a coil with 24 turns of # 32 AWG $\phi_{\text{wire}} = 0.203 \text{ mm}$ (length of the wire $l = \pi \phi (24 \text{ turns}) = 0.22 \text{ m}$; Area of the Cross-section of the wire $S = \frac{\pi}{4} \phi_{\text{wire}}^2 = 3.23 \times 10^{-8} \text{ m}^2$). Under these conditions, and for an electrical current of 1.7 mA (For # 32 AWG $i_{\text{max}} = 0.1 \text{ A}$) through the coil, it is possible to produce a magnetic field through the core with intensity $B_{\text{rms}} = B_{H(rms)} = 0.2 \text{T}$, and $f = f_{fr} = 1 \text{ Hz}$. Then, Eqs. (13) and (14) tell us that

$$V \approx 1.72 \text{ volts} \quad (I)$$

$$i_{\text{max( theoretical)}} = 1.72 \sigma S = 0.57 \text{ A} \quad (II)$$

Since the maximum current supported by # 32 AWG is $i_{\text{max}} = 0.1 \text{ A}$, then we can write that the maximum outlet power of this Micro Gravelectric Generator is

$$P_{\text{max( theoretical)}} = 0.37 \times 0.57 \approx 0.2 \text{ W} \quad (III)$$

This power is sufficient to feed the most of modern mobile phones.

Now consider this Micro Gravelectric Generator inside a mobile phone. As shown in Fig. 4, the Micro Gravelectric Generator produces the electrical current $i$ at any position of the phone, in respect to Earth’s surface. Also note that, the direction of the Gravitational Electromotive Force (vector in blue) is always in opposition to gravity (g), because $\chi_{\text{fr}}$ is negative.

Finally, the most important fact to be observed here is that the electrical energy, which comes from the Gravelectric Generator, is directly converted from the Gravitational Energy, which is a type of renewable energy, always available for use, and that never ends.

![Fig. 4 – Schematic diagram of a Micro Gravelectric Generator inside a mobile phone. Note that the Gravelectric Generator produces the electrical current $i$ at any position of the phone, in respect to Earth’s surface. Also note that, the direction of the Gravitational Electromotive Force (vector in blue) is always in opposition to gravity (g), because $\chi_{\text{fr}}$ is negative.](image-url)