Power from Electrostatic Charges

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ABSTRACT: This article aims to investigate the possibility of using atmospheric and earth electrostatic charges, and sea water ions in electric energy generation systems. To do this, it is developed a set of equations based on the Lorentz's force to collect electric charges and ions to work as an electric current power source. These charges have more mobility then the valence electrons of electric conducting materials, then they will perform work when they are added to any electrical circuit.

KEYWORDS: atmospheric electrostatic field, electrostatic charges, electric current source, Lorentz's force, sea water ions, magnetic vortex.

Contents

1 Introduction

There is a major reason for studying the use of electrostatic charges and ions as sources of electricity: they are abundantly available in Nature. In this paper we will develop some methods to

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collect electrostatic charges of air and earth, and sea water ions by the principle of Lorentz's force, with the use of magnetic fields.

Unlike the actual means of electricity production, these electrostatic charges and ions are easily collected and stored, allowing abundant production of electric energy directly from natural reservoirs, that is atmosphere, earth and sea, so no currently used conversion methods are required. Having collected these charges, they may be used as electric current source and, because they have greater mobility, replace the valence layer electrons of conductive materials. Then, if we electrically connect the electrostatic/ion reservoir to a power source of certain electric potential (DC or AC of any voltage), the input electric current of the power source will decrease and the electric current of the load will be supplied by the electrostatic/ion current source.

The principle of the Lorentz's force is that moving electric charges subjected to a magnetic field suffer a force given by:

$$\vec{F}=q_E(\vec{v}\times\vec{B}) \quad \text{and} \quad F=|q_E|\,v\,B\sin(\theta) \quad .$$

With:

F = Force [N];
q_E = Electric charge [C];
v = Speed of the electric charge [m s^{-1}];
B = Surface density of magnetic charge [Wb m^{-2}] [T];
θ = Angle between trajectory and magnetic field [rad] [°].

The above equation is useful for electric charges that are in movement, such as air or sea water currents or forced air tunnels. For situations where these charges are stationary, with some manipulation, we have the force exerted on a stationary electric charge by a time varying magnetic field:

$$\vec{F}=q_E(\vec{v}\times\vec{B})=q_E\left(\frac{d\vec{l}}{dt}\times\vec{B}\right)=q_E\left(\vec{l}\times\frac{d\vec{B}}{dt}\right) \quad .$$

The time varying magnetic field, in a point of space, may be produced with the movement of a constant magnetic field (as a permanent magnet) or the time variation of a stationary field (as an AC powered electromagnet).

2 Electricity from the Atmospheric Air

The earth is constantly bombarded by radiation from outer space that interacts with gas molecules in the atmosphere to create a scattering of secondary ionizing radiation that ensures that the atmosphere is weakly conductive and constantly charged with new ions. This way, the earth with its atmosphere looks like a charged spherical capacitor.

The total potential difference from the surface of the earth to the top of the atmosphere is about 400,000 Volts. The air above the surface is positively charged, while the terrestrial surface charge is negative. But because the air is not a perfect insulator, there is an electric current density continuously flowing to the earth's surface of only 10^{-12} A/m^2, that adds up to 1,800 A at any time, considering the total surface of the earth. That is a power of 700 MW.[1]

The distribution of these charges into the atmosphere provides a density of electrostatic charges that varies with altitude. The electron density of atmospheric air, at sea level where the pressure is 1 atmosphere, is $4*10^{25}$ electrons/m^3. At the pressure of 1 atmosphere and temperature of 300 K there are approximately $2.447*10^{25}$ molecules or atoms of gases per m^3, so there are 1.63 electrons/molecule. The relationship between the pressure and the electric charge density of the atmosphere at the temperature of 300 K is:

$$q_{Em3} = n_e e P_{[atm]} = 4 * 10^{25} * 1.602 * 10^{-19} * P_{[atm]} = 6.408 * 10^{6} * P_{[atm]} C m^{-3} \quad .$$

With:

q_{Em3} = Density of electric charge [C m^{-3}];
n_e = Density of electrons in the atmosphere [electrons m^{-3}];
e = Electric charge of electron = $1.602*10^{-19}$ C;
$P_{[atm]}$ = Atmospheric pressure [atm].

2.1 Accumulated Energy in the Atmosphere

The energy of the electric field stored in the atmosphere from the ground up to 50 km altitude can be calculated by considering that the air layer corresponds to the electrolyte of a spherical capacitor with one face on the planet surface and the other face 50 km away. The diameter of the planet is 12,800 km, so the capacitance of the spherical capacitor corresponding to the atmosphere is given by:

$$C = \varepsilon_0 \frac{S}{d} = \varepsilon_0 \frac{4\pi r_1 r_2}{r_2 - r_1} = 8.854 * 10^{-12} \frac{4\pi * 6.400 * 10^{6} * 6.450 * 10^{6}}{6.450 * 10^{6} - 6.400 * 10^{6}} = 9.186 * 10^{-2} F \quad .$$

With:

C = Capacitance [C V^{-1}] [F];
ε_0 = Electric permittivity of air = $8.854*10^{-12}$ C V^{-1} m^{-1} [F m^{-1}];
r_1 = Radius of the planet = $6.400*10^{6}$ m;
r_2 = Radius of the planet + 50 km = $6.450*10^{6}$ m;
S = Spherical capacitor surface = $4\pi r^2 = 4\pi r_1 r_2 = 5{,}187 * 10^{14} m^2$;
d = Distance between capacitor plates = $r_2 - r_1$ = $5.00*10^{4}$ m.

The average electric field of the atmosphere is about 120 V/m, which corresponds to a surface density of electric charge D = ε_0E = $-1.1*10^{-9}$ C/m^2. Integrated into the earth's surface results a total negative charge of $-5.5*10^{5}$ C, while in the atmosphere there is a similar positive charge. Because there is an exponential increase in altitude conductivity, the electric field decreases exponentially. At an altitude of 30 km, the electric field is 300 mV/m. Integrating the electric field from the surface to the ionosphere we have a potential difference of 400 kV.

The electrostatic energy stored in the atmospheric layer is:

$$U = \frac{1}{2} C V_E^2 = \frac{1}{2} 9.186 * 10^{-2} \left(4.00 * 10^{5}\right)^2 = 7.35 * 10^{9} Joules \quad .$$

With:

U = Potential energy [J];
C = Capacitance = $9.186*10^{-2}$ F;
V = Electric potential stored in the capacitor = $4.00*10^{5}$ V.

2.2 Inexhaustible Energy

The distribution of electrostatic charges in the atmosphere creates an electric field with the establishment of a positive potential in the upper layers of the atmosphere and a negative potential in the planet ground. Due to the high impedance of this source, it is possible to collect electricity directly from the air by projecting these charges towards a collector. The excess of electrostatic charges can be transferred from the collector to any electrical circuit by simple electrical connection, as it behaves as a source of electric current.

One method for continuously extracting electrical energy from the atmosphere is by concentrating the dispersed electrostatic charge particles through a magnetic vortex created by the rotation of electromagnets or permanent magnets through the Lorentz force, which is the principle on which Faraday's disc is based. A rotating magnetic field passes through the air and pushes the electrostatic charges perpendicular to the direction of the field and the rotational speed of this field.

The two energy poles created are: a positive electric pole in the center of the magnetic core and a negative electric pole in the perimeter of the magnetic field. In fact, while negatively charged particles are deflected to the periphery, positively charged particles are deflected to the center. This center of positive charges, which is where there is less concentration of negative charges than in the surrounding environment, attracts new negative charges that are again deflected to the periphery. Thus, although the atmosphere equalizes the concentration of ions, while the magnetized object remains spinning, the ionic imbalance between the center and the periphery will remain, which can be used as an inexhaustible source of electric energy.

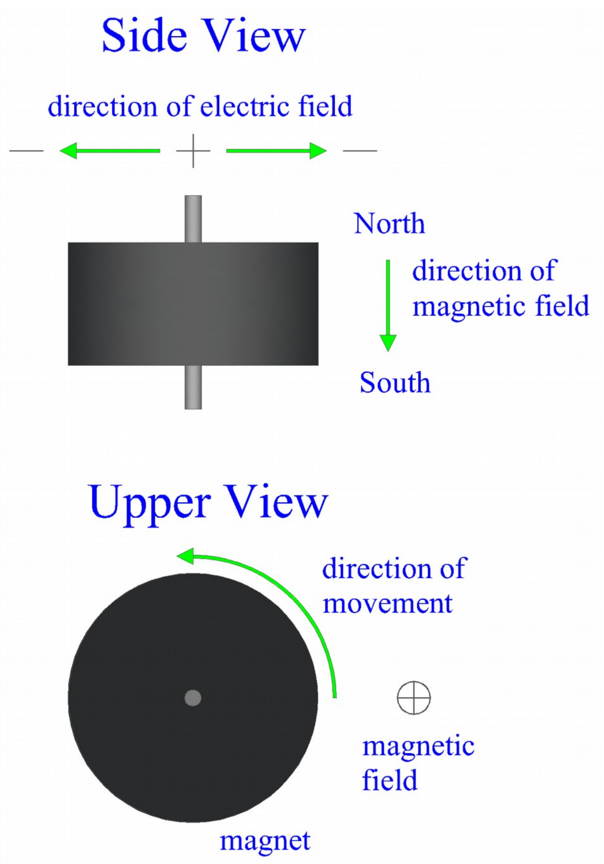

Figure 1: Magnet rotation principle.

The text below confirms the possibility of extracting electric charges from the electrostatic field of the atmosphere with its deflection.[2]

> … To create a vortex that operates on the physical dimension in a similar way, we must rotate a physical object that is or can be magnetized. By rotating a magnetized object we will create a vortex that induces the energy of space to move toward its neutral center. Once the energy particles of space are attracted into the vortex by magnetic attraction, they assume orbital positions around the center of the magnetic nucleus. Accumulation of energy particles around the rotating magnetic center generates a high density magnetic field. In this condition we can create two poles, one at the center of the magnetic core and one at the perimeter of the magnetic field. Here we can perpetually draw energy in the form of positive and negative electric current.
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> …
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> … This system does not require external sources of energy to function, such as fossil fuels or nuclear power. This generator self-perpetuates because it produces more energy than it consumes to run. We can therefore have an unlimited source of totally free energy.

An improved system from this simple model can be constructed by fixing several magnets along the perimeter of a mechanical support (such as a disc) whose center of rotation is coupled to the shaft of a motor. To create a magnetic vortex, the most suitable configuration for mounting is with radially positioned magnetic bars – the magnetic polarization of the magnets is axial, with the north poles facing the same direction and the south poles in the opposite direction. Deflected electrostatic charges are collected by a plate or strap of electrical conductive material placed some distance from the periphery of the rotating disk.

The configuration of this energy vortex resembles the torus.

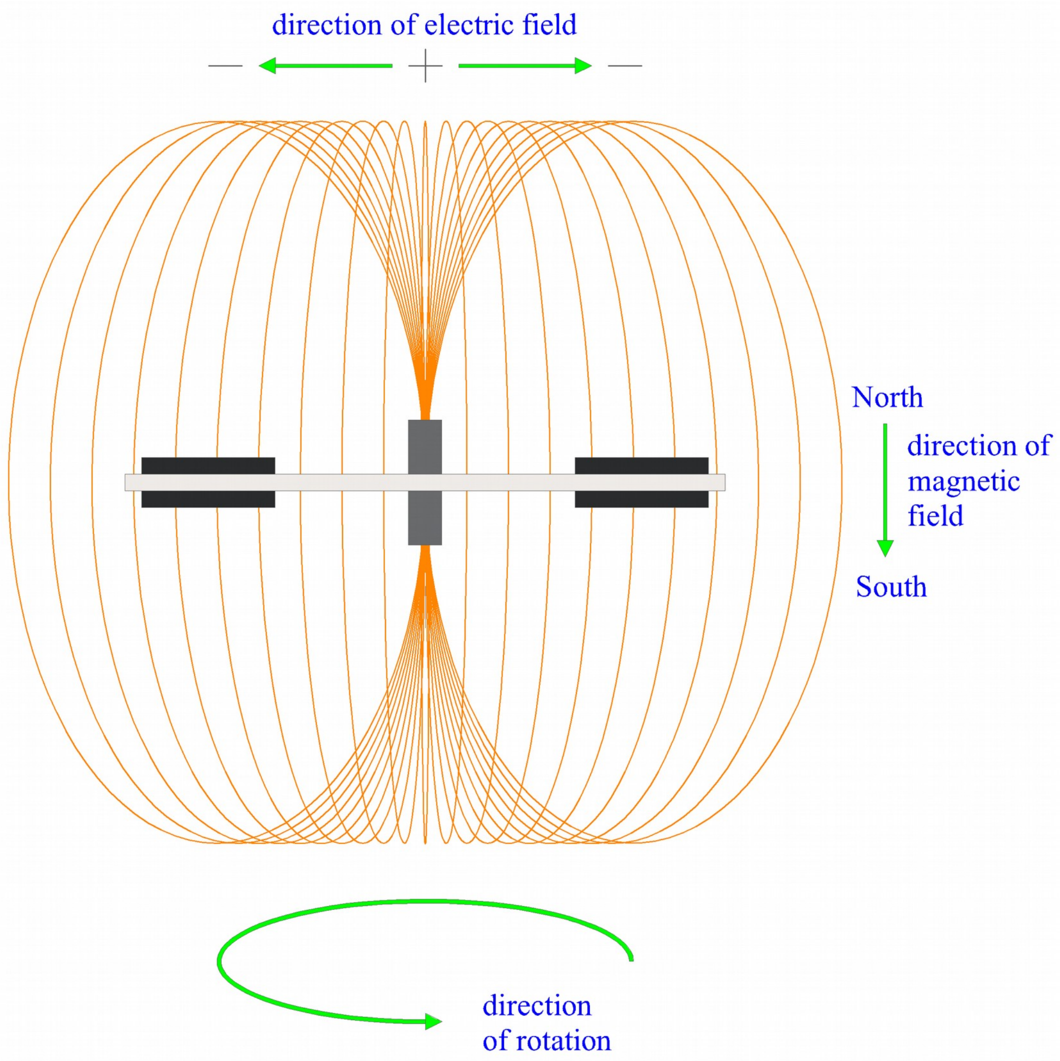

Figure 2: Magnetic vortex configuration.

Applying the right-hand rule in the configuration described, the electric field forms in the radial direction (perpendicular to the axis) as a consequence of the axial magnetic field (parallel to the axis) and angular velocity (whose tangential component is perpendicular to both the electric and magnetic fields). The magnetic field vortex that moves the energy particles is due to the sum of the following effects:

1. The rotation of the magnetic fields of the magnets deflects the energy particles (electrostatic charges) from the environment and separates the positive from the negative charges as a result of the Lorentz's force.
2. Positive charges are accumulated at the neutral center of the assembly, and negative charges are projected to the periphery in orbital positions, depending on their charge and mass.
3. These charges move in a circular motion because of the assembly rotation, which drags them around the axis of rotation and makes them equivalent to an electric current ring.
4. This circular electric current creates an axial magnetic field (parallel to the axis of rotation) in the center of the assembly that reinforces the individual magnetic field of the magnets and thus deflects a greater amount of ambient charges.
5. Positive charges concentrated at the center and negative charges projected at the periphery form a high electrostatic field. These electric charges can be collected in the form of electric current.

6. The kinetic energy of the deflected charges is sufficient to dissociate the surrounding air molecules, thus producing more ions that are also deflected.
7. The dissociation of air molecules causes a drop in the atmospheric pressure of the assembly and, because of this pressure difference, more atmospheric air is pushed to its center.
8. Positive charges concentrated in the center of the set attract negative charges from the environment through the two vortex cones and they are deflected at the periphery. Negative charges concentrated at the periphery of the assembly attract the positive charges of the environment and they are deflected to the center by the Lorentz's force.
9. The set will find a balance that depends on the intensity of the magnetic field generated and its rotational speed. The current consumption by the load causes an imbalance in the set, which is immediately corrected by the deflection of new electrical charges.
10. The energy particles from the environment, being constantly attracted to the neutral magnetic center of the array, are constantly deflected by the magnetic field and can be indefinitely collected, providing a constant supply of electric energy.

The electrostatic field of the atmosphere is an inexhaustible source of free electrostatic charges. When projected to the periphery and center of the vortex, they will collide with metal collecting plates that are electrically insulated, which will keep them dispersed on their surface creating a high surface density of electric charges. As long as these collecting plates are electrically insulated, the created electric field will tend to rise until it finds a balance between Lorentz's force, collisions with air molecules and electric field strength. These charges can be conducted to any electrical circuit with a simple electric contact because, being in excess in the collecting plate, they will follow the circuit seeking a uniform surface distribution of charges.

In conventional electric circuits, the electric current is a consequence of the movement of electrons from the conductor valence layer and, due to internal collisions with atoms of the conducting material, cause thermal losses. Electrostatic charges that flow from the collector plates to the circuit run across the surface of the conductive metal to the load connected to the electric system and show no heat loss, reducing the electric current at the electrical system inlet because they are more mobile. Due to the electrical resistance of the circuit, they perform work in the same way as conventional electric current.

2.3 Electric Charge Gathering by Magnetic Vortex

There are two ways to work with magnet rotation: positioning magnets with radial or axial magnetic orientation. Both configurations allow separating negative electric charges from positive ones dispersed in the atmosphere by collecting them into electrodes. But only the device that has magnets with axial magnetic polarization allows the formation of the magnetic vortex that amplifies the individual magnetic field of the magnets. Despite this difference, we present a description of each of these configurations.

2.3.1 Radial Magnetic Polarization

The system consists of:

1. A horizontally positioned disc of insulating material coupled to the axis of a motor with 12 radial magnetic polarization magnets fixed to the disc in regular spaces;
2. Two circular metallic electrodes: one on the upper side and one on the lower side of the disc;
3. A motor with speed control.

The motor shaft extends vertically to the center of the disc. The two electrodes are fixed and come into contact with the ions that, due to the magnetic force of the rotating disc magnets, will accumulate on the top and bottom sides of the disc, according to their polarity.

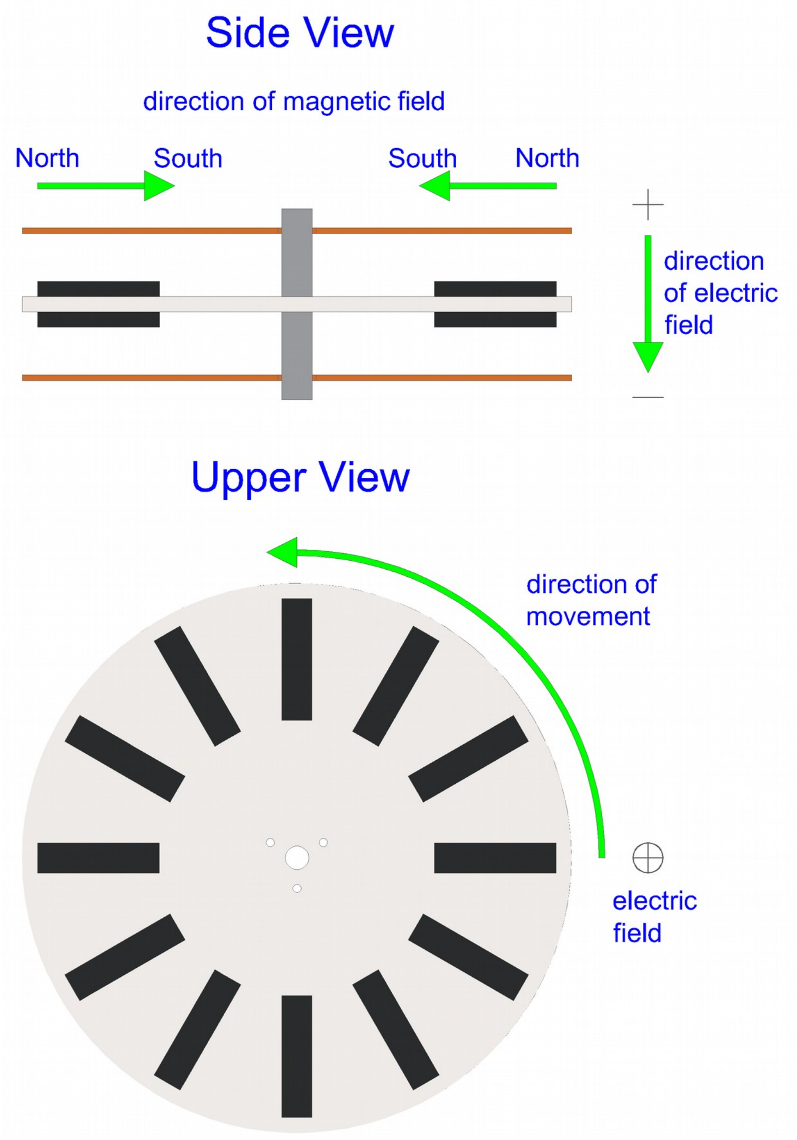

Figure 3: Radial magnetic field ion collector.

2.3.2 Axial Magnetic Polarization

The system consists of:

1. A horizontally positioned disc of insulating material coupled to the axis of a motor with 12 axial magnetic polarization magnets fixed to the disc in regular spaces;
2. One metallic electrode, which serves as the disc axis and coupled to the motor;
3. One concave-shaped metallic electrode around the disc;
4. A motor with speed control.

The motor shaft extends vertically to the center of the disc. The electrode around the perimeter remains fixed and contacts the ions that, by the magnetic force of the magnets fixed to the rotating disc, will move to the disk shaft or the periphery of the disk, according to its polarity. The collecting plate at the perimeter of the disc may be concave-shaped to collect a larger amount of projected charges at the periphery of the disc. We recommend rotating the disk in the direction that negative ions are projected to the periphery of the disk, as this is the preferred vortex direction by Nature.

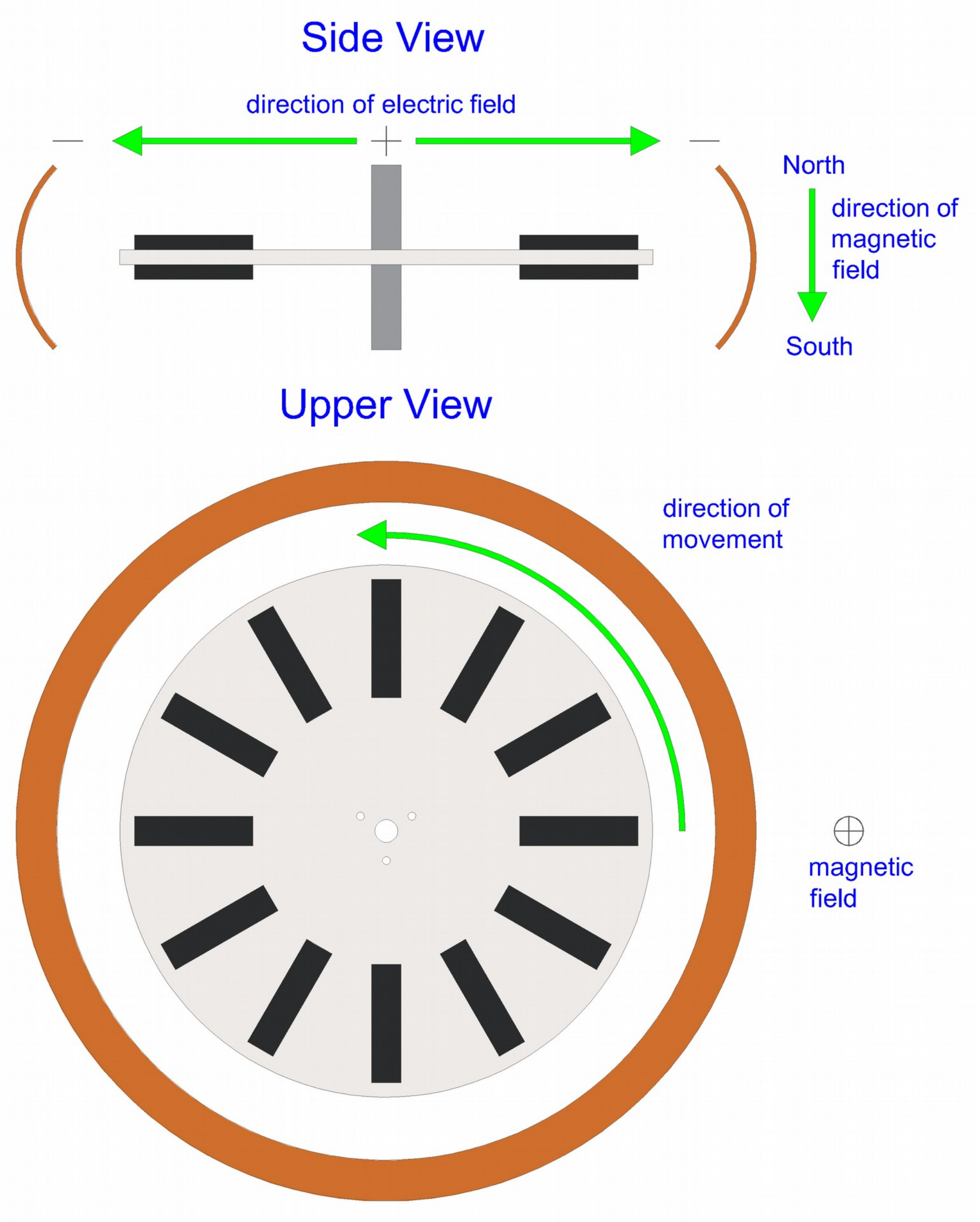

Figure 4: Axial magnetic field ion collector.

2.3.3 Mathematical Model for Magnetic Vortex

In order to calculate the above devices, we first need to know the amount of electric charges from the atmosphere that the system displaces to the disc periphery in the time unit. At the nominal rotation of the disc, it displaces an amount of electric charges proportional to the following variables:

- Density of electric charge of the atmosphere, which is given by $n_e q_E$;
- Quantity of magnets on the disc;
- Area of the magnetized surface of each magnet where the magnetic field is maximum;
- Field penetration distance of magnets in air, which depends on the surface density of magnetic charge B of the magnets.

The total displaced electric charge is:

$$Q_E = N n_e q_E S d \quad .$$

With:

Q_E = Electric charge [C];
N = Amount of magnets on the disc;
n_e = Ion density of atmosphere = $4*10^{25}$ electrons m^{-3};
q_E = Electric charge of ion [C];
S = Magnet area [m^2];
d = Magnetic penetration distance [m].

In order for the amount of charges calculated above to be displaced and collected in the electrode, it is necessary that the electric charges of the air volume under the influence of the magnetic field undergo a radial acceleration given by $\vec{a}=\vec{F}/m=q_E\vec{E}/m=q_E(\vec{v}\times\vec{B})/m$ and travel the distance from the magnets to the charge collecting plate, the electrode. If the speed of the disc is not sufficient to produce an acceleration that exceeds air collisions and prevents these ions from shifting due to the electrostatic field of the atmosphere, no charge will reach the collector. At higher speeds, only part of these charges will reach the collector.

We will consider that the acceleration of electric charges occurs only while under the influence of the maximum magnetic field of the magnets, that is, while they are on the surface within the field penetration distance. Outside this volume there is no acceleration because the intensity of the magnetic field decreases with the square of the distance, and during the path until the charges reach the collector, the velocity reached at the end of the acceleration will be decreased by collisions with air gas molecules, and there will also be absorption into the atmosphere thanks to its electrostatic field.

To simplify the calculations, we will consider that the ion-collecting metallic plate is positioned at a distance where the influence of the magnetic field on the electric charges is still sufficient to maintain a constant drag velocity. Under these conditions, the distance traveled by the electric charges is given by:

$$d_T=d_2+d_1=v_0t_2+\frac{at_1^2}{2} \quad , \quad d_1=\frac{l_m}{2} \quad , \quad d_2=r_c-(r_m+d_1) \quad , \quad v_o=at_1 \quad , \quad a=\frac{F}{m}=\frac{q_E vB}{m} \quad .$$

With:

d_T = Distance traveled to the collecting belt [m];
d_1 = Distance traveled during acceleration [m];
d_2 = Distance traveled during average drag speed [m];
l_m = Magnet length [m];
t_1 = Acceleration time [s];
t_2 = Constant speed time [s];
r_c = Distance from collecting plate to motor shaft [m];
r_m = Distance from center of magnets to motor shaft [m];
v_0 = Maximum velocity of ions (at the end of acceleration) [m s^{-1}];
v = Tangential speed of magnets [m s^{-1}];
a = Acceleration of ions [m s^{-2}];
F = Force on ions [N];
q_E = Electric charge of ion [C];
m = Mass of ion [kg];
B = Surface density of magnetic charge of magnets [Wb m^{-2}] [T].

The charges will be accelerated while traveling d_1, where they will be under the influence of the total magnetic field of the magnets during time t_1, and will travel the path d_2 to the collecting plate with average drag speed during time t_2. The total time that the total amount of charges $Q_E=Nn_eq_ESd$ takes to collide with the collecting plate is $t=t_1+t_2$, which is the time that each of the charges under the influence of the total magnetic field of the magnets takes to reach the collecting plate. Thus we have:

$$F=q_E v B=q_E(\omega r_m)B \quad , \quad \omega=2\pi f=2\pi\frac{v_{RPM}}{60} \quad ;$$

$$a=\frac{F}{m}=\frac{q_E B\omega r_m}{m} \quad ; \quad d_1=\frac{l_m}{2}=\frac{a t_1^2}{2} \quad ; \quad t_1=\sqrt{\frac{l_m}{a}}=\sqrt{\frac{m l_m}{q_E B\omega r_m}} \quad ;$$

$$v_0=a t_1=a\sqrt{\frac{l_m}{a}}=\sqrt{a l_m}=\sqrt{\frac{q_E B\omega r_m l_m}{m}} \quad ; \quad d_2=r_c-(r_m+d_1)=r_c-\left(r_m+\frac{l_m}{2}\right)=v_o t_2=a t_1 t_2 \quad ;$$

$$t_2=\frac{d_2}{v_0}=\frac{\left(r_c-r_m-\frac{l_m}{2}\right)}{\sqrt{\frac{q_E B\omega r_m l_m}{m}}}=\left(r_c-r_m-\frac{l_m}{2}\right)\sqrt{\frac{m}{q_E B\omega r_m l_m}} \quad .$$

With:

ω = Angular velocity of disc [rad s^{-1}];
v_{RPM} = Rotation speed of disc [RPM];
f = Rotation frequency of disc [cycles s^{-1}];
l_m = Length of magnets [m].

The electric current $I_E=q_E/t$ that can be extracted from the system at full time $t=t_1+t_2$ may be calculated by:

$$I_E=\frac{Q_E}{t}=\frac{N n_e q_E S d}{t_1+t_2} \quad .$$

With:

I_E = Electric current [A];
Q_E = Total amount of electric charge reaching the collecting plate in time t [C];
N = Quantity of magnets on disc;
S = Area of magnet [m^2];
d = Magnetic field penetration distance of magnet [m];
$t=t_1+t_2$ = Ions travel time [s].

The electric charge particles (ions), when attracted by the magnetic vortex created by the rotation of the device and displaced to the periphery, assume orbital positions because they are attracted to the center of the vortex and then deflected to the periphery of the disc by the field of the magnets (Lorentz's force), and their speed of travel around the circumference of the device tends to be the same as that of the disc. Thus, the system should be designed so that the charges collecting plate is placed around the perimeter of the disk, as the electrons, being radially accelerated, will collide with this metallic collector.

This system operates as a DC electric current generator because the excess charge of the collecting plate flows to the load in the form of an electrostatic charge flow. One way to harness this energy is by charging chemical accumulators (batteries). However, for applications where high voltage DC production is required, we can roughly calculate the potential and electric field produced by the device on the collecting belt after t seconds:

$$q_E = C V_E \quad , \quad C = \varepsilon \frac{S_c}{r_c} \quad \Rightarrow \quad V_E = \frac{q_E}{C} = \frac{q_E r_c}{\varepsilon S_c} = \frac{I_E r_c}{\varepsilon S_c} t \quad , \quad E = \frac{V_E}{r_c} = \frac{q_E}{\varepsilon S_c} = \frac{I_E}{\varepsilon S_c} t \quad .$$

With:

C = Device capacitance (may contain external capacitor) [F];
V_E = Electric potential [V];
I_E = Electric current [C s^{-1}] [A];
ε = Electrical permittivity of the medium [C V^{-1} m^{-1}] [F m^{-1}];
S_c = Collector plate (belt) surface [m^2];
r_c = Distance between collector plate and motor shaft [m];
t = Ions travel time [s].

If the device has an external capacitor connected to the collector plates, the potential and electric field are determined by:

$$V_E = \frac{q_E}{C} = \frac{I_E}{C} t \quad , \quad E = \frac{V_E}{r_c} = \frac{I_E}{C r_c} t \quad .$$

2.3.4 Balance between Magnetic and Electric Forces

Considering that the device does not have the collecting plate connected to a circuit, rotating the disc will increase the charge density on the plate. As a result, the electric field between the axis and the collecting plate will increase to a value that depends on the balance between the Lorentz's force $F = q_E v B$ and the electric field force $F = q_E E$. The Lorentz's force depends on the rotational speed of the disc and the magnetic field strength of the magnets, and the electric force is contrary to the deflection direction of the charges. Equilibrium occurs when the electric field reaches the value:

$$F = q_E E = q_E v B \quad \Rightarrow \quad E = v B = \omega r_m B \quad .$$

If the rotational speed increases, this electric field will increase to maintain this equilibrium ratio; if the rotation decreases, the loads will not reach the collecting belt, that is, it is a condition of saturation, when the electric field prevents new electric charges from reaching the plate. In this condition, the amount of electric charges Q_E accumulated in the collecting plate and the surface density of electric charges D of the plate are:

$$E = \frac{Q_E}{\varepsilon S_c} \quad \Rightarrow \quad Q_E = \varepsilon E S_c = \varepsilon \omega r_m B S_c \quad \Rightarrow \quad D = \frac{Q_E}{S_c} = \varepsilon E S_c = \varepsilon \omega r_m B \quad .$$

With the collecting plate connected to an electrical circuit that consumes the accumulated charges, this condition will not occur and the charge flow will occur while the disc rotates.

2.3.5 Balance between Kinetic and Electric Energies

Considering that the device does not have the collecting plate connected to a circuit, rotating the disc will increase the charge density on the plate. As a result, the electric field between the axis and the collecting plate will increase to a value that depends on the balance between the kinetic energy acquired by the ions as they travel the acceleration distance d_1 within the electric field, and the ion braking electrical energy, contrary to its direction, during its journey to the collecting plate $d_2 = r_c - (r_m + d_1)$. The equilibrium point occurs when the kinetic energy of the ions is not sufficient to make them reach the collecting plate, so:

$$K=\frac{1}{2}mv_0^2=U=F\,d_2=q_E\,E_f\,d_2\quad .$$

With:

K = Kinetic energy of ions [J];
m = Mass of ion [kg];
v_0 = Maximum velocity of ions (at the end of acceleration) [m s^{-1}];
F = Force exerted on ions by electric field [N];
d_2 = Distance between magnets and collecting plate [m];
q_E = Electric charge of ion [C];
E_f = Breaking electric field (between motor shaft and collecting plate) [V m^{-1}].

As we see, the accumulation of electric charges on the collecting plate determines the electric field and the braking potential:

$$E_f=\frac{m v_0^2}{2q_E d_2}\quad\Rightarrow\quad V_{Ef}=E_f r_c=\frac{m v_0^2 r_c}{2q_E d_2}\quad .$$

With:

V_{Ef} = Braking electric potential [V];
r_c = Distance between collector plate and motor shaft [m].

But if the collecting plate is connected to an electrical circuit that consumes the accumulated electric charges, this condition will not occur and the charge flow will occur while the disc rotates.

2.3.6 Calculation Example

The following example use the equations developed in the Mathematical Model for Magnetic Vortex section without considering the central magnetic field created by the circulation of electrostatic charges on the perimeter of the device, because we do not yet know the magnetic effects of such electrostatic currents. Our current physics works only with electric currents produced by the motion of electrons that are in the valence layer of atoms, not electrostatic charges.

On the one hand, the final velocity v_0 of the ions acquired in the acceleration path d_1 is greatly decreased in the path d_2 to the collecting plate by collisions with air molecules; on the other hand, we will consider that during this second part of the ion path there is still enough magnetic field to maintain a constant average drag velocity. This simplification of calculations is only intended to provide an initial estimate of the electrostatic current that can be produced using magnetic vortex devices, in other words, it is a first ideal approximation.

We will consider that ions projected at the perimeter of the disc are negative electrostatic charges, that is, electrons, because they are the most abundant in the atmosphere. The assembly of this example is as follows:

1 m diameter support disc with 12 neodymium (NdFeB) magnets fixed onto its perimeter with axial magnetic polarization. The magnets are 10 cm in diameter and 20 mm high, have a remaining magnetic induction Br = 13,800 G (1,38 T) (1 Gauss = 10^{-4} Tesla), intrinsic coercive magnetic field iHc = 13 kOe (1.0 MA/m) (1 kOe = 79.67 kA/m) and 48 MGOe (382 kJ/m^3) BHmax energetic product (1 MGOe = 7.957 kJ/m^3). They are equally spaced from each other and their centers are 44 cm far from the center of the disc, this is, they are fixed at 1 cm from the edge of the disc. The center of the disc is fixed to the shaft of a motor that has speed control. The motor is mounted vertically and the disc attached to its shaft is horizontal. The electron collection system is a 1 mm thick, 20 cm wide and 1.40 m diameter aluminum foil strap and is fixed so that its center coincides with the motor shaft, and the disc rotates at half its height.

The positive pole of the system is the motor shaft itself and the negative pole is the aluminum strap. We will calculate the available electrical current between the motor shaft and the metal strap for 60 RPM ($\omega = 2\pi$ rad/s) and 1,800 RPM ($\omega = 60\pi$ rad/s) speeds.

Calculus of the amount of electric charge of air under influence of magnetic field:

$$Q_E = N n_e e S d = 12 * 4 * 10^{25} * 1.602 * 10^{-19} * 25\pi * 10^{-4} * 0.1 = 6.04 * 10^4 C \quad .$$

With:

Q_E = Total amount of electric charge displaced [C];
N = Quantity of magnets on disc = 12;
n_e = Ion density of atmosphere = $4*10^{25}$ electrons m^{-3};
e = Electric charge of electron = $1.602*10^{-19}$ C;
S = Area of magnet = $\pi r^2 = \pi(5*10^{-2})^2 = 25\pi*10^{-4}$ m^2;
d = Magnetic field penetration distance of magnet = 10 cm = 0.1 m.

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Calculus of the force on charges at 60 RPM rotation:

$$F = e\omega r_m B = 1.602 * 10^{-19} * 2\pi * 0.44 * 1.38 = 6.11 * 10^{-19} N \quad .$$

With:

F = Force [N];
B = Surface density of magnetic charge of magnets = 1.38 T;
ω = Angular velocity of disc = 2π rad s^{-1};
r_m = Distance from center of magnets to motor shaft = 44 cm = 0.44 m.

Calculus of charge acceleration at 60 RPM rotation:

$$a = \frac{F}{m_e} = \frac{6.11 * 10^{-19}}{9.109 * 10^{-31}} = 6.71 * 10^{11} m s^{-2} \quad .$$

With:

a = Acceleration of charge [m s^{-2}];
F = Force on charge = $6.11*10^{-19}$ N;
m_e = Mass of electron = $9.109*10^{-31}$ kg;

$$t_1 = \sqrt{\frac{l_m}{a}} = \sqrt{\frac{0.1}{6.71 * 10^{11}}} = 3.86 * 10^{-7} s \quad .$$

With:

t_1 = Acceleration time [s];
l_m = Magnet length = 0.1 m;
a = Acceleration of charge = $6.71*10^{11}$ m s^{-2}.

Calculus of charge speed after acceleration at 60 RPM rotation:

$$v_o = \sqrt{\frac{e\omega B r_m l_m}{m_e}} = \sqrt{\frac{1.602 * 10^{-19} * 2\pi * 1.38 * 0.44 * 0.1}{9.109 * 10^{-31}}} = 2.59 * 10^5 m s^{-1} \quad ;$$

$$t_2 = \frac{d_2}{v_o} = \frac{r_c - (r_m + ½ l_m)}{v_o} = \frac{0.70 - (0.44 + ½ * 0.1)}{2.59 * 10^5} = 8.11 * 10^{-7} s \quad .$$

With:

t_2 = Constant speed time [s];
d_2 = Distance traveled during average drag speed (between magnet to collector plate) [m];
v_0 = Electron speed (at the end of acceleration) = $2.59*10^5$ m s^{-1};
r_c = Distance from collecting plate to motor shaft = 0.70 m.

The travel time of the charges from the center of the magnets to the collecting belt is:

$$t=t_1+t_2=3.86*10^{-7}+8.11*10^{-7}=1.20*10^{-6}s \quad .$$

Calculus of electric current at 60 RPM rotation:

$$I_E=\frac{Q_E}{t}=\frac{6.04*10^4}{1.20*10^{-6}}=5.03*10^{10}A \quad .$$

With:

I_E = Electric current [A];
Q_E = Total amount of electric charge displaced = $6.04*10^4$ C;
t = Travel time = $1.20*10^{-6}$ s.

***

Calculus of the force on charges at 1800 RPM rotation:

$$F=e\omega r_m B=1.602*10^{-19}*60\pi*0.44*1.38=1.83*10^{-17}N \quad .$$

With:

F = Force [N];
B = Surface density of magnetic charge of magnets = 1.38 T;
ω = Angular velocity of disc = 60π rad s^{-1};
r_m = Distance from center of magnets to motor shaft = 44 cm = 0.44 m.

Calculus of charge acceleration at 1800 RPM rotation:

$$a=\frac{F}{m_e}=\frac{1.83*10^{-17}}{9.109*10^{-31}}=2.01*10^{13}m s^{-2} \quad .$$

With:

a = Acceleration of charge [m s^{-2}];
F = Force on charge = $1.83*10^{-17}$ N;
m_e = Mass of electron = $9.109*10^{-31}$ kg;

$$t_1=\sqrt{\frac{l_m}{a}}=\sqrt{\frac{0.1}{2.01*10^{13}}}=7.05*10^{-8}s \quad .$$

With:

t_1 = Acceleration time [s];
l_m = Magnet length = 0.1 m;
a = Acceleration of charge = $2.01*10^{12}$ m s^{-2}.

Calculus of charge speed after acceleration at 1800 RPM rotation:

$$v_o=\sqrt{\frac{e\,\omega\,B\,r_m\,l_m}{m_e}}=\sqrt{\frac{1.602*10^{-19}*60\pi*1.38*0.44*0.1}{9.109*10^{-31}}}=1.42*10^{6}\,m\,s^{-1}\quad ;$$

$$t_2=\frac{d_2}{v_o}=\frac{r_c-(r_m+½l_m)}{v_o}=\frac{0.70-(0.44+½*0.1)}{1.42*10^{6}}=1.48*10^{-7}\,s\quad .$$

With:

t_2 = Constant speed time [s];
d_2 = Distance traveled during average drag speed (between magnet to collector plate) [m];
v_0 = Electron speed (at the end of acceleration) = $1.42*10^6$ m s^{-1};
r_c = Distance from collecting plate to motor shaft = 0.70 m.

The travel time of the charges from the center of the magnets to the collecting belt is:

$$t=t_1+t_2=7.05*10^{-8}+1.48*10^{-7}=2.19*10^{-7}\,s\quad .$$

<u>Calculus of electric current at 1800 RPM rotation:</u>

$$I_E=\frac{Q_E}{t}=\frac{6.04*10^{4}}{2.19*10^{-7}}=2.76*10^{11}\,A\quad .$$

With:

I_E = Electric current [A];
Q_E = Total amount of electric charge displaced = $6.04*10^4$ C;
t = Travel time = $2.19*10^{-7}$ s.

This electrical current is approximately 5 times greater than that at 60 RPM, and will be supplied continuously provided that the collecting plate and the motor shaft are electrically connected to a circuit that provides a DC or AC potential, because this device is an electric current source.

The electric currents calculated above are the maximum the system can deliver at any given rotation. The velocity of charges during the journey to the collection belt is hardly slowed by collisions with air molecules and is sufficient to dissociate them, which causes a drop in atmospheric pressure in the device. This low pressure envelope will reduce the collision of new charges with gas molecules and atmospheric particles. If the device is designed so that the electric charges are deflected in greater quantity at its top, there will be lower atmospheric pressure above it than below, which will tend to rise the device because of the vertical up force resulting from the pressure difference. This principle can therefore be used as a propulsion system.

Circulating electrostatic charges (electric current) on the periphery of the device generate a high intensity magnetic field within the circumference (central axis) that forces the charges into an outermost orbit, according to the equation $F=q\,v\,B$. Thus, the balance of forces on the circulating electric charges is altered, which favors an increase in the amount of ions projected to the device periphery and, if there is no electrical circuit connected to the device, an increase in the electric field generated between the axis and the device periphery.

If there is no collecting plate around the perimeter of the device, the magnetic torus will create an ion flux that will reach considerable dimensions, with effects of atmospheric air ionization and ozone formation, as well as lowering of atmospheric pressure and temperature (due to negative ion flow) in the center of the device. Electromagnetic interference will also occur in electric/electronic equipment and electrostatic discharges in the vicinity of the device.

2.4 Electric Charge Gathering by Magnetic Tunnel

Another way to collect these ions dispersed in the air is by harnessing the air currents. In this case, the ions are in constant motion and we only need to position magnets in chambers so that the magnetic field is perpendicular to the movement of the air currents, and collect the deflected electric charges on plates positioned perpendicular to the magnetic field and the air currents. The device must move like the wind vane (weathercock) in order to orientate itself in the direction of the air currents and keep the speed axis always perpendicular to the axis of the magnetic field, or use fans to propel atmospheric air into the chambers.

With this device, the higher the velocity of the air currents, the greater will be the applied force on the ions and the greater will be the amount of deflected charges, according to $\vec{F}=q(\vec{v}\times\vec{B})$. The depth of the device chamber should be calculated at the highest airflow velocity such that the ions entering the device at slower speeds are all collected, or nearly all, for the best operating efficiency.

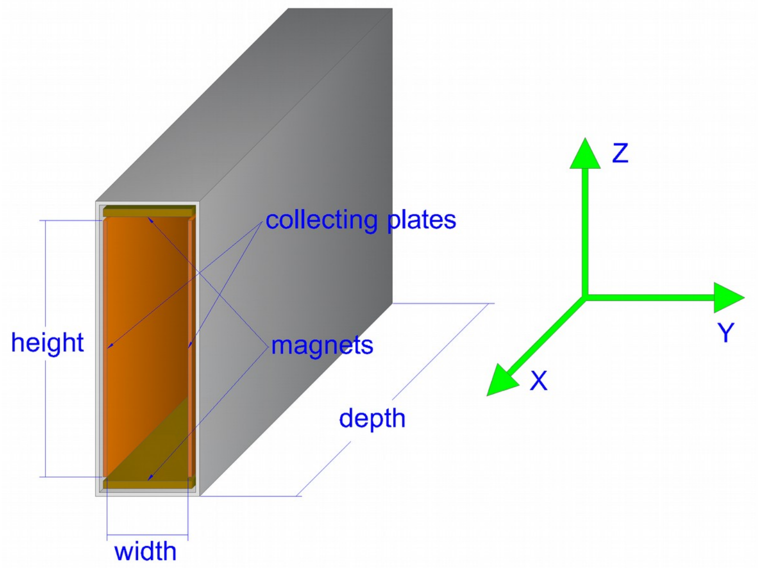

Figure 5: Magnetic tunnel ion collecting chamber.

To dimension such a device, adopting the Cartesian coordinate system, we place the magnetic field on the Z axis, the velocity on the X axis and the electric field collected on the Y axis. We will consider that the gravitational attraction does not influence the movement of the charges passing through the device chamber. So the Lorentz's force is $F_y=q_E v_x B_z$. Since in the wind the velocity of the positive and negative ions have the same direction, their polarity will determine the direction of the force and its deflection movement according to the right hand rule. The dimensions of this chamber are related to the components of the equation as follows:

1. X axis: chamber depth, maximum distance traveled by ions within the chamber, direction of air velocity (and ions);
2. Y axis: chamber width, distance between ion collecting plates, direction of electric field;
3. Z axis: chamber height, distance between magnets, direction of magnetic field.

The width of the device chamber is determined by the distance between the electrodes on the Y axis, so that the ions entering from the left end must reach the right side before completing the X axis path inside the chamber. The same can be said for ions entering from the right end. Otherwise, ions will pass into the chamber and will not be collected.

In this assembly, the Lorentz's force is applied to the Y axis and the maximum time of the ion trajectory is determined by the chamber width. This time also determines the depth of the chamber, knowing the air velocity, therefore:

$$d_y = \frac{a_y t^2}{2} = \frac{F_y t^2}{2m} = \frac{q_E v_x B_z t^2}{2m} \quad \text{and} \quad d_x = v_x t \quad .$$

With:

d_y = Distance on Y axis = chamber width [m];
a_y = Particle acceleration [m s^{-2}];
F_y = Force applied to the particle [N];
B_z = Surface density of magnetic charge [Wb m^{-2}] [T];
v_x = Speed of particle [m s^{-1}];
d_x = Distance on X axis = chamber depth [m];
q_E = Electric charge of particle [C];
m = Mass of particle [kg];
t = Acceleration time on Y axis = Velocity time on X axis [s].

By isolating time in the distance equation d_y, which is the width of the chamber we defined, we can calculate the depth of the chamber, which is the distance d_x:

$$t = \sqrt{\frac{2 m d_y}{q_E v_x B_z}} \quad \text{and} \quad d_x = v_x t = v_x \sqrt{\frac{2 m d_y}{q_E v_x B_z}} = \sqrt{\frac{2 m v_x d_y}{q_E B_z}} \quad .$$

With this sizing, all ions entering the device chamber with maximum velocity v will be collected at the electrodes. However, we must take into account that gases and air particles carry ions and therefore their trajectory on the X axis is longer than calculated, but as the distances involved in these trajectories are extremely small relative to the physical dimensions of the equipment, this will not be a problem.

We must also take into account that if there is no consumption of the accumulated electric charges between the electrodes, an electric field will be created between them. This electric field will print a force $\vec{F} = q\vec{E}$ contrary to the Lorentz's force, which will be the equilibrium or saturation point of the system, when there will be no separation of ions. This electric field is determined by equality $\vec{F} = q(\vec{v} \times \vec{B}) = q\vec{E}$, therefore $\vec{E} = \vec{v} \times \vec{B}$.

This device operates as a source of electric current, and the variation in air velocity through the chamber will affect the current produced by the device. Assuming that all ions entering the chamber are collected, the maximum electric current that can be extracted from this device is given by:

$$I_E = n_e q_E S v \quad .$$

With:

I_E = Electric current [A];
n_e = Volumetric density of electric charges of atmosphere [íons m^{-3}];
q_E = Electric charge of ion [C];
S = Area perpendicular to velocity = width x high [m^2];
v = Air velocity (and of ions) [m s^{-1}].

An important issue to consider is the radius of the orbit of the ions within the chamber, because if it is too small they may not reach the sidewalls where the collecting plates are located and just spin in their own orbits. The orbit radius of moving electric charges subjected to magnetic fields in an evacuated environment is given by:

$$r=\frac{m v}{q_E B} \quad .$$

With:

r = Electric charge orbit radius [m].

However, we must also consider that, because of the air density (at 1 atm and 300 K is 2.447*10^{25} molecules or atoms per m^3), when the air is moving causes a drag on these ions that, when subjected to magnetic fields, can’t properly perform their orbits, being dragged along the air and, consequently, making curved trajectories. To ensure that these deflected ions reach the collecting plates, it is possible to implement a forced ventilation system that ensures that the ions are effectively dragged and using weak magnetic fields so that the force on the ions is small. Therefore, the calculations presented below are only approximations that require corrections based on experimentation.

2.4.1 Calculation Example

The device is mounted where air passes at a minimum speed of 1 m/s (3.6 km/h) and a maximum speed of 100 m/s (360 km/h). The chamber is 10 cm wide and 5 cm high, where a surface density of magnetic charge of 0.2 T is maintained.

Minimum velocity of 1 m/s

The travel time of negative ions (electrons) inside the chamber with air at a speed of 1 m/s is given by:

$$t=\sqrt{\frac{2 m d_y}{q_E v_x B_z}}=\sqrt{\frac{2*9.109*10^{-31}*0.1}{1.602*10^{-19}*1*0.2}}=2.38*10^{-6} s \quad .$$

With:

t = Acceleration time on Y axis = Velocity time on X axis [s];
m = Mass of electron = 9.109*10^{-31} kg;
d_y = Distance on Y axis = chamber width = 0.1 m;
q_E = Electric charge of electron = 1.602*10^{-19} C;
v_x = Speed of ions = 1 m s^{-1};
B_z = Surface density of magnetic charge = 0.2 Wb m^{-2} [T].

The depth of the chamber is defined by:

$$d_x=v_x t=1*2.38*10^{-6}=2.38*10^{-6} m \quad .$$

The minimum electric current that may be consumed from the device is:

$$I=n_e q_E S v_x=4*10^{25}*1.602*10^{-19}*5*10^{-3}*1=3.20*10^4 A \quad .$$

With:

I_E = Electric current [A];
n_e = Volumetric density of electric charges of atmosphere = 4*10^{25} íons m^{-3};
S = Area perpendicular to velocity = width x high = 0.1*0.05 = 5*10^{-3} m^2;
v_x = Air velocity (and of ions) = 1 m s^{-1}.

Maximum velocity of 100 m/s

The travel time of negative ions (electrons) inside the chamber with air at a speed of 100 m/s is given by:

$$t=\sqrt{\frac{2 m d_y}{q_E v_x B_z}}=\sqrt{\frac{2*9.109*10^{-31}*0,1}{1.602*10^{-19}*100*0,2}}=2.38*10^{-7}s \quad .$$

With:

t = Acceleration time on Y axis = Velocity time on X axis [s];
v_x = Speed of ions = 100 m s^{-1}.

The depth of the chamber is defined by:

$$d_x=v_x t=100*2.38*10^{-7}=2.38*10^{-5}m \quad .$$

The maximum electric current that may be consumed from the device is:

$$I=n_e q_E S v_x=4*10^{25}*1.602*10^{-19}*5*10^{-3}*100=3.20*10^{6}A \quad .$$

With:

I_E = Electric current [A];
v_x = Air velocity (and of ions) = 100 m s^{-1}.

Calculations indicate that such chambers may be very small in size and that they may also function properly with extremely weak magnetic fields. To get an idea of the orbit radius of the ions, we adopt the air velocity of 100 m/s with B = 0.2 T:

$$r=\frac{m v}{q_E B}=\frac{9,109*10^{-31}*100}{1,602*10^{-19}*0,2}=2,842*10^{-10}m \quad .$$

In an evacuated environment, this would be the orbit of the ions, but with the dragging of a forced wind and very weak magnetic fields, it is possible to collect these ions in extremely thin multi-layer chambers, which could be interesting in places with little space.

3 Electricity from the Sea Water

Seawater is an abundant source of ions, resulting from the dissolution of numerous inorganic salts at a mass ratio of 3% to 5% (30 to 50 grams per kilogram of seawater), mainly Sodium Chloride – NaCl, with 97 % to 95% (970 to 950 grams per kilogram) of pure water. In this condition, salt water resembles an electrolytic fluid that can be used as a source of electric energy by separating these ions into electrical polarity and recombining them through the passage of electric current, similar to an electrochemical accumulator.

The salinity of seawater is not uniform in the seas of the planet. At an average proportion of 3.5% sodium chloride, in approximately 1 m^3 of salt water we will have 35 kg of salt, which is what makes seawater salt. The atomic mass of sodium (Na) is M_{Na} = 22.8989 g/mol and that of chlorine (Cl) is M_{Cl} = 35.453 g/mol; the molecular mass of NaCl is M_{NaCl} = 58.4428 g/mol. Thus, with 35 kg of salt, which corresponds approximately to 1 m^3 of seawater, we will have a Na density of:

$$\rho_{Na}=\rho_{NaCl}\frac{M_{Na}}{M_{NaCl}}=35\frac{22.9898}{58.4428}=13.77\,kg\,m^{-3} \quad .$$

With:

ρ_{Na} = Na density of seawater [kg m^{-3}];
ρ_{NaCl} = NaCl density of seawater [kg m^{-3}];

M_{Na} = Atomic mass of Na = 22.9898 g mol^{-1};
M_{NaCl} = Atomic mass of NaCl = 58.4428 g mol^{-1}.

Knowing the amount of dispersed sodium mass per unit volume of salt water, we can calculate the density of Na atoms in this same volume. These atoms are dispersed as ions, so salt water has a Na$^+$ ion density of:

$$n_e=\rho_{Na}\frac{N_A}{M_{Na}*10^{-3}}=13.77\frac{6.022*10^{23}}{22.9898*10^{-3}}=3.607*10^{26}\,ions\,m^{-3}$$

With:

n_e = Ion density [ions m^{-3}];
N_A = Avogadro’s number = 6.022*10^{23} atoms mol^{-1}.

This is also the density of Cl$^-$ ions, which behave like electric charges, being comparable to electrons in terms of electric charge. Thus, the electric charge density of salt water is:

$$n_e\,e=3.607*10^{26}*1.602*10^{-19}=5.779*10^{7}\,C\,m^{-3}\quad .$$

3.1 Electric Charge Gathering by Magnetic Vortex

It is possible to use the dispersed ions in seawater as source of electric current by separating them into polarity through the Lorentz's force with the rotation of magnets, and collecting them into electrodes. We can place the magnets with radial or axial polarity, just as it was done for the electrostatic charges of the atmosphere in the section Electric Charge Gathering by Magnetic Vortex in the Electricity from the Atmospheric Air chapter.

The device is immersed in seawater protected by a non-metallic dome, which is immobile because it is fixed to a support. The two electrodes are fixed and remain in the water and outside the dome, as they will be in contact with the ions that, due to the rotating disc magnets, will accumulate on the top and bottom sides of the disc for the device with radial magnetic polarity, and on the axis and periphery for the device with axial magnetic polarity. The motor is fixed to the dome and the disc rotates with the magnets, both inside the dome, without contact with salt water.

In both cases above, the electrodes have electrical cables that allow the use of available DC electric energy. Negative ions (Cl$^-$) will accumulate at the cathode, positive ions (Na$^+$) will accumulate at the anode. Electrons will flow from the cathode to the anode as they feed the system load. As long as the electric current is flowing from the cathode to the anode, chlorine atoms will form in the cathode, which will come off as gas, and metallic sodium atoms in the anode, which will react with water to form sodium oxide and releasing heat that will be dissipated by the water.

The calculations of the above mentioned devices are exactly the same as the Mathematical Model for Magnetic Vortex, differing only in the density of electric charges (which in salt water is about 10 times higher), the mass of the charges and the electric permittivity of medium, which is why we will not do them again.

The mass of sodium chloride ions (NaCl) dissolved in seawater is defined by the atomic mass of sodium (Na) and chlorine (Cl) atoms. The atomic mass of these atoms are determined by:

$$m_{Na}=\frac{M_{Na}*10^{-3}}{N_A}=22\frac{,9898*10^{-3}}{6,0225*10^{23}}=3,8175*10^{-26}\,kg\quad ;$$

$$m_{Cl}=\frac{M_{Cl}*10^{-3}}{N_A}=\frac{35.453*10^{-3}}{6.0225*10^{23}}=5.8871*10^{-26}\,kg\quad .$$

With:

m_{Na} = Mass of sodium atom [kg];
m_{Cl} = Mass of chlorine atom [kg];
M_{Na} = Atomic mass of Na = 22.9898 g mol^{-1};
M_{Cl} = Atomic mass of Cl = 35.453 g mol^{-1};
N_A = Avogadro's number = $6.022*10^{23}$ atoms mol^{-1}.

The relative permittivity of sea salt water is $\varepsilon_r=81$ and its total electric permittivity is $\varepsilon=\varepsilon_r\varepsilon_0=81\varepsilon_0=81*8.854*10^{-12}=7.1719*10^{-10}\,F m^{-1}$.

3.2 Electric Charge Gathering by Magnetic Tunnel

Another way to collect these ions dispersed in seawater is by harnessing the oceanic currents. In this case, the ions are in constant motion and we only need to position magnets so that their magnetic field is perpendicular to the movement of sea currents. The device must be able to move like the wind vane to orientate itself according to the marine currents and to keep the axis of the current velocity always perpendicular to the axis of the magnetic field and the electrodes (ion collecting plates).

With this device, the higher the velocity of the marine currents, the greater will be the force applied on the ions and the greater will be the amount of deflected electrical charges in contact with the electrodes. The depth of the device chamber should be designed for the highest velocity of marine currents such that the ions entering the device at slower speeds are all collected, or nearly all, for the best operating performance.

The operating principle, chamber model and sizing calculations of this device are exactly the same as for Electric Charge Gathering by Magnetic Tunnel in the Electricity from the Atmospheric Air chapter, with the difference in the ion mass. In this case, the depth of the chamber will be calculated for chlorine ions, which will travel a greater distance because they are heavier than sodium ions. Thus, all ions entering the device chamber with maximum velocity will be collected at the electrodes. However, we must take into account that water drags ions and that its trajectory on the Z axis is longer than calculated, but as the distances involved in these trajectories are extremely small relative to the physical dimensions of the device, this will not be a problem.

3.2.1 Calculation Example

The device is mounted in the sea where a stream of water passes at a minimum speed of 1 m/s (3.6 km/h) and a maximum speed of 100 m/s (360 km/h). The chamber is 10 cm wide and 5 cm high, where a surface density of magnetic charge of 0.2 Wb/m^2 is maintained.

Minimum velocity of 1 m/s

The travel time of negative ions (chlorine ions) inside the chamber with water at a speed of 1 m/s is given by:

$$t=\sqrt{\frac{2 m d_y}{q_E v_x B_y}}=\sqrt{\frac{2*5.887*10^{-26}*0.1}{1.602*10^{-19}*1*0.2}}=6.06*10^{-4}s \quad .$$

With:

t = Acceleration time on Y axis = Velocity time on X axis [s];
m = Mass of chlorine ion = $5.887*10^{-26}$ kg;
d_y = Distance on Y axis = chamber width = 0.1 m;
q_E = Electric charge of ion = $1.602*10^{-19}$ C;
v_x = Speed of ions = 1 m s^{-1};
B_z = Surface density of magnetic charge = 0.2 Wb m^{-2} [T].

The minimum depth of the chamber is defined by:

$$d_x = v_x t = 1*6.06*10^{-4} = 6.06*10^{-4} m \quad .$$

The minimum electric current that may be consumed from the device is:

$$I_E = n_e q_E S v_x = 5.185*10^{26}*1.602*10^{-19}*5*10^{-3}*1 = 4.15*10^5 A \quad .$$

With:

I_E = Electric current [A];
n_e = Volumetric density of ions in the sea = 5.185*10^{26} íons m^{-3};
S = Area perpendicular to velocity = width x high = 0.1*0.05 = 5*10^{-3} m^2;
v_x = Air velocity (and of ions) = 1 m s^{-1}.

<u>Maximum velocity of 100 m/s</u>

The travel time of negative ions (chlorine ions) inside the chamber with water at a speed of 100 m/s is given by:

$$t = \sqrt{\frac{2 m d_y}{q_E v_x B_z}} = \sqrt{\frac{2*5.887*10^{-26}*0.1}{1.602*10^{-19}*100*1}} = 6.06*10^{-5} s \quad .$$

With:

t = Acceleration time on Y axis = Velocity time on X axis [s];
v_x = Speed of ions = 100 m s^{-1}.

The depth of the chamber is defined by:

$$d_x = v_x t = 100*6.06*10^{-5} = 6.06*10^{-3} m \quad .$$

The maximum electric current that may be consumed from the device is:

$$I_E = n_e q_E S v = 5.185*10^{26}*1.602*10^{-19}*5*10^{-3}*100 = 4.15*10^7 A \quad .$$

With:

I_E = Electric current [A];
v_x = Air velocity (and of ions) = 100 m s^{-1}.

4 Electricity from the Ground

As we have seen in previous chapters, the electrostatic field of the atmosphere extends from the ground, which is its negative pole, to the high layers of the atmosphere, which is its positive pole. We can think of collecting negative electric charges from the ground by a process similar to that used to collect electrostatic charges from the atmosphere. Since ground is the negative pole of this constantly charged capacitor, the concentration of negative electrostatic charges (free electrons) is much higher than the concentration in the atmosphere. Thus, when connecting a conductor wire to the electrical grounding system mesh, the excess electrostatic charges of the ground will be distributed on the outer surface of the wire. The mobility of the charges on the metal and the repulsive forces between the charges of the same signal causes an evenly distribution of charges on the surface of electrical conductive materials.

The principle of collecting electrostatic charges is that a variable magnetic field (in space or time) shifts electrostatic charges perpendicular to the magnetic field applied by Lorentz's force. Electrostatic charges are not in the valence layer of the atoms of the conductive wire material, there is no ionization potential to be achieved, so by subjecting any bare part of the wire coming from ground to a variable magnetic field, these charges will be easily removed from the wire.

Earth’s ground is an inexhaustible source of negative electrostatic charges, so while the surface charges on the wire (or the metal that it is attached to) are being removed by the magnetic field, more charges will flow through the ground as a result of the surface distribution of electric charges equilibrium. The electric current drawn from the grounding circuit is determined by the amount of electrostatic charges removed from the wire, that is consequence of the intensity and frequency of the magnetic field to which the bare part of the wire is subjected.

A suitable arrangement for subjecting to an alternating magnetic field a metal plate or grid connected to the ground wire may be the air gap of an electromagnetic transformer, where there is a maximum of variable magnetic field that allows a large amount of electrostatic charges to be removed. Within this air gap, if the variable magnetic field is in the direction of the Z axis (vertical axis), the electrostatic charges will suffer a force that project them radially in the XY plane (horizontal plane). Then, with a metallic collecting strap positioned around the air gap, with the magnetic field at its axis, the electrostatic charges will collide with the strap and accumulate there until it forms a sufficiently strong electrostatic field to prevent new charges from reaching the strap.

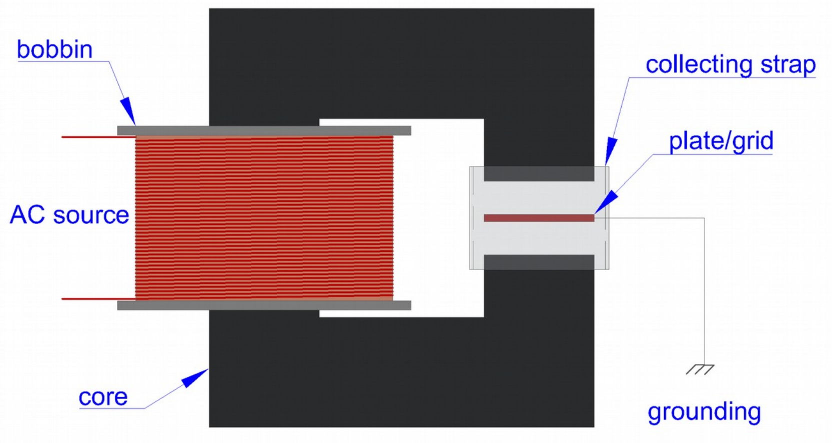

Figure 6: Electrostatic charge collector from Earth's soil.

To utilize these excess electrostatic charges on the collecting strap, simply connect the strap electrically to any DC or AC voltage circuitry that these charges will flow through the circuit and act as electric current source. These charges flow to other circuits because, being electrostatic, they tend to distribute evenly across metal surfaces and, as they are in excess of the collecting strap, serve as a source of current (not voltage) for the circuit in which the charges are flowing. Because it is easier to move surface electrostatic charges than the free electrons of the conductors, these charges are distributed superficially and replace the free electrons that circulate in the electric current of the circuits.

A modern variation of this arrangement can be made with a switched-mode power source circuit, designing the transformer to provide in its air gap an alternating medium frequency magnetic field and adjusting the field strength to the voltage variation of the circuit that receives the electrostatic charges, through its feedback link.

Another possible arrangement is with a transformer without air gap, but designed to work with a shorted-circuit secondary to produce a high current. By Ampere's induction law, around the shorted secondary wire, a circular magnetic field is formed that can be used to remove the electrostatic charges from the metal plate surrounding this covered wire, which is connected to the cable coming from the grounding system, or even the bare cable itself and simply tangled a few turns around the shorted secondary wire.

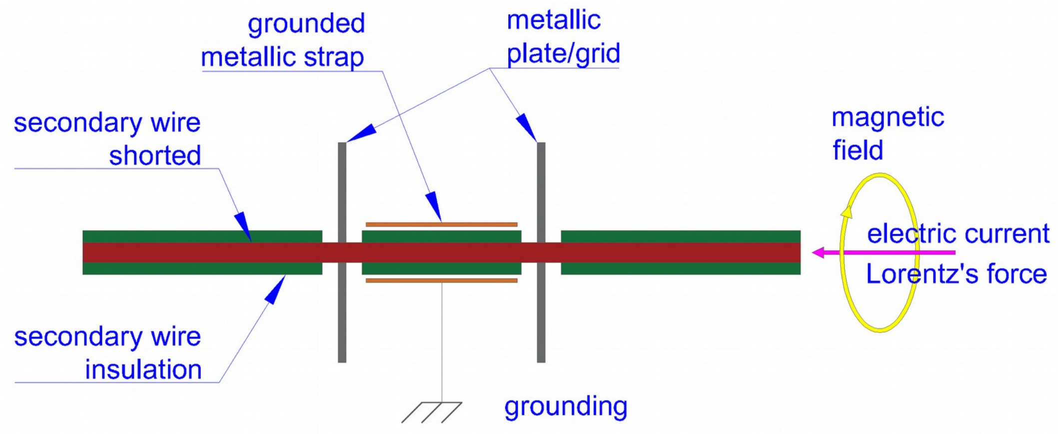

Figure 7: Shorted secondary wire with strap and metal plates/grids.

The circular magnetic field induced by the high current of the shorted secondary is perpendicular to the direction of the secondary wire and, being tangent to the metal strap (or the turns of the bare grounding wire around the covered secondary wire), withdraws electrostatic charges and moves them in the same direction as the secondary current. With two plates/grids electrically connected to the transformer shorted secondary wire and placed perpendicular to the direction of movement of the deflected charges, they collide and circulate in the secondary wire. Because electrostatic charges are more easily moved than free copper electrons in the wire, they replace these and lower the electric current at the transformer input. Any circuit that is electrically connected to the shorted secondary will have its input current decreased because electrostatic charges begin to circulate in the circuit replacing the conductor free electrons, being removed from ground.

The latter arrangement was described in the International Patent Application entitled "Electromagnetic Device for Capturing Electrons from the Ground to Generate Energy" under WO 2013/104042 A1 of July 18, 2013, filed with the World Intellectual Property Organization, on behalf of Evoluções Energia Ltda.

The text below describes Figure 7 of the patent, that is a schematic representation of the transformer electric circuit, with two coils or with one coil, with the shorted loop of the polarized secondary, that is, connected to one of the poles of the mains supplying the transformer. It is recommended that it be the PHASE, not the NEUTRAL, because home power grids have a grounded neutral at the input which would shunt electrostatic charges to ground. The output circuit, also powered by the mains, is connected to the transformer secondary at another point, to facilitate the flow of electrostatic charges from the secondary to the output, this is, the connection of the secondary to the mains electrical network serves only as a referential electric potential. On page 9 of the patent we can read:

> Figure 7 shows how the connections of one of the electrical circuits of the electron captor proposed in the present invention should be made. In the diagram it is shown an electric circuit of an electron captor with the voltage polarized conductive link/loop 4. This is one of the ways to accomplish the electron captor, with two coils 1 and 2, where a conductor link/loop 4 is polarized with voltage, that is, there is a conductor connecting this link/loop 4 to one of the supply leads 3.1 or 3.2, whatever the phase.
>
> Thus, electron captors from the ground adopting this electrical circuit, that is, with the conductor link/loop 4 polarized with voltage from coils 1 and 2, besides being used as a power source for external loads, can also be used for thermal energy generation.

The figure bellow is a clearer representation of the figure 7 of the patent, and shows only one transformer. The red numbers corresponds to the numbers in the patent.

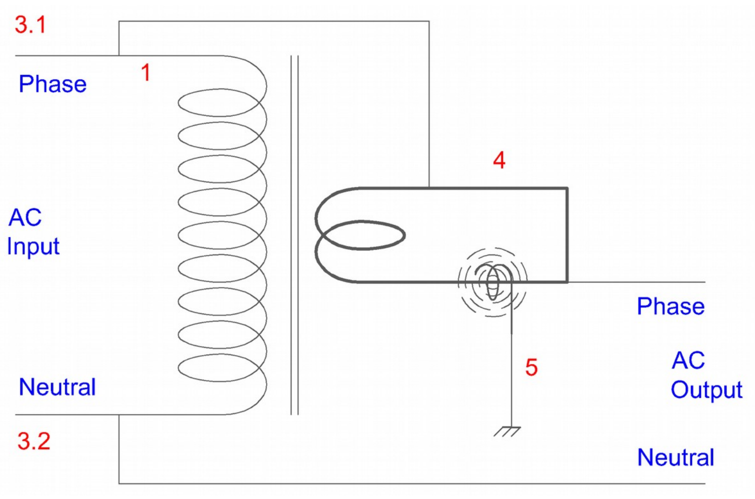

Figure 8: Electron captor from the ground.

The production of thermal energy described above occurs by heating the short-circuited secondary wire as a result of the high current flowing through it.

We can see from the figure that the connection between the grounding cable and the shorted secondary is not electrical, but is made by twisting the cable over it to produce an electromagnetic coupling. It is evident that the transformer magnetic core is not part of the coupling and thus the available magnetic field is what the shorted secondary wire provides around itself, circular and perpendicular to the direction of the electric current. This alternating magnetic field removes the electrostatic charges that are on the surface of the bare part of the cable that connects to the grounding mesh and circulates them in the same direction as the electric current of the short-circuited secondary. The dashed concentric lines represent one or two plate/grid that collect the electrostatic charges by collision, because the plate/grid is electrically connected to the shorted secondary. The explanation of device operation is described on page 4 of the patent:

> The equipment object of the present invention works as follows: the electromagnetic field generator device, when powered by an electrical power source, produces an electromagnetic field that induces an electrical current in the closed loop conductive element itself, creating an interaction between the equipment magnetic poles and the earth magnetic poles, there is – through electromagnetic attraction and repulsion – an endless supply of electrons from earth to the closed-loop conductive element itself, which is connected to a grounding mesh, through the interconnecting conductor element. The attracted electrons are added to the present current circulating in the closed loop conductive element itself, from which electrical power is provided for high power loads, although the equipment object of the present invention is supplied with a small power. Thus, advantageously, the equipment object of the present invention turns out to be an electron captor from earth, for electric power generation.

The electric current circulating in the transformer primary is reduced until it is just sufficient to maintain the core hysteresis cycle, because the projected short-circuit current to the secondary is supplied by ground through the electromagnetic coupling between the cable coming from the ground and the shorted secondary. Therefore, the cable coming from the grounding loop and the shorted secondary cable must be calculated to withstand such current without overheating.

The transformer shall be designed to operate with a short-circuit current on the secondary that is equal to or greater than the maximum current of the circuit to which it will be electrically connected, that is, as this device functions as a current source, the maximum load current will be supplied by the shorted secondary current, no matter what is the circuit supply voltage, which can be AC or DC of any voltage.

For example, if the load power at 220 VAC is 22 kW, the transformer must be designed for a secondary short current of $I_E = P / V_E = 22\,kW / 220\,V \approx 100\,A$, and the secondary coil induced voltage must be the one that circulates this current, according to wire/cable resistance used in the secondary.

It is also possible to work with an uninterruptible power supply – UPS by connecting the secondary to one pole of its output and one of its input, which would be the PHASE, and the other input and output poles would be the NEUTRAL, and start the system on battery, without connection to the home power grid. It is an autonomous power generation system that does not depend on the power distribution company.

4.1 Work Function of Electrostatic Charge

The attractive force between an electrostatic charge and a nearby metallic surface can be calculated by the method of images, which states that an opposite signal image charge is positioned at equal distance on the opposite side of the metallic surface. The electric charge induces on the metal surface a charge distribution equivalent to an opposite signal charge whose force calculation can be established by two opposite signal charges that are twice the distance between the charge and the surface. The calculation of the attraction force is given by:

$$F=-\frac{1}{4\pi\varepsilon_0}\frac{q_{E1}q_{E2}}{(2d)^2} \quad .$$

With:

F = Force [N];
q_{E1} = Proof electric charge [C];
q_{E2} = Image electric charge [C];
ε_0 = Electric permittivity of vacuum = $8.854188*10^{-12}$ $C^2 N^{-1} m^{-2}$ [$C V^{-1} m^{-1}$] [$F m^{-1}$];
d = Distance between q_{E1} and metal surface [m].

The negative sign indicates that the force is attractive. However, the distance d is for charges away from the surface and not distributed superficially, which makes it difficult to estimate the distance of the charge to the metallic surface. Supposing that the charge assumes a position relative to the constituent atoms of the metal, understanding that the attractive force is with the atom nucleus, we can estimate that the maximum force necessary for the extraction of the electrostatic charges is related to the atomic radius, because these charges remain in the metallic surface. Then we can consider the distance 2d to be the atomic radius r of the atoms of metallic material. And the force equation is:

$$F=-\frac{1}{4\pi\varepsilon_0}\frac{q_{E1}q_{E2}}{r^2} \quad .$$

The consideration is that the sum of the opposite charges induced at the atoms near the electrostatic charge is equivalent to an opposite charge positioned at the center of the nearest atom. The atomic radius of the most common metallic elements are:

1. Aluminum (Al): r = 1.42 Å = $1.42*10^{-10}$ m;
2. Copper (Cu): r = 1.28 Å = $1.28*10^{-10}$ m;
3. Zinc (Zn): r = 1.38 Å = $1.38*10^{-10}$ m.

As an approximation, let’s consider a radius of 1 Å = $1*10^{-10}$ m. The electrostatic force between the charge and the surface is given by:

$$F=-\frac{1}{4\pi\varepsilon_0}\frac{q_{E1}q_{E2}}{r^2}=-\frac{1}{4\pi\varepsilon_0}\frac{(1.602*10^{-19})^2}{(1*10^{-10})^2}=-2.307*10^{-8}N \quad .$$

The energy associated with this force is calculated by:

$$U=F\,r=\frac{1}{4\pi\varepsilon_0}\frac{q_{E1}q_{E2}}{r}=\frac{1}{4\pi\varepsilon_0}\frac{\left(1.602*10^{-19}\right)^2}{1*10^{-10}}=2.307*10^{-18}N=14.40\,eV \quad .$$

This value corresponds to the 1st Ionization Energy (E1) of the hydrogen atom, which is the minimum energy required to remove an electron from the neutral atom in the gas phase. Surely this magnetic field energy will not be required to remove electrostatic charges from the surface of a metal because such charges do not occupy the valence layers of the metal atoms.

In this case, a better approximation would be the photoelectric effect, which specifies the work function W, which is the energy required to remove an electron from a material exposed to radiation. There are values as low as 1.96 eV for Cesium and high as 6.35 eV for Platinum. Therefore, smaller than the ionization energy seen above.

It should be assumed that, again, the energy required to remove an electron from the atom is always greater than that required to extract electrostatic charges from the metal surface.

4.1.1 Mathematical Model for Electrostatic Work Function

Lorentz’s force on an electric charge by a time-varying magnetic field is given by:

$$\vec{F}=q_E(\vec{v}\times\vec{B})=q_E\left(\frac{d\vec{l}}{dt}\times\vec{B}\right)=q_E\left(\vec{l}\times\frac{d\vec{B}}{dt}\right) \quad .$$

The velocity v is of the electric charge, which in this case is stationary, therefore, the force refers to the variation of the surface distribution of magnetic charge B in the unit of time, and the length l refers to the distance that the electric charge remains subjected to the magnetic field. In the transformer air gap situation, this distance is the length or width of the plate/grid subjected to the magnetic field of the air gap. In the strap connected to the grounding cable (or bare cable) around the shorted secondary wire, this is the circumference length of its surface.

To calculate the work performed on electrostatic charges, we consider the distance traveled by the charges under the influence of the magnetic field due to Lorentz’s force, this is, the width or length of the plate/grid. With the magnetic field on the Z axis, the plate/grid will have its surface S exposed to the field in the XY plane, with distances l_x and l_y. The equation of the force and energy supplied by the magnetic field to the charges is:

$$F=q_E\left(l_x\frac{dB}{dt}\right) \quad \Rightarrow \quad U=F\,d=\frac{1}{2}q_E\left(l_x\frac{dB}{dt}\right)l_y=\frac{1}{2}q_E S\frac{dB}{dt} \quad .$$

With:

U = Energy [N m] [J];
F = Lorentz’s force [N];
B = Surface density of magnetic charge [Wb m^{-2}];
d = ½ l_y = Average distance traveled by the charge [m];
q_E = Electrostatic charge [C];
l_x = Plate/grid length [m];
l_y = Plate/grid width [m];
S = l_x*l_y = Plate/grid surface [m^2];
t = 1/f = Cycle time [s].

The above equations of force and energy are proportional to the derivative of the surface density of magnetic charge B, so it is necessary to know the function B(t) to calculate its derivative. If the magnetic field is a sinusoidal function (VCA powered transformer) we have:

$$\omega=2\pi f \quad , \quad B_0=\sqrt{2}B \quad , \quad B(t)=B_0\sin(\omega t)=\sqrt{2}B\sin(\omega t) \quad ;$$

$$\frac{dB(t)}{dt}=B_0\,\omega\cos(\omega t)=\sqrt{2}\,\omega\,B\cos(\omega t) \quad .$$

In the case of the strap (or bare cable) around the shorted secondary wire, the surface is given by the perimeter x length $S=l_x l_y=2\pi r\, l_y$ under the action of the magnetic field created around the secondary wire. For the calculation of this magnetic field, the equation is given by Ampère's induction law $\oint \vec{H}\cdot d\vec{l}=H\,l_x=I_E$, where l_x is the circumference length (perimeter) around the secondary wire whose radius is the distance from the center of the wire to the surface of the metal strap. The energy supplied to the electrostatic charges distributed on the plate surface around the secondary wire is given by:

$$H=\frac{I_E}{l_x} \quad \Rightarrow \quad B=\mu_0 H=\mu_0\frac{I_E}{l_x} \quad , \quad U=\frac{1}{2}q_E S\frac{dB(t)}{dt}=\frac{\sqrt{2}}{2}q_E S\,\omega\,B\cos(\omega t) \quad .$$

With:

H = Magnetic field [A m^{-1}];
μ_0 = Magnetic permeability of vacuum = 1.256637*10^{-6} Wb^2 N^{-1} m^{-2} [Wb A^{-1} m^{-1}] [H m^{-1}];
I_E = Electric current on shorted secondary [A];
l_x = Perimeter length around the secondary wire [m].

The average energy spent by the magnetic field on each electrostatic charge is given by the average of the above value, whose cosine value is ½:

$$\bar{U}=\frac{\sqrt{2}}{4}q_e S\,\omega\,B \quad .$$

The equations show that working with higher frequencies (10 to 100 kHz), the process of electrostatic charge extraction is proportionally increased, which justifies working with switching power sources. In addition, using a plate/grid in a transformer air gap allows the use of a much higher magnetic charge density, resulting in extremely compact equipment.

We have seen in the section Accumulated Energy in the Atmosphere that for an average electric field of 120 V/m, the surface density of electrostatic charges on the earth is D = –1.1*10^{-9} C/m^2. Any metal part connected to the grounding system mesh will also contain this charge density and, in the case of bare wire or plate/grid subjected to a varying magnetic field, will allow an electrostatic current to flow from ground to any electrical circuit when the charges are removed by the magnetic field.

The average energy expended by the magnetic field to extract electrostatic charges from the strap surface, which has the distribution of electrostatic charges above, is that which keeps the electric current flowing in the shorted-circuited secondary, even under the condition of supplying electric current to the output circuitry. So this is the maximum electric current drawn from the ground through the grounding system.

The amount of electric charge distributed on the strap surface connected to the grounding system is determined by:

$$q_E=\int_S \vec{D}\cdot d\vec{S}=D\,S \quad .$$

With:

q_E = Electrostatic charge [C];
D = Surface density of electric charge [C m^{-2}];

S = Strap surface [m^2].

Considering the calculated average energy and that the amount of strap surface charge is removed in the unit of time, the resultant electric current extracted from the strap is:

$$I_E = q_E f = D S f \quad .$$

With:

I_E = Electrostatic current [A];
f = Magnetic field frequency [cycles s^{-1}].

4.1.2 Calculation Example

The following example aims to show that the electrostatic charge extraction energy of metal surfaces (its work function W) is much lower than that of the photoelectric effect. It is based on a video published in the Internet by Evoluções Energia Ltda., with the title “Energia da terra” (Energy from earth), which shows the operation of a device called Earth Electron Captor, whose purpose is to extract the electrostatic charges from the ground and use them to produce work, reducing the energy consumption of the local power grid. Information and measurements made directly on the operating equipment allow determination of the following technical characteristics:

- Output circuit power (resistive load): 220 VAC (60 Hz) @ 26.7 A ≈ 6 kW;
- Input power: 220 VAC (60 Hz) @ 0.1 A ≈ 22 W;
- Electric current in short-circuited secondary: 55 A;
- Short-circuited secondary cable diameter: 10 mm^2.

These data allow us to estimate for this equipment a power gain of:

$$Gain = \frac{P_o}{P_i} = \frac{6*10^3}{22} \approx 273 \quad .$$

As indicated in the video, although the output circuit power under test is 6 kW, this transformer supports maximum power of $P = V_E I_E = 220\,V*55\,A \approx 12\,kW$, confirming that the equipment operates as a current source, because the current flowing in the shorted secondary is the maximum that can be supplied to the output circuit.

There is no technical information about the dimensions of the electromagnetic coupling between the shorted secondary and the grounding wire cable, so we will estimate that the cable with insulating cover plus the thickness of the metal strap (or bare cable) totalize 10 mm in diameter. The perimeter is determined by $l_x = 2\pi r = 2\pi 5*10^{-3} = \pi*10^{-2} m$. Because the measured electric current is effective (RMS), the effective surface density of magnetic charge is given by:

$$H = \frac{I_E}{l_x} = \frac{55}{\pi*10^{-2}} = 1.75*10^3\,A\,m^{-1} \quad \Rightarrow$$

$$B = \mu_0 H = 1.256637*10^{-6}*1.75*10^3 = 2.20*10^{-3}\,Wb\,m^{-2}[T] \quad .$$

The mains frequency is 60 Hz, so function B(t) is determined by the angular frequency:

$$\omega = 2\pi f = 2*60\pi = 120\pi \quad , \quad B_0 = \sqrt{2} B \quad ;$$

$$B(t) = B_0 sen(\omega t) = \sqrt{2} B sen(120\pi t) = 3.11*10^{-3} sen(120\pi t)\,Wb\,m^{-2} \quad ;$$

$$\frac{dB(t)}{dt}=B_0\omega\cos(\omega t)=120\pi*3.11*10^{-3}\cos(120\pi t)=1.17\cos(120\pi t)Wb\,m^{-2} \quad .$$

To calculate the available energy in the magnetic field for electrostatic charge extraction, we will estimate that the strap length around the secondary wire is l_y = 30 mm, so the strap surface area where the electrostatic charges are distributed is:

$$S=l_x l_y=2\pi r\,l_y=\pi*10^{-2}*3*10^{-2}=3\pi*10^{-4}m^2 \quad .$$

The energy function U(t) produced by the magnetic field over each electrostatic charge is:

$$U(t)=\frac{1}{2}q_E S\frac{dB(t)}{dt}=\frac{1}{2}1.602*10^{-19}*3\pi*10^{-4}*1.17\cos(120\pi t)=8.83*10^{-23}\cos(120\pi t)J \quad .$$

The average energy spent by the magnetic field on each electrostatic charge is given by the average of the above value:

$$\bar{U}=\frac{1}{2}8.83*10^{-23}=4.42*10^{-23}J=2.76*10^{-4}eV \quad .$$

This value confirms that the energy required to extract an electrostatic charge from a metal surface is much less than that of the photoelectric effect. However, it may be that the work function W of the electrostatic charges is lower than this, because this calculated energy value corresponds to that provided by the magnetic field of this particular equipment.

In this calculation example we assumed that the strap surface was $S=l_x l_y=3\pi*10^{-4}m^2$ and the frequency f = 60 Hz, so if the strap's surface electrical charge is shifted in the unit of time, the electric current is:

$$I_E=DSf=1.1*10^{-9}*3\pi*10^{-4}*60=6.22*10^{-11}A \quad .$$

It is evident that this current is undersized for the experimental result, so the energy required to remove electrostatic charges from the strap surface is much smaller, that is, to reach the 55 A measured in the shorted secondary, the calculated average energy extracts in the time unit much more charges than those distributed superficially on the strap. An approximate value for the number of times surface charges are removed from the strap is given by:

$$n=\frac{I_{Esec}}{I_{Estp}}=\frac{55}{6.22*10^{-11}}=8.84*10^{11} \quad .$$

With:

n = Number of times that strap charges are removed;
I_{Esec} = Shorted secondary electric current [A];
I_{Estp} = Strap electric current [A].

This extremely high value shows that, in the unit of time, the calculated average energy $\bar{U}=4.42*10^{-23}J=2.76*10^{-4}eV$ extracts $n=8.84*10^{11}$ the amount of surface electrical charge from the strap. There are three possibilities:

1. The energy required to extract an electrostatic charge (its work function W) is much less than estimated;
2. Charges are removed at a speed large enough to extract several times the amount of strap surface charge;

3. Both possibilities above.

If we conclude that only the energy required to extract an electrostatic charge from the metal surface is smaller, its approximate value is given by:

$$\bar{U}_e = \frac{\bar{U}}{n} = \frac{4.42 * 10^{-23}}{8.84 * 10^{11}} = 5.00 * 10^{-35} J = 3.12 * 10^{-16} eV \quad .$$

It is an extremely small value, which leads us to conclude that both possibilities mentioned above occur.

5 Conclusion

Until now, there is no literature about the use of electrostatic charges as a source of electric energy, but as we can see with the calculations here realized, using electrostatic charges from the atmosphere and ground and ions from sea water may be promising in electric generation systems.

The simple and old Lorentz’s force principle is sufficient to gather completely free electric charges that are dispersed in nature. The methods presented here are only some of many forms to gather that charges and ions and the math developed here are only first approximations to calculate such electric current sources.

The calculation example showed that 1m diameter rotating device with twelve magnets can produce an excess of 10^{10} Amperes of electrostatic current. Even considering that this is a super estimated value, due to not considering air collisions and atmospheric field absorption, it is a huge value that deserves experimentation to get more exact values.

Sea water as a source of ions is not new because salt water is an ionic liquid. To separate magnetically these ions is a solution to get electricity directly without any conversion method. Because ion density of sea water is greater than air, we may obtain 10 or more times the electricity from sea than from atmosphere.

The soil of earth is an electron reservoir, it is the negative pole of the atmospheric electric field. The electron captor described in the patent "Electromagnetic Device for Capturing Electrons from the Ground to Generate Energy" confirms the theory developed here. So electrostatic charges from ground may be used to drive loads in the same manner we do with electric charges of conductors. The math developed to get the work function of electrostatic charges show us that the energy spent to gather electrostatic charges is almost none compared with the photoelectric affect.

New power generation systems can be born from these experiments because we do not yet used such electrostatic currents. Do magnetic fields created by electrostatic currents have different behavior from that created by electric currents? Nature, itself, has all the electric energy we need, without necessity of other fuels or machines to convert pollutant substances into electricity.

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