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Fran de Aquino

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Fran De Aquino
Professor Emeritus of Physics, Maranhao State University, UEMA.
Titular Researcher (R) of National Institute for Space Research, INPE

It is proposed a very simple device for controlling the gravitational mass of a metallic lamina, and the gravity acceleration above it. These effects are obtained when a specific extra-low frequency current passes through a specially designed metallic lamina.

Key words: Gravitational Interaction, Gravitational Mass, Gravitational Force Control.

1. Introduction

In a previous paper [1] we shown that there is a correlation between the gravitational mass, m_g, and the rest inertial mass m_{i0}, which is given by

$$\chi = \frac{m_g}{m_{i0}} = \left\{1-2\left[\sqrt{1+\left(\frac{\Delta p}{m_{i0}c}\right)^2}-1\right]\right\} = \left\{1-2\left[\sqrt{1+\left(\frac{Un_r}{m_{i0}c^2}\right)^2}-1\right]\right\} = \left\{1-2\left[\sqrt{1+\left(\frac{Wn_r}{\rho c^2}\right)^2}-1\right]\right\} \quad (1)$$

where Δp is the variation in the particle's *kinetic momentum*; U is *the electromagnetic energy absorbed or emitted by the particle;* n_r is the index of refraction of the particle; W is the density of energy on the particle (J/kg); ρ is the matter density (kg/m^3) and c is the speed of light.

The *instantaneous values* of the density of electromagnetic energy in an *electromagnetic* field can be deduced from Maxwell's equations and has the following expression

$$W = \tfrac{1}{2}\varepsilon E^2 + \tfrac{1}{2}\mu H^2 \quad (2)$$

where $E = E_m \sin\omega t$ and $H = H\sin\omega t$ are the *instantaneous values* of the electric field and the magnetic field respectively.

It is known that $B = \mu H$, $E/B = \omega/k_r$ [2] and

$$v = \frac{dz}{dt} = \frac{\omega}{\kappa_r} = \frac{c}{\sqrt{\frac{\varepsilon_r\mu_r}{2}\left(\sqrt{1+(\sigma/\omega\varepsilon)^2}+1\right)}} \quad (3)$$

where k_r is the real part of the *propagation vector* $\vec{k}$ (also called *phase constant*); $k = |\vec{k}| = k_r + ik_i$; ε , μ and σ, are the electromagnetic characteristics of the medium in which the incident (or emitted) radiation is propagating ($\varepsilon = \varepsilon_r\varepsilon_0$; $\varepsilon_0 = 8.854\times10^{-12}F/m$; $\mu = \mu_r\mu_0$ where $\mu_0 = 4\pi\times10^{-7}H/m$). From Eq. (3), we see that the *index of refraction* $n_r = c/v$ is given by

$$n_r = \frac{c}{v} = \sqrt{\frac{\varepsilon_r\mu_r}{2}\left(\sqrt{1+(\sigma/\omega\varepsilon)^2}+1\right)} \quad (4)$$

Equation (3) shows that $\omega/\kappa_r = v$. Thus, $E/B = \omega/k_r = v$, i.e.,

$$E = vB = v\mu H$$

Then, Eq. (2) can be rewritten as follows

$$W = \tfrac{1}{2}\varepsilon E^2 + \tfrac{1}{2}\mu\left(\frac{E}{v\mu}\right)^2 = \tfrac{1}{2}\varepsilon E^2 + \tfrac{1}{2}\left(\frac{1}{v^2\mu}\right)E^2 = \tfrac{1}{2}\left(\frac{1}{v^2\mu}\right)E^2 + \tfrac{1}{2}\left(\frac{1}{v^2\mu}\right)E^2 = \left(\frac{1}{v^2\mu}\right)E^2 = \left(\frac{c^2}{v^2\mu c^2}\right)E^2 = \left(\frac{n_r^2}{\mu c^2}\right)E^2 \quad (5)$$

For $\sigma >> \omega\varepsilon$, Eq. (3) gives

$$n_r^2 = \frac{c^2}{v^2} = \frac{\mu\sigma}{2\omega}c^2 \quad (6)$$

Substitution of Eq. (6) into Eq. (5) gives

$$W = (\sigma/2\omega)E^2 \quad (7)$$

Substitution of Eq. (7) into Eq. (1), yields

$$m_g = \left\{1-2\left[\sqrt{1+\frac{\mu}{c^2}\left(\frac{\sigma}{4\pi f}\right)^3\frac{E^4}{\rho^2}}-1\right]\right\}m_{i0} = \left\{1-2\left[\sqrt{1+\left(\frac{\mu_0}{64\pi^3c^2}\right)\left(\frac{\mu_r\sigma^3}{\rho^2f^3}\right)E^4}-1\right]\right\}m_{i0} = \left\{1-2\left[\sqrt{1+7.032\times10^{-27}\left(\frac{\mu_r\sigma^3}{\rho^2f^3}\right)E^4}-1\right]\right\}m_{i0} \quad (8)$$

Note that if $E = E_m\sin\omega t$ .Then, the average value for E^2 is equal to $\frac{1}{2}E_m^2$ because

E varies sinusoidaly (E_m is the maximum value for E). On the other hand, we have $E_{rms}=E_m/\sqrt{2}$. Consequently, we can change E^4 by E_{rms}^4, and the Eq. (8) can be rewritten as follows

$$m_g=\left\{1-2\left[\sqrt{1+7.032\times10^{-27}\left(\frac{\mu_r\sigma^3}{\rho^2 f^3}\right)E_{rms}^4}-1\right]\right\}m_{i0} \quad (9)$$

The *Ohm's vectorial Law* tells us that $j_{rms}=\sigma E_{rms}$. Thus, we can write Eq. (9) in the following form:

$$m_g=\left\{1-2\left[\sqrt{1+7.032\times10^{-27}\,\frac{\mu_r j_{rms}^4}{\sigma\rho^2 f^3}}-1\right]\right\}m_{i0} \quad (10)$$

where $j_{rms}=j/\sqrt{2}$ [3]. Since

$$j=\frac{i}{S}=\frac{V/R}{S}=\frac{V}{RS}=\frac{V}{(L/\sigma S)S}=\sigma\left(\frac{V}{L}\right) \quad (11)$$

Then, we can write that

$$j_{rms}=\frac{\sigma}{\sqrt{2}}\left(\frac{V}{L}\right) \quad (12)$$

By substitution of Eq. (12) into Eq.(10), we get

$$\chi=\frac{m_g}{m_{i0}}=\left\{1-2\left[\sqrt{1+1.758\times10^{-27}\left(\frac{\mu_r\sigma^3}{\rho^2}\right)\frac{(V/L)^4}{f^3}}-1\right]\right\} \quad (13)$$

Also, it was shown in the above mentioned paper [1] that, if the *weight* of a particle in a side of a lamina is $\vec{P}=m_g\vec{g}$ ($\vec{g}$ perpendicular to the lamina) then the weight of the same particle, in the other side of the lamina is $\vec{P}'=\chi m_g\vec{g}$, where $\chi=m_g^l/m_{i0}^l$ (m_g^l and m_{i0}^l are respectively, the gravitational mass and the rest inertial mass *of the lamina*). Only when $\chi=1$, is that the weight is equal in both sides of the lamina. Thus, the lamina can control the gravity acceleration above it, and in this way, it can work as a *Gravity Controller Device*.

Since the gravitational mass of a body above the lamina is $m_g=m_{i0}$, then we can conclude that $P'=m_{i0}(\chi g)$. Therefore, this means that the gravity acceleration above the lamina is $g'=\chi g$.

Here, we describe a very simple device, which works as the mentioned lamina. This device is easy to build, and can be used in order to test the correlation between gravitational mass and inertial mass previously mentioned (Eq. (1)), and also the modification of the gravity acceleration above the lamina (χg).

2. The Device

Consider the device shown in Fig.1 (a). It is basically a thin Aluminum strip attached to an electrical insulating plate. This strip has been designed over an Aluminum lamina, in order to an electrical current $(j_{rms};f)$ to pass through it, producing the decreasing of its gravitational mass $m_{g(strip)}$, according to Eq. (10). The Aluminum of this strip has the following characteristics: 99.9% Aluminum; $\mu_r=1$; ρ = 2700 kg/m^{-3};σ = 3.5x10^{7}S/m. The Aluminum strip has the following dimensions; Length, *L*=3528 mm; Width: *l* = 5mm; Thickness: Δx =3μm. The Resistance of the Aluminum strip is: $R=L/\sigma S=L/\sigma(\Delta x l)=6.7\Omega$ and the maximum current density, according to Eq. (12), is:

$$j_{\max(rms)}=\frac{\sigma}{\sqrt{2}}(V/L)_{\max}=3.5\times10^6\,A/m^2=3.5A/mm^2;$$

the maximum current is $i_{\max(rms)}=j_{\max(rms)}S=0.05A$ [*]; the Maximum Dissipated Power is: $P_{\max}=Ri_{\max(rms)}^2=0.017watts$.

By substuting the values of μ_r, σ, ρ and L into Eq. (13), we obtain.

$$\chi=\frac{m_{g(strip)}}{m_{i0(strip)}}=\left\{1-2\left[\sqrt{1+6.67\times10^{-14}\,\frac{V^4}{f^3}}\right]-1\right\} \quad (14)$$

Consequently, the gravity acceleration *above the Aluminum strip* is given by

$$g'=\chi g=\left\{1-2\left[\sqrt{1+6.67\times10^{-14}\,\frac{V^4}{f^3}}\right]-1\right\}g \quad (15)$$

The calculated results starting from Eqs.(14) and (15) for $f=5\mu Hz$; $f=10\mu Hz$; $f=15\mu Hz$, in the voltage range $0.1V-0.5V$ are plotted in Table 1.

Figure 1(b) shows an experimental set up in order to control the decreasing of the *Gravitational Mass* of the Aluminum strip. Figure 1(c) shows an experimental set up in order to control the decreasing of the *gravity acceleration above the Aluminum strip*.

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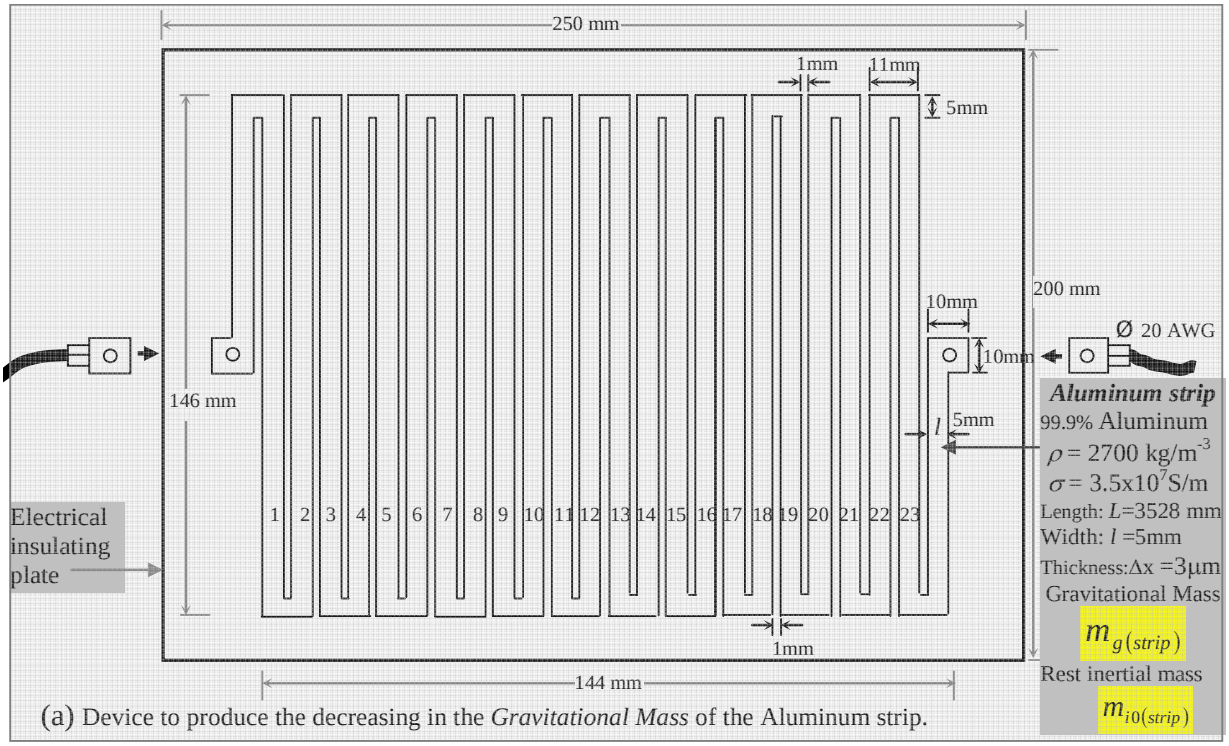
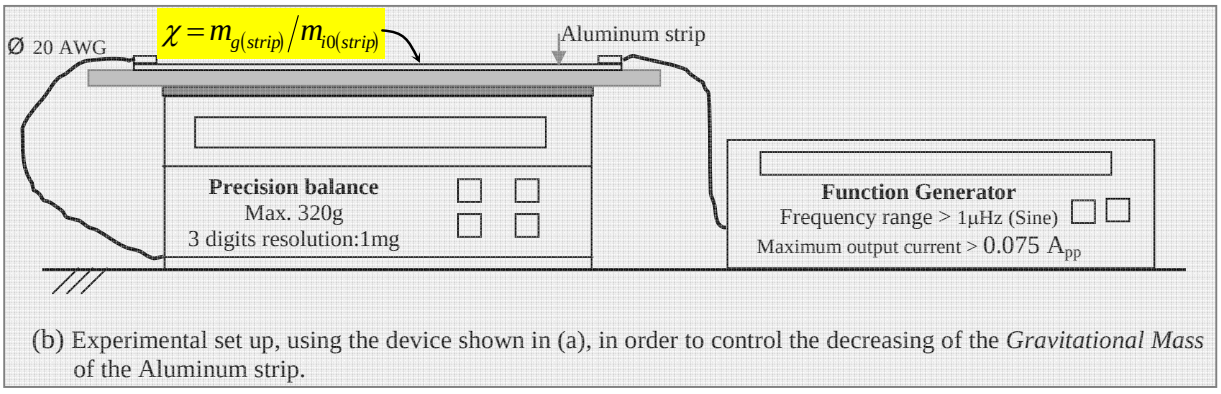
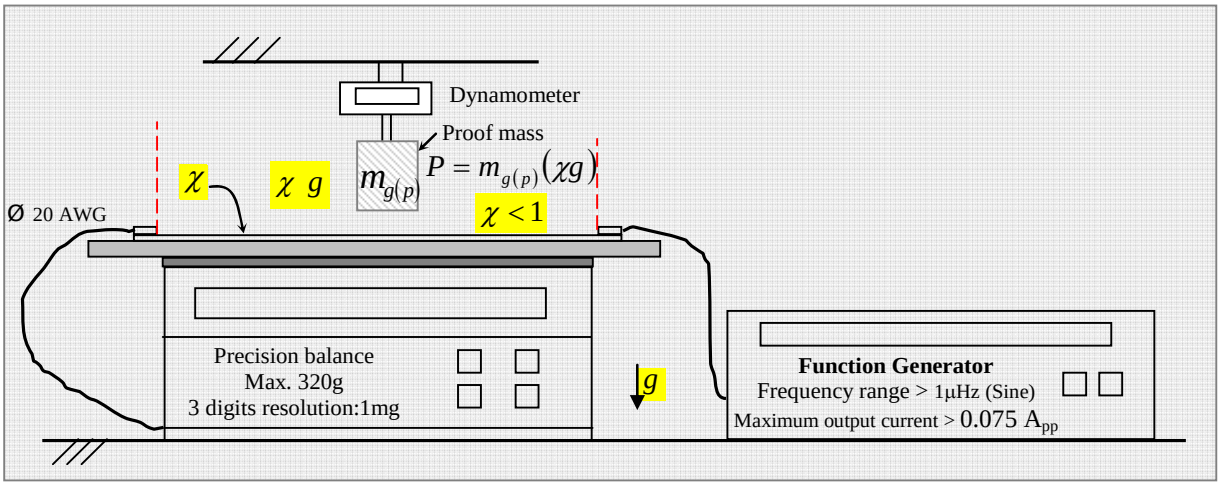
[*] The *maximum out put current* of the HP 3325 Function Generator (option 002 High Voltage out put) is 0.08A$_{pp}$.(0.056A$_{rms}$). Voltage range 4.0mV to 40.0V$_{pp}$; sine 1 μHz to 20MHz.



(a) Device to produce the decreasing in the *Gravitational Mass* of the Aluminum strip.



(b) Experimental set up, using the device shown in (a), in order to control the decreasing of the *Gravitational Mass* of the Aluminum strip.



(c) Experimental set up, using the device shown in (a), in order to control the decreasing of the Local *Gravity* (g) *above the Aluminum strip* (*Gravity Controller Device*).

Fig. 1 – Experimental set ups for controlling the *Gravitational Mass* of the Aluminum strip, and the *Gravity* acceleration above it.

$$\chi = \frac{m_{g(strip)}}{m_{i0(strip)}} = \left\{1 - 2\left[\sqrt{1 + 1.758\times10^{-27}\left(\frac{\mu_r\sigma^3}{L^4\rho^2}\right)\frac{V^4}{f^3}}\right] - 1\right\} = \left\{1 - 2\left[\sqrt{1 + 6.67\times10^{-14}\,\frac{V^4}{f^3}}\right] - 1\right\}$$

$\sigma = 3.5\times10^7\, S/m;\ \rho = 2700\, kg/m^3;\ L = 3.528 m;\ \mu_r = 1;$
$m_{i0(strip)} = \rho(\Delta x l L) = 1.428\times10^{-4}\, kg = 0.1428\, grams$

f = 5 μHz

V (volts)	$m_{i0(strip)}$ (gr)	$m_{g(strip)}$ (gr)	χ	χg (m/s^2)
0.1	0.1428	0.1352	0.9473	9.2930
0.2	0.1428	0.0395	02769	2.6771
0.3	0.1428	-0.2304	-1.6139	-15.8323
0.4	0.1428	-0.6651	-4.6577	-45.6922
0.5	0.1428	-1.2454	-8.7217	-85.5598

g =9.81 m/s^2

f = 10 μHz

V (volts)	$m_{i0(strip)}$ (gr)	$m_{g(strip)}$ (gr)	χ	χg (m/s^2)
0.1	0.1428	0.1418	0.9933	9.7442
0.2	0.1428	0.1279	0.8959	8.7887
0.3	0.1428	0.0794	0.5178	5.0796
0.4	0.1428	-0.0415	-0.2909	-2.8537
0.5	0.1428	-0.2209	-1.5469	-15.1750

g =9.81 m/s^2

f = 15 μHz

V (volts)	$m_{i0(strip)}$ (gr)	$m_{g(strip)}$ (gr)	χ	χg (m/s^2)
0.1	0.1428	0.1425	0.9980	9.7903
0.2	0.1428	0.1383	0.9686	9.5019
0.3	0.1428	0.1207	0.8458	8.2972
0.4	0.1428	0.0779	0.5456	5.3523
0.5	0.1428	0.0014	0.0098	0.0961

g =9.81 m/s^2

Tab. 1 – Calculated results for the *Gravitational Mass* of the Aluminum strip $m_{g(strip)}$, and for the *Gravity* acceleration above the Aluminum strip (χg).

Next, we will show that by reducing the thickness of the Aluminum strip to $3nm$ [†] it is possible to design a similar device for working with *frequency* up to $f = 2mHz$. In this case the period T of the wave is $T = 500s \cong 8.3\min$ [‡].

Let us then consider an Aluminum strip with $3nm$ thickness, $5mm$ width and $3{,}528mm$ length as shown in Fig.2. If the *maximum* applied voltage is $V_{\max} = 22.2volts$ then, according to Eq. (13), we have

$$\chi = \frac{m_{g(strip)}}{m_{i0(strip)}} =$$

$$= \left\{1 - 2\left[\sqrt{1 + 1.758\times10^{-27}\left(\frac{\mu_r \sigma^3}{\rho^2}\right)\frac{(V_{\max}/L)^4}{f^3}} - 1\right]\right\} =$$

$$= \left\{1 - 2\left[\sqrt{1 + \frac{1.6\times10^{-8}}{f^3}} - 1\right]\right\} \qquad (16)$$

For $f = 2mHz$, Eq. (16) gives

$$\chi = \frac{m_{g(strip)}}{m_{i0(strip)}} = -0.46 \qquad (17)$$

Through the Aluminum strip, the maximum intensity of the electrical current is given by

$$i_{\max} = j_{\max} S = \sigma (V_{\max}/L) S =$$

$$= (3.5\times10^7 \, S/m)(22.2/3.528)\left[(3\times10^{-9})(5\times10^{-3})\right] =$$

$$= 3.3mA$$

The electrical resistance of the Aluminum strip is

$$R_{strip} = \frac{L}{\sigma S} =$$

$$= \frac{3.528}{(3.5\times10^7)\left[(3\times10^{-9})(5\times10^{-3})\right]} = 6720\Omega$$

Therefore, the *maximum dissipated power* by the strip has now the following value

$$P_{strip}^{\max} = R_{strip} i_{\max}^2 = 73.2mW$$

Note that this power is almost the double of the power in the first device ($37.7mW$).

Let us now verify if the area of the surface of the Aluminum strip (area of the surface of thermal transfer ; 5mm x 3,528mm) is sufficient to transfer to the surrounding air *all the heat* produced by the strip (in order to avoid the fusion of the strip).

The coefficient of heat transfer, h, can be expressed by the following equation [4, 5,6]

$$h = \frac{(\Delta Q/\Delta t)}{A_n \Delta T} \qquad (18)$$

where $\Delta Q/\Delta t$ (in W) is the dissipated power ; A_n (in m^2) is the necessary area of the surface of thermal transfer and ΔT the difference of temperature between the area of the solid surface and the surrounding fluid (K).

When the surrounding fluid is the *air* , the heat transfer coefficient, h, varies from 10 up to $100 W/m^2.°K$ [7]. Assuming $h = 10 W/m^2.°K$, and $\Delta T = 1°K$, then for $P_{strip}^{\max} = 73.2mW$, Eq. (18) gives

$$A_n = \frac{(\Delta Q/\Delta t)}{h\Delta T} = 7.32\times10^{-3} m^2 \qquad (19)$$

Since the area of the surface of the Aluminum strip is

$$A_{strip} = 5mm \times 3{,}528mm = 17.6\times10^{-3} m^2 >> A_n$$

Then, we can conclude that *the area of the Aluminum strip is sufficient to transfer to the surrounding air all the heat produced by it*. The same is valid in the case of the first device, where the dissipated power by the Aluminum strip is even smaller than in the second device.

[†] Ultra Thin Aluminum Nanofoils (foils with *nanometers* thicknesses) are manufactured, for example by *American Elements - The Advanced Materials Manufacturer* (See the available nanofoils at: https://www.americanelements.com/ultra-thin-aluminum-nanofoil-7429-90-5).

[‡] In the case of the first device the frequency it were $f = 10\mu Hz$ and the period $T = 10^5 s \cong 27.77hours$.

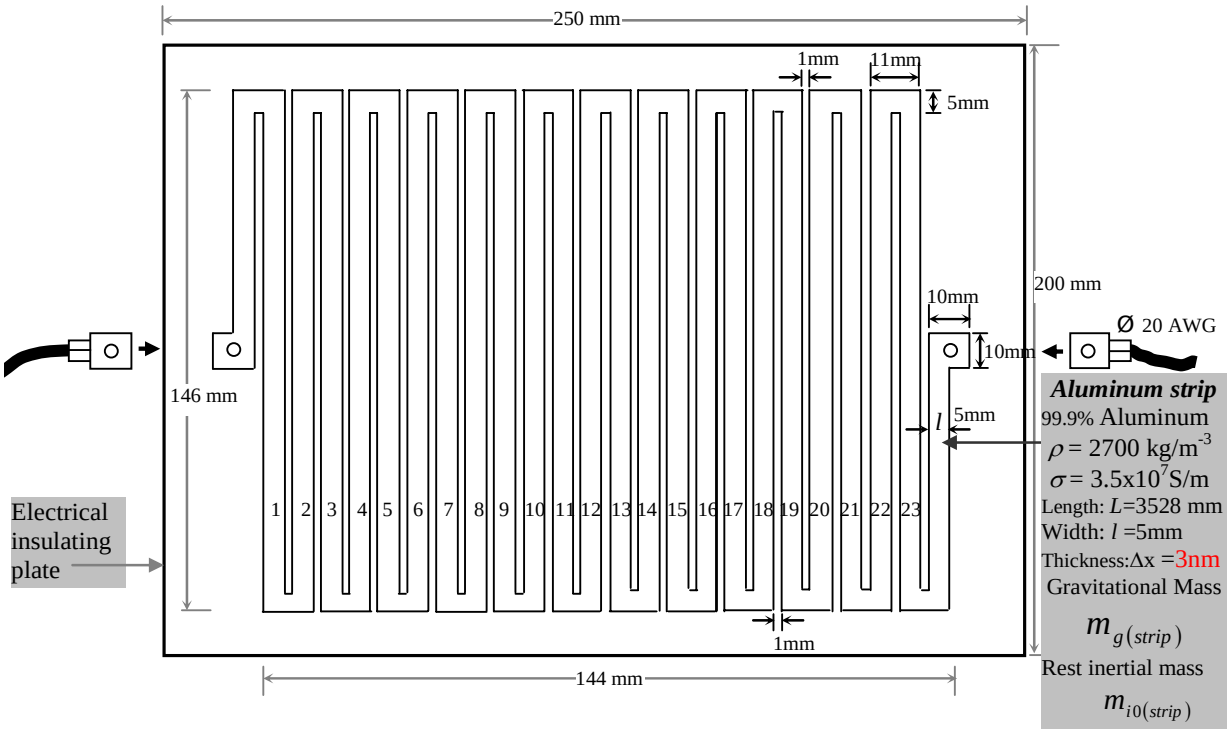


Fig. 2 – Device using Aluminum strip with 3*nm* thickness.

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