Electrostatic Cannon

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Abstract

The author proposes a new type of gun, in which the projectile is accelerated by an electrostatic field. It shows that a strong electrostatic field (high voltage pulse) can accelerate a small charge (shell) to huge speeds (up to 1000 km/s). If this micro-projectile (10^{-4} grams) consists of thermonuclear fuel, its explosion will destroy the target. This idea can be used to create thermonuclear engines and missiles, for conventional long-range artillery.

Introduction

Everyone knows the widely used gunpowder guns. But the speed of the projectile's departure in them is limited by the speed of gas molecules and usually does not exceed 1 km/s. This means that the range and lethal force of their projectiles is also limited. This flaw is trying to eliminate in electromagnetic guns, in which the projectile accelerates to a higher speed (3-5 km/s). But an electromagnetic gun requires enormous current power. The gun turns out to be very complex, expensive and not unreliable. Sliding contacts quickly burn and the barrel has to change literally after each shot. Experiments with electromagnetic guns are conducted in the U.S. for many years, but so far, the experiments have not moved forward. The speed achieved is insufficient and is unlikely to significantly exceed the results (3 - 4 km/s).

Gauss' gun uses magnetic projectiles (or pushers) and can hardly give the required speeds.

Electrostatic cannon. The principle of action.

The author offers an electrostatic cannon, which requires high voltages, but can provide almost any speed (up to 1000 km/s and above) charged microparticles or micro-shells (mass of about 10^{-4} grams). Such a micro-projectile can harm the target only if the explosion is thermonuclear. In this case, the energy of a thermonuclear explosion is equal to the energy of 2 to 5 kg of conventional explosives (e.g. TNT) and this is more than enough to damage (destroy) any object.

In addition, the speed of a thermonuclear micro-projectile is very high (above the speed of exit beyond the solar system) and it can be delivered to an unlimited range in space in a short time and can serve as a defense not only for the Earth, but also for the entire solar System. The micro-projectile easily breaks through the Earth's atmosphere with the loss of 10-15% of its original speed and can hit any vehicle. And most thermonuclear reactions are pure, i.e. do not give radioactive isotopes.

But the reader can say that nuclear weapons are prohibited by international treaties. But when these treaties were adopted, nuclear bombs were meant in thousands of kilotons, not kilograms - the power of a conventional soldier's grenade. In addition, nuclear States openly declare that they will use nuclear weapons at serious risk, and dictatorial States are constantly blackmailing others with nuclear weapons.

In addition, the reader has the right to ask: How are you going to create a micro-thermonuclear reactor if the whole World has been working on the creation of the reactor for decades, spent tens of billions of dollars and cannot run even a thermonuclear reactor weighing thousands of tons The size of a high-rise building?

The short answer is given in the [1]. I'll try to summarize the basic idea. To start a chain thermonuclear reaction, you need a minimum temperature of about 10 million degrees. This is about 10 keV (the speed of THE COLLISION of the cores is about 1000 km/s). It is not difficult to accelerate the nucleus (shell) to such a speed. It is enough that the corresponding electric charge has passed the required path in the electric field of high voltage (which is carried out by an electrostatic gun). When faced with an obstacle, the micro-projectile penetrates the obstacle (fig. 1a,b). The atoms at the front of the projectile are inhibited, creating a plasma of gigantic density. The tail cores hit the inhibited nuclei at a speed of about 1000 km/s and cause a chain thermonuclear reaction that heats the fuel to millions of electron-volts and causes a thermonuclear explosion (fig.1c) (calculations made).

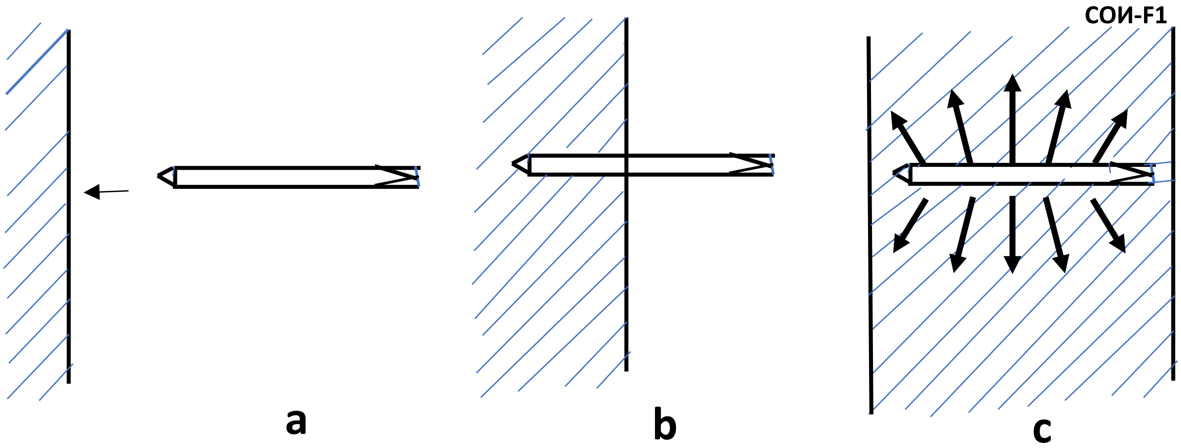

Fig. 1. Thermonuclear Micro-Shell. *Notation*: a –approach to the target; b-introduction into the target barrier; c – explosion.

An important advantage of the proposed method is that we can make very small micro-shells, i.e. create engines for vehicles, rockets and small energy sources. Scientists creating the International Experimental Thermonuclear Reactor ITER, have been working since 2005, spent billions of dollars and are asking for another 10 years and billions to create a large industrial reactor, which will be like a large power plant produce an electric current. And a huge number of transport engines will continue to consume liquid fuel and release CO_2 into the atmosphere.

The great advantage of the proposed method is also that it does not produce radioactive isotopes and carbon dioxide into the atmosphere. The disadvantage as well as other pulse reactors in the demand of high voltage and energy storage in pulse storage (example, condenser).

The electrostatic gun is also high (almost 100%) electric efficiency (E.E.) , the practical absence of a large demasking flash and sound. In fact, in a conventional powder weapon, in addition to the projectile, a mass of compressed, hot powder gas is thrown at a high speed. And these are all useless losses (efficiency is about 3 - 7%). And in the proposed electrostatic cannon, along with the projectile, only a small mass of neutralized pushing plasma, which has a speed not exceeding the speed of the projectile, is thrown away.

A schematic device of an electrostatic cannon.

The principle device of the electrostatic cannon is shown on figs. 2a. The cannon has two spherical electrodes 3 and 4, immersed in the insulator 5. The electrodes are connected by a high voltage pulse generator 1. It can be a high-voltage high-speed capacitor. In the center of the gun is an isolated vacuum tube 6, which is located a small pushing charge 8 and micro-projectile 7. The charge should be easily converted into highly ionized plasma. It is desirable that the micro-projectile could be charged with an electric charge of one sign. Tube 6 has electric contacts 9, connected with the electric (current conductive) external layer of electrodes 3, 4, wires 10.

To increase the speed, several fig.1a accelerators can be connected in a chain (fig. 1b). In some cases, instead of spherical electrodes 3, 4 you can use flat electrodes 12, 13 (fig. 2c).

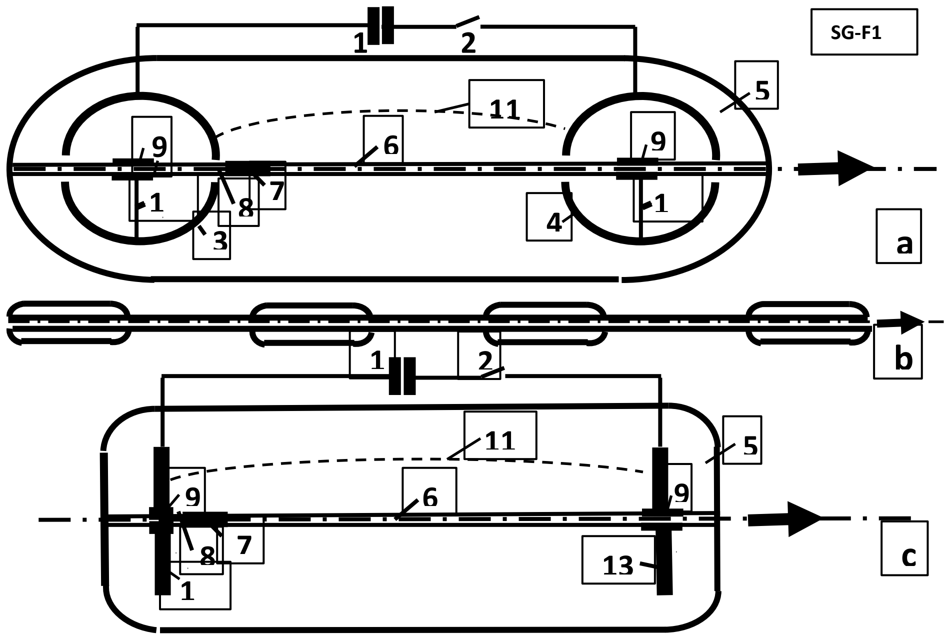

Fig. 2. Principal schema of Electrostatic Gun. *Notation*: a – Electrostatic Gun having spherical electrodes; b – multi-Gun having the running high intensity wave; *c* – Electrostatic Gun having plate electrodes; 1 – Impulse high voltage generator (or condenser), 2 – turn on, 3 – 4 - spherical electric electrodes (положительный и отрицательный) , 5 – isolator, 6 – Canal for shell acceleration, 7 – shell, 8 – electric charge, 9 – contact, 10 – connection to sphere, 11 – lines of electric intensity, 12 -13 – plates.

The work of the Electrostatic Cannon.

Electrostatic Cannon (EC) works like this. A capacitor or pulsed (explosive) generator produces a high voltage electrical pulse. As a result, between electrodes 3, 4 there is a high-intensity electric field. Part of this field ionizes Charge 8, turns it into plasma and divides into positive and negative. Positively charged nuclei (protons) are attracted by a heavily negatively charged electrode and disperse the micro-projectile.

When the dispersing plasma (or charged micro-projectile) reaches the pins of the 9nd electrode there is a discharge. The micro-projectile leaves the EC.

The corresponding high-voltage equipment is developed in powerful linear accelerators, Van de Graaff generator, pellertons, Grand Collider, etc. existing devices to accelerate beams of protons to almost light speeds (300,000 km/s).

Detailed calculations and development of specific parts will be needed, but the benefit of the implementation of the proposed idea is so great (for defense, energy, space, transport engines) that it is worth trying.

The pros and cons of an electrostatic cannon.

1. Efficiency of the electrostatic cannon about 100%. K.P.D. powder gun generally 3 -7%.
2. EP does not produce sound, electromagnetic pulse or release of a large mass of powder gases. (Electromagnetic cannon creates a powerful demasking electromagnetic pulse).
3. The device is safe because it does not contain explosives.
4. The range is virtually unlimited.
5. The cost of a shot is low.

The downside is that you need a high-voltage capacitor and a charger or a high voltage pulse. High voltage currents are used.

Estimates of some projects.

The estimates will require data on the electrical strength and punching of dielectrics. More than 15 years ago, the author collected some data that might be required for evaluation.

Table 1. Properties of various good insulators (recalculated in metric system

Insulator Ohm-m.	Resistivity MV/m. E_i	Dielectric strength constant, ε	Dielectric kg/mm², $\sigma \times 10^7 N/m^2$	Tensile strength
Lexan	10^{17}–10^{19}	320–640	3	5.5
Kapton H	10^{19}–10^{20}	120–320	3	15.2
Kel-F	10^{17}–10^{19}	80–240	2–3	3.45
Mylar	10^{15}–10^{16}	160–640	3	13.8
Parylene	10^{17}–10^{20}	240–400	2–3	6.9
Polyethylene	10^{18}–5×10^{18}	40–680*	2	2.8–4.1
Poly (tetra-fluoraethylene)	10^{15}–5×10^{19}	40–280**	2	2.8–3.5
Air (1 atm, 1 mm gap)	-	4	1	0
Vacuum (1.3×10^{-3} Pa, 1 mm gap)	-	80–120	1	0

*For room temperature 500–700 MV/m.
** 400–500 MV/m.
Source: Encyclopedia of Science & Technology (Vol. 6, p. 104, p. 229, p. 231).

Initial assessment of the main parameters.

Project 1. Electrostatic Cannon for Space with Thermonuclear Micro-Shells.

Original micro-projectile data: Thermonuclear explosive ***LiD***. Thermonuclear reaction, [2] p.11:

#	Synthesis	Result (received Energy, MeV)	%
1	D+D→	T(1.01)+p(3.02)	50%
2	D+D→	^{3}He(0.82)+n(2.45)	50%

The mass of thermonuclear explosives is 10^{-7} kg. The planned energy of the W_1 micro-projectile is W_1 = 10 keV = $1.6\text{x}10^{-15}$ J. *D* core impact rate is (speed of *D* core)

$$\boldsymbol{V=\sqrt{\frac{2W_1}{\mu m_p}}=\sqrt{\frac{W_1}{m_p}}=\sqrt{\frac{1.6\cdot10^{-15}}{1.67\cdot10^{-27}}}=0.93\cdot10^6\approx10^6\quad m/s},$$

Here $\mu = 2$ is the number of nucleons in the nucleus *D*, m_p - mass of one nucleon, *V* – speed of *D* core.
Energy required for a micro-projectile with a mass of $m = 10^{-7}$ kg

$$W=\frac{mV^2}{2}=\frac{10^{-7}\cdot10^{12}}{2}=0.5\cdot10^5\ \ J.$$

The average force required to disperse the micro-projectile of this mass at the origin of the barrel is l = 2 m.

$$F=\frac{W}{l}=\frac{5\cdot10^4}{2}=2.5\cdot10^4\ \ N.$$

Required driving charge at constant average intensity of the electric field E = $5\cdot10^7$ V/m

$$q=\frac{F}{E}=\frac{2.5\cdot10^4}{5\cdot10^7}=5\cdot10^{-4}\ \ C.$$

This *q* is the total charge of the micro-projectile and the part of plasma near the bottom of the projectile.
Required voltage for l = 2 m

$$V=l\cdot E=2\cdot5\cdot10^7=100\,MV.$$

Acceleration and acceleration time in the trunk

$$\boldsymbol{a=\frac{V^2}{2l}=\frac{10^{12}}{4}=0.25\cdot10^{12}\ m/s^2,\quad t=\sqrt{\frac{2l}{a}}=\sqrt{\frac{4}{0.25\cdot10^{12}}}=8\cdot10^{-6}\ sec}.$$

$$\textbf{Here's } \boldsymbol{a} - \textbf{acceleration micro} - \textbf{projectale},\quad \boldsymbol{t} - \textbf{time}.$$

Since the weight of the pushing part of the plasma is about 0.1% of the mass of the projectile, the electric c.p. of the electrostatic cannon is almost 100%.

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Project 2. Electrostatic Gun to launch the small satellite.

Initial data: Satellite mass m = 1 kg, Initial speed V = 8000 m/s=8.10^3 m/s.

Energy required for micro-satellite with a mass of m = 1 kg

$$\boldsymbol{W = \frac{mV^2}{2} = \frac{1 \cdot 64 \cdot 10^6}{2} = 32 \cdot 10^6 \;\; J.}$$

The average force required to disperse the micro-projectile of this mass on the path of l = 10 m.

$$F = \frac{W}{l} = \frac{32 \cdot 10^6}{10} = 3.2 \cdot 10^6 \;\; N.$$

Required driving charge at constant tension of the electric field E = 3·10^8 V/m

$$q = \frac{F}{E} = \frac{3.2 \cdot 10^6}{3 \cdot 10^8} = 1.07 \cdot 10^{-2} \;\; C.$$

Required voltage for l = 10 m

$$V = l \cdot E = 10 \cdot 3 \cdot 10^8 = 3000\, MV.$$

Dispersal time in the barrel

$$\boldsymbol{a = \frac{V^2}{2l} = \frac{64 \cdot 10^6}{20} = 3.2 \cdot 10^6 \;\; m/s^2, \quad t = \sqrt{\frac{2l}{a}} = \sqrt{\frac{20}{3.2 \cdot 10^6}} = 2.5 \cdot 10^{-3} \;\; sec.}$$

Here a-acceleration micro-satellite, t-time.

Loss speed in the atmosphere for satellite diameter is 2 cm is 17%. Loss from maintain 4 km is 8.5%.

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Project 3. Electrostatic Gun for Long Distance Shell

Initial data: Shell mass m = 2 kg, Initial speed V = 3000 m/s = 3·10^3 m/s.

Energy required for a projectile with a mass of m = 2 kg

$$\boldsymbol{W = \frac{mV^2}{2} = \frac{2 \cdot 9 \cdot 10^6}{2} = 9 \cdot 10^6 \;\; J.}$$

The average force required to disperse the micro-projectile of this mass on the path of l = 10 m.

$$\boldsymbol{F = \frac{W}{l} = \frac{9 \cdot 10^6}{10} = 9 \cdot 10^5 \;\; N.}$$

Required driving charge at constant tension of the electric field E = 3·10^8 V/m

$$\boldsymbol{q = \frac{F}{E} = \frac{9 \cdot 10^5}{3 \cdot 10^8} = 3 \cdot 10^{-3} \;\; C.}$$

Required voltage for l = 10 m

$$V = l \cdot E = 10 \cdot 3 \cdot 10^8 = 3000\, MV.$$

Dispersal time in the barrel

$$\boldsymbol{a = \frac{V^2}{2l} = \frac{9 \cdot 10^6}{20} = 0.45 \cdot 10^6 \;\; m/s^2, \quad t = \sqrt{\frac{2l}{a}} = \sqrt{\frac{20}{0{,}45.10^6}} = 6.7 \cdot 10^{-3} \;\; sec.}$$

Here a-acceleration of shell, t-time.

The range of electromagnetic cannon (EmP) at this velocity speed reaches on a ballistic trajectory of 150 km. But the EMP is low because it has a large loss of inductive resistance.

Discussion

This idea, like any idea, needs an experiment. However, it is more promising than the railroad, which has been in development for about 10 years and has spent hundreds of millions of dollars. The main novelty that moved it from the dead point is the use of plasma charge as a pusher and a strong electrostatic field. The main advantage is acceleration to any speeds and application in defense and nuclear power. Developing materials with great resilience can help implement this idea.

References:

1. Bolonkin A. A., Thermonuclear Micro-Projectile and Methods for its Use in Defensive Protection from Space Rockets, Peaceful Energy and Transport. http://viXra.org/abs/1909.0475, https://archive.org/details/articleafterrcstrategicdefthermonuclearmicro-projectileandmethodsforitsuseindefe.

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3. Wikipedia. Railgun.

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