Jet Electric Generator

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Abstract

Author offers and develops the theory of a new simple cheap efficient electric (electron) generator. This generator can convert pressure or kinetic energy of any non-conductive flow (gas, liquid) into direct current (DC). The generator can convert the mechanical energy of any engine into high voltage DC. One can covert the wind and water energy into electricity without turbine. One can convert the rest energy of an internal combustion engine or turbojet engine in electricity and increase its efficiency.

Key words: Jet Electric Generator, Electron generator, AB generator, Wind electric generator, Water electric generator, DC generator, High voltage generator.

Introduction

Electric Generator.

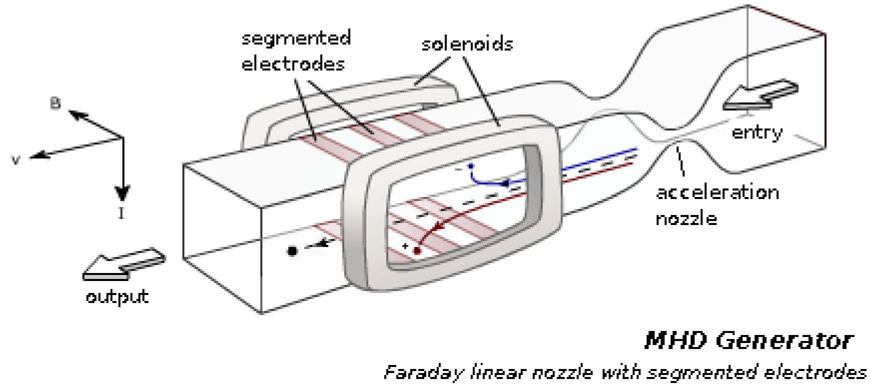
In electricity generation, an electric generator is a device that converts mechanical energy to electrical energy. A generator forces electric current to flow through an external circuit. The source of mechanical energy may be a reciprocating or turbine steam engine, water falling through a turbine or waterwheel, an internal combustion engine, a wind turbine, a hand crank, compressed air, or any other source of mechanical energy. Generators provide nearly all of the power for electric power grids.

The reverse conversion of electrical energy into mechanical energy is done by an electric motor, and motors and generators have many similarities. Many motors can be mechanically driven to generate electricity and frequently make acceptable generators.

The **MHD** (magneto hydrodynamic) **generator** transforms thermal energy and kinetic energy directly into electricity. MHD generators are different from traditional electric generators in that they operate at high temperatures without moving parts. MHD was developed because the hot exhaust gas of an MHD generator can heat the boilers of a steam power plant, increasing overall efficiency. MHD was developed as a topping cycle to increase the efficiency of electric generation, especially when burning coal or natural gas. MHD dynamos are the complement of MHD propulsors, which have been applied to pump liquid metals and in several experimental ship engines.

An MHD generator, like a conventional generator, relies on moving a conductor through a magnetic field to generate electric current. The MHD generator uses hot conductive plasma as the moving conductor. The mechanical dynamo, in contrast, uses the motion of mechanical devices to accomplish this. MHD generators are technically practical for fossil fuels, but have been overtaken by other, less expensive technologies, such as combined cycles in which a gas turbine's or molten carbonate fuel cell's exhaust heats steam to power a steam turbine.

Natural MHD dynamos are an active area of research in plasma physics and are of great interest to the geophysics and astrophysics communities, since the magnetic fields of the earth and sun are produced by these natural dynamos.



The jet electric generator offered in given article is principal different from MHD generator. One does not need hot plasma, magnets and a magnetic field, it's easier, cheaper by ten times and more efficient. It might serve for purposes of propulsion. MHD is also not reversible.

The first author publications about new jet AB electron-electric generator are in [1] – [5].

AB Jet Electric Generator (ABJEG)

Principal schema. Jet electric generator (ABJEG) is very simple (fig.2). That is nonconductive tube 2, injector 4 of electrons (ions) in beginning of tube and collector 5 of electrons (ions) in end of tube. If generator does not have grounding 10, one may have the charge compensator 10.

The electron injector is conventional: cold field electron emission (edge needles) or hot electron emission (hot cathode). See more detailed description and computation of the injectors in next chapters. Correct design of them practically does not consume electricity.

The charge (electron) collector may be conductive plates or conductive net located in end of tube. The ABJEG needs in it if one does not have the good grounding or want to improve the efficiency.

The charge compensator deletes the opposed charges (electrons and positive ions) and injects the surplus charges into exhaust flow.

The charge compensator is necessary if ABJEG cannot have the grounding (for example ABJEG is located in aircraft).

The offered generator can work on non-conductive gas or liquid. It may be convertible to either a pump or propulsion system.

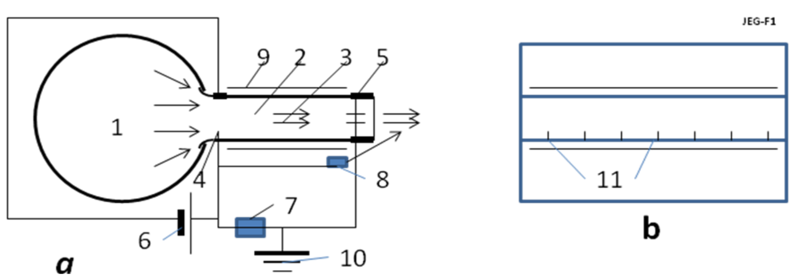


Fig.2. Schema of AB Jet electric generator. ***a*** – side view; ***b*** – back view. *Notations:* 1 is pressured gas or liquid, 2 is Jet Electric Generator (ABJEG), 3 is flow, 4 is injector of electrons, 5 is collector of electrons, 6 is source of injector voltage, 7 is useful load, 8 is compensator of the lost electrons, 9 is compensator of internal charge, 10 is grounding (if no grounding we need the compensator 8), 11 needles of the ejector 4.

Work of the ABJEG (fig. 3). The nonconductive pressure gas (or liquid) locates into volume 1 (fig.2). Under pressure the gas flow into ABJEG (fig.3, tube 1). In beginning of tube the injector 2 injects into gas the electrons 5. The electrons are captured by the flow 6 and move to end of tube 1 against the electric field between injector and collector. They brake the flow (get the work, create the opposed pressure). The flow reaches the collector (plate 7, 11) and charges it. When the charge of collector became over the charge of the injector 4 (fig.2) the electrical current appears in the circuit. It consume by load 7 (fig.2).

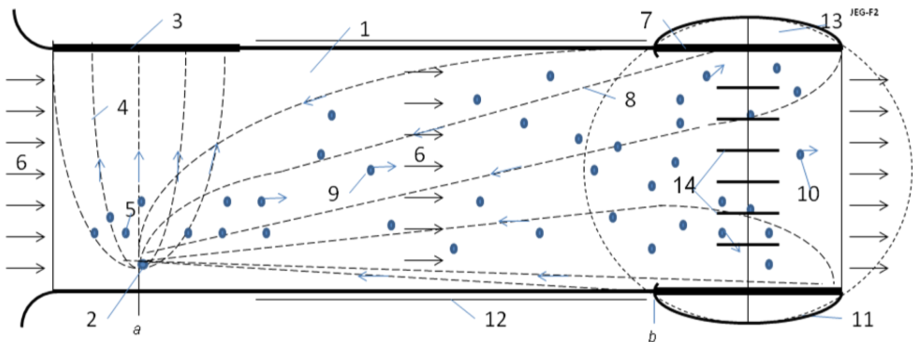


Fig.3. Work of the AB Jet Electric Generator. *Notations*: 1 is Jet Electric Generator, 2 is needle injector, 3 is opposed cathode plate of needle injector, 4 is the electric intensity lines of needle injector, 5 is the injected electrons, 6 is flow of working mass (gas or liquid), 7 is plate of collector, 8 is the electric intensity lines of the needle injector, 9 is electron moved against the electric field under flow pressure, 10 is electron not captured collector, 11 conductive isolated surface of collector, 12 is conductive coating of the dielectric tube 1 for balancing the internal charge of electrons, 13 is collector of electrons, 14 are conductive internal plates of collector.

Different designs of the injectors, collectors, compensators and electric schemas of ABJEG are possible. One of them is shown in fig. 4. This injector has a conductivity net a high transparency and collector having opposed charged plates. This collector attracts the electron and increases the efficiency. Correct design of them practically does not consume electricity.

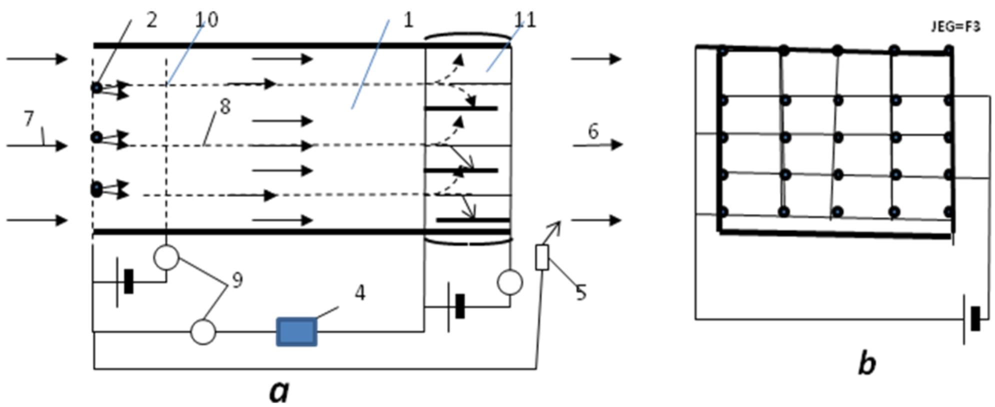


Fig.4. Electric schema of one version of the ABJEG. *Notations*: 2 is electron injector, 4 is useful load, 5 is compensator, 6 is exhaust flow, 7 is input stream, 8 is trajectory of electrons, 9 is control, 10 is anode net of injector, 11 is collector with opposed charged plates.

Differences of ABJEG (AB Electric Generator) relative to MHD (magnetohydrodynamic generator).

The jet electric generator is principal different from MHD generator. MHD works on plasma or conductive liquid. ABJEG works on dielectric (non-conductive gas or liquid (for example, water)). MHD needs in very hot gas (high conductivity plasma). The currently available materials cannot endure this temperature. Result in practical systems is low efficiency. Converting of gas to a high conductivity plasma requests a lot of energy for heating, ionization and dissociation of gas. Most part of this energy is useless loses. The MHD needs very powerful magnets (better superconductive magnets). For increasing efficiency the MHD connects to conventional gas turbine. The installation is very complex and expensive. MHD is not reversible.

Advantages of ABJEG over MHD:

1. ABJEG does not need hot plasma, magnets and magnetic field.
2. ABJEG is easier, cheaper by ten (perhaps a hundred) times and more efficient.
3. ABJEG may be used for getting energy from wind, river and moving water (ocean stream).
4. ABJEG can be small and it may be used for getting energy in small vehicles.
5. ABJEG can work as propulsion or pump.

Advantages ABJEG over the conventional electric (magnetic) generator:

1. ABJEG is easier, by some times than a conventional generator.
2. ABJEG produces high voltage electricity. Big electric stations do not need a heavy expensive and vulnerable transformer.
3. ABJEG produces a direct current (DC). That is suitable for transfer over long distance.
4. The small DC generators can easy connect to the common net. Not necessary the harmonize the frequency and phase of current.

Theory of Jet Electric generator. Computation and Estimation.

1. Ion and electron speed.

Ion mobility. The ion speed onto the gas (air) jet may be computed by equation:

$$j_s = qn_-b_-E + qD_-(dn_-/dx)\ , \qquad (1)$$

where j_s is density of electric current about jet, A/m^2; $q = 1.6\times10^{-19}$ C is charge of single electron, C; n_- is density of injected negative charges in 1 m^3; b_- is charge mobility of negative charges, m^2/sV; E is electric intensity, V/m; D_- is diffusion coefficient of charges; dn_-/dx is gradient of charges. For our estimation we put $dn_-/dx = 0$. In this case

$$j_s = qn_-b_-E\ ,\quad Q = qn\ ,\quad v = bE\ ,\quad j_s = Qv\ , \qquad (2)$$

where Q is density of the negative charge in 1 m^3; v is speed of the negative charges about jet, m/s.

The air negative charge mobility for normal pressure and temperature $T = 20^oC$ is:

In dry air $b_- = 1.9\times10^{-4}$ m^2/sV, in humid air $b_- = 2.1\times10^{-4}$ m^2/sV. (3)

In Table 1 is given the ions mobility of different gases for pressure 700 mm Hg and for $T = 18^oC$.

Table 1. Ions mobility of different gases for pressure 700 mm Hg and for T = 18 ^oC.

Gas	Ion mobility 10^{-4} m^2/sV, b_+, b_-		Gas	Ion mobility 10^{-4} m^2/sV, b_+, b_-		Gas	Ion mobility 10^{-4} m^2/sV, b_+, b_-	
Hydrogen	5.91	8.26	Nitrogen	1.27	1.82	Chloride	0.65	0.51
Oxygen	1.29	1.81	CO_2	1.10	1.14			

Source [8] p.357.

In diapason of pressure from 13 to 6×10^6 Pa the mobility follows the Law bp = const, where p is air pressure. When air density decreases, the charge mobility increases. The mobility strength depends upon the purity of gas. The ion gas mobility may be recalculated in other gas pressure p and temperature T by equation:

$$b = b_0 \frac{Tp_0}{T_0 p}\ , \qquad (4)$$

where lower index "$_o$" mean the initial (known) point. At the Earth surface H = 0 km, T_0 = 288 K, p = 1 atm; at altitude H = 10 km, T_0 = 223 K, p = 0.261 atm;

For normal air density the electric intensity must be less than 3 MV (E < 3 MV/m) and depends from pressure.

Electron mobility. The ratio $E/p \approx$ constant. Conductivity σ of gas depends upon density of charges particles n and their mobility b, for example:

$$\sigma = neb, \quad \lambda = 1/n\sigma, \tag{5}$$

where b is mobility of the electron, λ is a free path of electron.

Electron mobility depends from ratio E/n . This ratio is given in Table 2.

Table 2. Electron mobility b_e in gas vs E/n

Gas	***E/n*** $\times 10^{-17}$ 0.03 V·cm²	***E/n*** $\times 10^{-17}$ 1 V·cm²	***E/n*** $\times 10^{-17}$ 100 V·cm²	Gas	***E/n*** $\times 10^{-17}$ 0.03 V·cm²	***E/n*** $\times 10^{-17}$ 1 V·cm²	***E/n*** $\times 10^{-17}$ 100 V·cm²
N_2	13600	670	370	He	8700	930	1030
O_2	32000	1150	590	Ne	16000	1400	960
CO_2	670	780	480	Ar	14800	410	270
H_2	5700	700	470	Xe	1980	-	240

Source: Physics Encyclopedia http://www.femto.com.ua/articles/part_2/2926.html

The electrons may connect to the neutral molecules and produce the negative ions (for example, affinity of electron to O_2 equals 0.3 - 0.87 eV, to H_2O equals 0.9 eV [7] p.424). That way the computation of the mobility of a gas containing electrons and ions is a complex problem. Usually the computations are made for all electrons converted to ions.

The maximal electric intensity in air at the Earth surface is E_m = 3 MV/m. If atmospheric pressure changes the E_m also changes by law E_m/p = constant.

Example 4. If $E = 10^5$ V/m, than v = 20 m/s in Earth surface conditions.

2. Electron injectors.

There are some methods for getting the electron emissions: hot cathode emission, cold field electron emission (edge cold emission, edge cathode). The photo emission, radiation emission, radioisotope emission and so on usually produce the positive and negative ions together. We consider only the hot emission and the cold field electron emission (edge cathodes), which produces only electrons.

Hot electron emission.

Current i of diode from potential (voltage) U is

$$i = CU^{3/2} \tag{6}$$

where C is constant which depends from form and size cathode. For plate diode

$$C = \frac{4}{9}\varepsilon_0 \frac{S}{d^2}\sqrt{\frac{2e}{m_e}} \approx 2.33 \cdot 10^{-6}\frac{S}{d^2}, \tag{7}$$

where $\varepsilon_o = 8.85 \cdot 10^{-12}$ F/m; S is area of cathode (equals area of anode), cm²; d is distance between cathode and anode, cm; e/m_e is the ratio of the electron charge to electron mass, C/kg;

Result of computation equation (7) is in fig. 5.

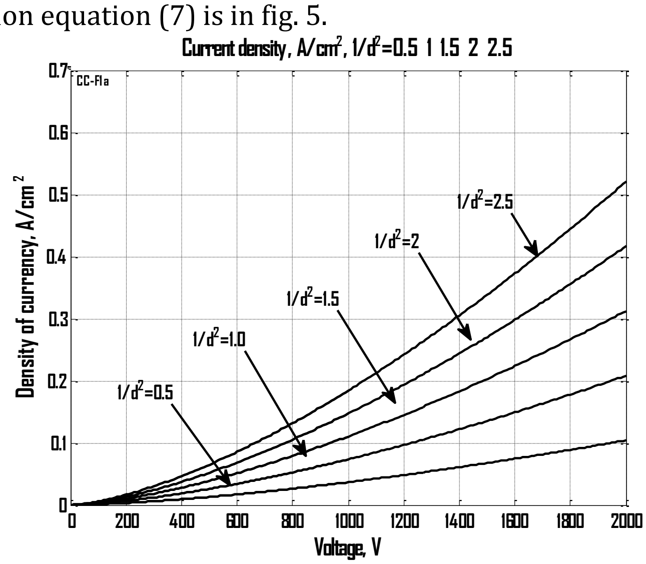


Fig.5. Electric current via voltage the plain cathodes for different ratio of the distance.

The maximal **hot cathode** emission computed by equation:

$$j_s = BT^2 exp(-A/kT)\,, \qquad (8)$$

where B is coefficient, A/cm^{2}K^2; T is cathode temperature, K; k = 1.38×10^{-23} [J/K] is Bolzmann constant; $A = e\varphi$ is thermoelectron exit work, J ; φ is the exit work (output energy of electron) in eV, e = 1.6·10^{-19} . Both values A, B depend from material of cathode and its cover. The "A" changes from 1.3 to 5 eV, the "B" changes from 0.5 to120 A/cm^{2}K^2. Boron thermo-cathode produces electric current up 200 A/cm^2. For temperature 1400 -1500K the cathode can produce current up 1000 A/cm^2. The life of cathode can reach some years.

Exit energy from metal are (eV):

W 4.5, Mo 4.3, Fe 4.3, Na 2.2 eV, (9)

From cathode covered by optimal layer(s) the exit work is in Table 3.

Table 3. Exit work (eV) from cathode is covered by the optimal layer(s):

Cr – Cs	Ti – Cs	Ni – Cs	Mo – Cs	W – Ba	Pt - Cs	W - O – K	Steel- Cs	Mo_2C-Cs	WSi_2-Cs
1.71	1.32	1.37	1.54	1.75	1.38	1.76	1.52	1.45	1.47

Source [8]: Kikoin, Table of physic values, 1976, p. 445 (in Russian).

Results of computation the maximal electric current (in vacuum) via cathode temperature for the different exit work of electrons f are presented in fig.6.

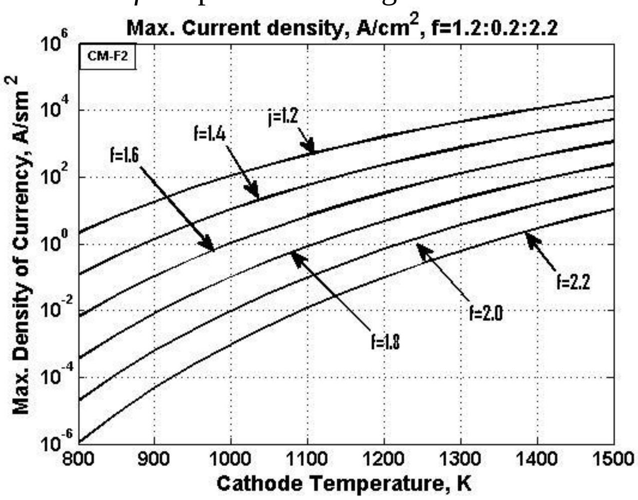


Fig.6. The maximal electric current via cathode temperature for the different exit work of electrons f.

Method of producing electrons and positive ions is well developed in the ionic thrusters for space apparatus.

The field electron emission. (The edge cold emission).

The cold field electron emission uses the edge cathodes. It is known that the electric intensity E_e in the edge (needle) is

$$E_e = U/a\,. \qquad (10)$$

Here a is radios of the edge. If voltage between the edge and nears net (anode) is U = 1000 V, the radius of edge a = 10^{-5} m, electric intensity at edge is the E_e = 10^8 V/m. That is enough for the electron emission. The density of electric current may reach up 10^4 A/cm^2 . For getting the required current we make the need number of edges.

The density of electric current approximately is computed by equation:

$$j \approx 1.4 \cdot 10^{-6} \frac{E^2}{\varphi} 10^{(4.39\varphi^{-1/2} - 2.82 \cdot 10^7 \varphi^{3/2}/E)}, \qquad (11)$$

where j is density of electric current, A/cm²; E is electric intensity near edge, V/cm; φ is exit work (output energy of electron, field electron emission), eV.

The density of current is computed by equation (11) in Table 4 below.

Φ = 2,0 eV		φ = 4,5 eV		φ = 6,3 eV	
$E\times10^{-7}$	lg j	$E\times10^{-7}$	lg j	$E\times10^{-7}$	lg j
1,0	2,98	2,0	-3,33	2,0	-12,9
1,2	4,45	3,0	1,57	4,0	-0,88
1,4	5, 49	4,0	4,06	6,0	3,25
1,6	6,27	5,0	5,59	8,0	5,34
1,8	6,89	6,0	6,62	10,0	6,66
2,0	7,40	7,0	7,36	12,0	7,52
2,2	7,82	8,0	7,94	14,0	8,16
2,4	8,16	9,0	8,39	16,0	8,65
2,6	8,45	10.0	8,76	18,0	9,04
		12,0	9,32	20,0	9,36

Source: http://www.femto.com.ua/articles/part_1/0034.html

Example: Assume we have needle with edge $S_1 = 10^{-4}$ cm², $\varphi = 2$ eV and net $S_2 = 10\times10 = 10^2$ cm² located at distance L = 10 cm. The local voltage between the needle and net is $U = 10^2$ volts. Than electric intensity at edge of needle, current density and the electric current is:

$$E = \frac{S_2 U}{S_1 L} = \frac{10^2 10^2}{10^{-4} 10^1} = 10^7 \text{ V/cm}, \quad j = 10^3 \text{ A/cm}^2, \quad i = jS_1 = 10^3 10^{-4} = 0.1 \text{ A}, \qquad (12)$$

Here j is taken from Table 4 or computed by equation (11). If we need in the electric current 10 A, we must locate 100 needles in the entrance area 1×1 m of generator.

Computation of equation (11) is presented in fig. 7.

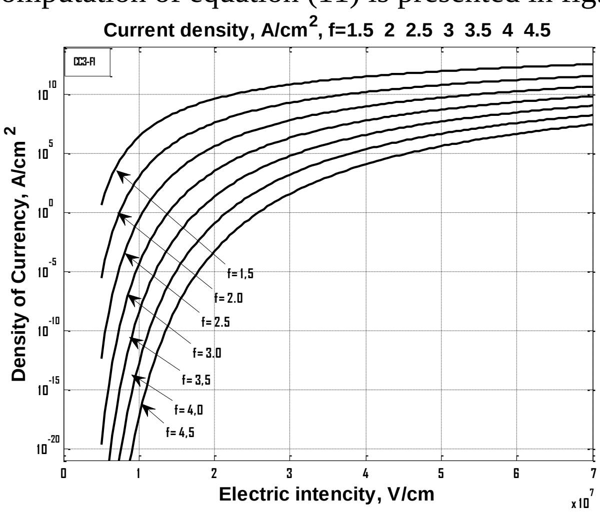


Fig.7. Density of electric current the noodle injector via the electric intensity for different the field electron emissions *f*.

3. Internal and outer pressure on the generator surface.

The electric charges located in the ABJEG generator produce electric intensity and internal and outer pressure. The electric intensity can create electrical breakdown; the pressure can destroy the generator.

a) For the cylindrical generator the electric intensity and pressure may be estimated by equations:

$$E = k\frac{2\tau}{\varepsilon r}, \quad \tau = \frac{i}{V_a}, \quad p = E\sigma, \qquad (13)$$

where E is electric intensify, V/m; $k = 9{\cdot}10^9$ is electric constant, Nm^2/C^2; τ is the linear charge, C/m; ε is dielectric constant for given material (ε = 1 - 1000), r is radius of tube (generator), m; i is electric current A; V_a is average speed of flow inside of generator, m/s; p is pressure, N/m^2; σ is the density of charge, C/m^2 at an tube surface.

Example. Assume the generator has r = 0.1 m, V_a = 50 m/s, i = 0.1 A. Let us take as isolator GE Lexan having the dielectric strength E_m = 640 MV/m and ε = 3. Than from (13) we have E = 120 MV/m < E_m = 640 MV/m.

If $E > E_m$ we can locate the part of the compensate charge inside generator.

b) For plate of generator having rectangular entrance h×w = 1× 3 m and compensation charges on two sides, the electric intensity and pressure may be estimated by equations:

$$E = 4\pi k\frac{\sigma}{\varepsilon}, \quad \tau = \frac{i}{2V_a w}, \quad p = 2\varepsilon\varepsilon_0 E^2, \qquad (14)$$

where w is width of entrance, m; ε is dielectric coefficient of the isolator.

4. Loss of energy and matter to ionization.

Let us estimate the energy and matter requested for ionization and discharge in the offered ABJEG generator**.** Assume we have ABJEG generator having the power P = 10,000 kW and a work voltage V = 1 MV. In this case the electric current is $i = P/V$ = 10 A = 10 C/s.

Assume we use the nitrogen N_2 for ionization (a very bad gas for it). It has exit work about 5 eV and relative molecular weight 14. One molecule (ion) of N_2 weights $m_N = 14{\cdot}1.67{\cdot}10^{-27} = 2.34{\cdot}10^{-26}$ kg. The 1 ampere has $n_A = 1/e = 1/1.6{\cdot}10^{-19} = 6.25{\cdot}10^{18}$ ions/s. Consumption of the ion mass is:
$M = m_N i\, n_A = 2.34{\cdot}10^{-26}{\cdot}10{\cdot}\ 6.25{\cdot}10^{18} = 1.46{\cdot}10^{-6}$ kg/s $= 1.46{\cdot}10^{-6}{\cdot}3.6{\cdot}10^{-3} = 5.26{\cdot}10^{-3}$ kg/hour $\approx$ 5 gram/hour.

If electron exit work equals φ = 4.5 eV the power spent extraction of one electron is: $E_1 = \varphi e = 4.5{\cdot}1.6{\cdot}10^{-19} = 7.2{\cdot}10^{-19}$ J.

The total power for the electron extraction is $E = i{\cdot}n_A{\cdot}E_1 = 10{\cdot}6.25{\cdot}10^{18}{\cdot}7.2{\cdot}10^{-19}$ = 45 W.

The received values mass M and power E are very small in comparison with conventional consumption of fuel (tons in hour) and generator power (thousands of kW).

Important note (Compensation of flow charge). Any contact collector cannot collect ALL charges. Part of them will fly away. That means the generator (apparatus) will be charged positive (if fly away electrons or negative ions) or negative (if fly away the positive ions). It is easy to delete the negative charges by edge. The large positive charge we may delete by a small ion accelerator. The art of ion engines for vacuum is well developed. They may be used as injectors and dischargers in the first design.

The charges may be deleted also by grounding.

Below is spark gap in air.

Table 5. Electric spark in air (in mm. For normal atmospheric pressure).

Voltage, kV	Two edges,	Two spheres, d = 5 sm	Two plates
20	15.5	5.8	6.1
40	45.5	13	13.7
100	200	15	36.7
		Two spheres, d = 2 sm	
200	410	262	75.3
300	600	530	114

Source [6], p124.

Application of Jet Electric Generator

1. Electric Station.

Estimations of main parameters of ABJEG for an electric station.

Assume we have ABJEG as the cylindrical tube with constant cross-section area $f = 0.01$ m^2 (fig.8). Let us take the pressure in balloon 1 $p = 0.5$ atm = 50,000 N/m^2 and the gas (air) speed in exit of ABJEG $V = 50$ m/s.

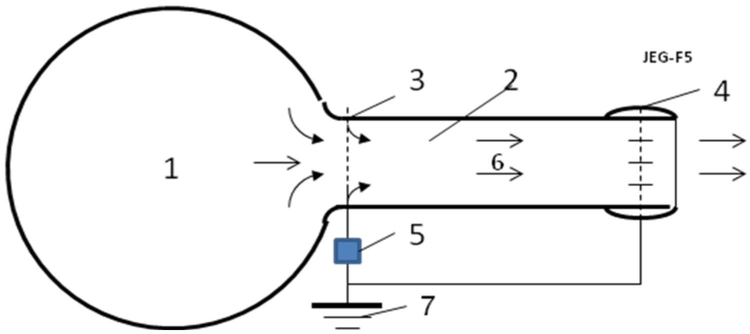


Fig.8. Principal schema of the Jet Electric Generator. *Nominations:* 1 – balloon with pressure gas, 2 – jet electric generator (ABJEG), 3 – injector of electrons, 4 – collector of electrons, 5 – outer load, 6 – gas flow, 7 – grounding.

The useful (working) pressure equals the pressure p into balloon 1 minus the kinetic loss of a gas in the exit

$$\Delta p_1 = p - \frac{\rho V^2}{2} = 5 \cdot 10^4 - \frac{1.225 \cdot 50^2}{2} = 4.847 \cdot 10^4, \quad \frac{N}{m^2} \quad . \qquad (15)$$

That is anti-pressure of electron (ions) moving against the flow.
Power of ABJEG is

$$P = f \cdot \Delta p_1 V = 0.01 \cdot 4.847 \cdot 10^4 \cdot 50 = 24.2 \text{ kW}, \qquad (16)$$

Coefficient of efficiency of ABJEG

$$\eta = \frac{\Delta p_1}{p} = \frac{4.847}{5} = 0.97 \quad . \qquad (17)$$

Let us estimate the voltage and current for length $L = 0.3$ m of active part of tube.
The maximum of electric intensity E_m must be less than

$$E_m < \frac{V}{b} = \frac{50}{2 \cdot 10^{-4}} = 2.5 \cdot 10^5 \ \frac{V}{m}. \qquad (18)$$

Let us take the electric intensity $E = 2 \cdot 10^5$ V/m. Than the work voltage will be

$$U = EL = 2 \cdot 10^5 \cdot 0.3 = 60 \text{ kV} . \qquad (19)$$

The current will be

$$i = P/U = 24.2/60 = 0.4 \text{ A} . \qquad (20)$$

The ABJEG is suitable as simple (tube) additional electric generator for internal combustion engines working by Otto's cycle or any machine having pressure or high speed exhaust gases. That increases their efficiency. Vast industrial possibilities are opened by recovery of otherwise waste energies at low opportunity cost.

The under critical speed w and consumption m of ideal gases from the converging nozzle may be estimated by equations:

$$w=\sqrt{2\frac{k}{k-1}p_1v_1\left[1-\left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}}\right]}, \quad m=f\sqrt{2\frac{k}{k-1}\frac{p_1}{v_1}\left[\left(\frac{p_2}{p_1}\right)^{2/k}-\left(\frac{p_2}{p_1}\right)^{\frac{k+1}{k}}\right]}, \quad (21)$$

where k is adiabatic coefficient in gas dynamic; p is gas pressure in beginning "1" and end "2" of nozzle; v is specific gas volume, f is cross-section area of tube, m^2.

Critical ratio β_k and critical speed w_k is

$$\beta_k=\frac{p_k}{p_1}=\left(\frac{2}{k+1}\right)^{\frac{k}{k-1}}, \quad \beta_k<\frac{p_2}{p_1}<1, \quad w_k=\sqrt{2\frac{k}{k+1}p_1v_1} \ . \qquad (22)$$

For one atom gas k = 1.66 and β_k = 0.42 ,
For two atom gas k = 1.4 and β_k = 0.528 ,
For one atom gas k = 1.3 and β_k = 0.546 .

Equation of gas state and continuity equation is

$$pV=mRT, \quad \frac{f\,w}{v}=const. \qquad (23)$$

Here V is gas volume, m^3; m is gas mass, kg; T is gas temperature, K; R is gas constant, for air R = 287 J/kg K.

These equations allow to compute the data of gas flow.

The steam is very suitable gas for converting its extension directly to electricity without steam piston machines, steam turbines and magnetic generator directly to electricity by ABJEG.

The steam speed after a converting nozzle may be computed by equation

$$w=44.72\sqrt{i_1-i_2}\ , \qquad (24)$$

where I is the steam enthalpy in the beginning and end of the adiabatic process. The enthalpy is found in diagram "*is*" by data of the beginning and end of the adiabatic process.

2. Wind Energy.

The simplest wind electric generator (ABJEG) is shown in fig.9. In end of mast 1 is installed the electron injector 2. The wind 6 pick up the electrons and moves them to the Earth surface. Under Earth surface the electros throw the grounding 4 and outer electric load 3 return to injector 2.

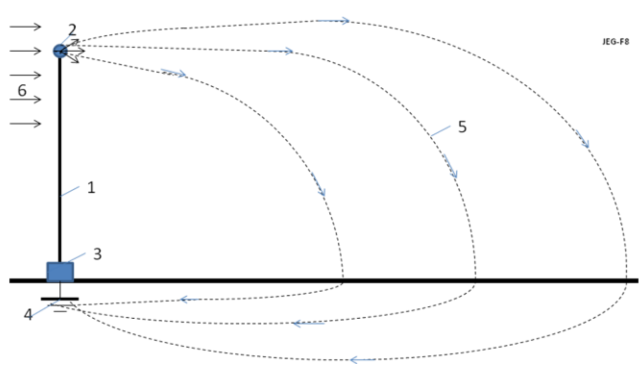


Fig.9. Simplest wind generator. *Notations:* 1 – mast, 2 - electron injector, 3 – electric load, 4 – grounding, 5 – trajectories of electrons, 6 = wind.

The electric resistance of the grounding may be estimated by equation

$$R = \frac{\rho}{2\pi a}\ , \qquad (25)$$

ρ is specific average resistance of the ground, Ωm ; a is average radius the plate of grounding.
The good grounding must be in place of underground water or in sea water. For sea water $\rho \approx 0.2\ \Omega m$. For underground water ρ is below. Connection having one line underground widely uses in communication.

Suggested method may be used for getting the wind energy at high altitude. The injector must be supported at high altitude by balloon, dirigible or wing apparatus [1].

a). **Power of a wind** energy N [Watt, Joule/sec]

$$N = 0.5\eta\rho AV^3 \quad [W] \ . \qquad (26)$$

The coefficient of efficiency, η, equals about 0.2 -0.25 for EABG; 0.15 - 0.35 for low speed propeller rotors (ratio of blade tip speed to wind speed equals $\lambda \approx 1$); η = 0.45 - 0.5 for high speed propeller rotors (λ = 5 - 7). The Darrieus rotor has η = 0.35 - 0.4. The gyroplane rotor has 0.1 - 0.15. The air balloon and the drag (parachute) rotor has η = 0.15 - 0.2. The Makani rotor has 0.15 - 0.25. The theoretical maximum equals $\eta \approx 0.6$. Theoretical maximum of the electron generator is 0.25. A - front (forward) area of the electron injector, rotor, air balloon or parachute [m^2]. ρ - density of air: ρ_o =1.225 kg/m^3 for air at sea level altitude H = 0; ρ = 0.736 at altitude H = 5 km; ρ = 0.413 at H = 10 km. V is average annually wind speed, m/s.

Table 5. Relative density ρ_r and temperature of the standard atmosphere via altitude

H, km	0	0.4	1	2	3	6	8	10	12
$\rho_r=\rho/\rho_o$	1	0.954	0.887	0.784	0.692	0.466	0.352	0.261	0.191
T, K	288	287	282	276	269	250	237	223	217

Source [6].

The salient point here is that the strength of wind power depends upon the wind speed (by third order!). If the wind speed increases by two times, the power increases by 8 times. If the wind speed increases 3 times, the wind power increases 27 times!

The wind speed increases in altitude and can reach in constant air stream at altitude H = 5 – 7 km up V = 30 – 40 m/s. At altitude the wind is more stable/constant, which is one of the major advantages that an airborne wind systems has over ground wind systems.

For comparison of different wind systems of the engineers must make computations for average annual wind speed V_0 = 6 m/s (or 10 m/s) and altitude H_0 = 10 m. For standard wind speed and altitude the maximal wind power equals 66 W/m^2.

The energy, E, produced in one year is (1 year $\approx 30.2\times10^6$ work sec) [J]

$$E = 3600\times24\times350N \approx 30\times10^6 N, \quad [J]. \qquad (27)$$

3. Water Energy.

Typical hydroelectric station is shown in fig, 10. The water from a top level 1 flows by tube 2 to ABJEG 3 and after working runoff to lower level 4.

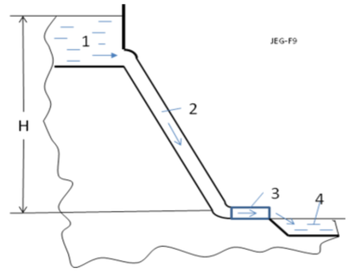


Fig. 10. Typical Hydroelectric station with ABJEG. *Notations:* 1 - upper source; 2 - water canal; 3 – ABJEG; 4 – lower runoff.

Note: It is possible also the water electric generator shown in fig. 8. One may be used in rivers and ocean streams.

1. **Power of a water flow** is N [Watt, Joule/sec]:

$$N = \eta\rho BgH \quad [\text{W}]. \qquad (28)$$

The coefficient of efficiency, η, equals about 0.8 - 0.95; ρ - density of liquid: $\rho \approx 1.000$ kg/m^3 for water; B is the flow in cubic meters per second; $g = 9.81$ m/s^2 is Earth gravity; H is the height difference between inlet and outlet of installation, m (fig.10).

Without ABJEG the H and V connected by equation

$$H = V^2/2g \quad . \qquad (29)$$

2. Resistance of water. Salt water conducts an electric current. The specific electric resistance of water is significantly depends from salinity of water. When we have the plates (nets) with both sides (cathode and anode), the specific electric resistance are:

1. Distilled water $R \approx 10^6$ Ωm.
2. Fresh water $R = 40 - 200$ Ωm (depends from water salinity). (30)
3. Sea water $R \approx 0.2$ Ωm.

In our case in one side we have the electron injector (cathode) which has conventionally a small area. In this case the specific electric resistance is:

$$R_o = R/\, 4\pi\, a \quad , \qquad (31)$$

where a is radius of needle (or cathode), m; this radius conventionally is very small (mm). That means the R_o has an electric resistance of hundreds Ohms. We can neglect their influence in the installation efficiency .

3. Electron speed in water.

The charge mobility in water is:

$$Cl^- \text{ is } 0.667\times10^{-7}\ \text{m}^2/\text{sV}, \quad Na^+ \text{ is } 0.450\times10^{-7}\ \text{m}^2/\text{sV}. \qquad (32)$$

As you see the mobility of ions in water is very small. The applied voltage in water is also small. That means the ion speed v is small in the comparison with water speed. In many case we can put $v = bE \approx 0$

If $v > 0$, the electrons accelerate the water ($E > 0$ and installation spends energy, works as engine). If $v < 0$, the electrons brake the water ($E < 0$ and the correct installation can produce energy, works as electric generator). If $v = 0$ (electron speed about installation equals water speed V), the electric resistance is zero.

4. The efficiency of installation from back electric current may be estimated by equation:

$$\eta \approx 1/(1+ R_u/R_o) \quad , \qquad (33)$$

where R_u is an useful electric resistance. Ratio R_u/R_o conventionally is small and η is closed to 1.

5. Specific power of Installation N_1 [W/m^2]. The specific power of the offered installation may be estimated by a series of equations:

$$N_1 \approx \eta\, A_1/t = \eta Q_1 EL/t = \eta Q_1 EV = j_s U = \eta\rho B_1 gh = 0.5\eta m_1 V^2, \qquad (34)$$

where A_1 is energy of flow through 1 m^2, J/m^2; t is time, sec; B_1 is flow in m^3 through cross section area of flow 1 m^2; E is electric intensity, V/m; L is distance between injector and net (cathode and anode); V is flow speed, m/s; j_s is density of electric **current**, A/m²; U is electric voltage, V; m_1 is flow mass per second through area 1 m²; Q_1 is density of the negative charge in 1 m³; g = 9.81 m/s^2 is Earth gravity; h is the height difference between inlet and outlet of installation (between electron injector and net, between cathode and anode), m.

Summary

Relatively no progress has been made in electric generators in the last years.
The author proposes a fundamentally new efficient electric generator for gas and liquid. No gas (water) turbine, no dynamo-machine. Practically there is only a tube.
It is not comparable to conventional MHD generator or heat machine. The MHD generator requests very high temperature, which cannot be endured by available materials. MHD generator is very complex and expensive.
Author offers and develops theory of a new simple cheap and efficient electric (electron) generator. This generator can convert pressure or kinetic energy of the any non-conductive flow (gas, liquid) into direct current (DC). The generator can convert the mechanical energy of any engine in high voltage DC. One can covert in electricity the wind and water energy without turbine. One can convert the rest energy of an internal combustion engine or turbojet engine in electricity and increase its efficiency. ABJEG may be propulsors, which have been applied to pump a gas or dielectric liquid and as engine in several experimental ships.
As any new idea, the suggested concept is in need of research and development. The theoretical problems do not require fundamental breakthroughs. It is necessary to design small, cheap installations to study and get an experience in the design electron wind (water) generator.
This paper has suggested some design solutions from patent application. The author has many detailed analysis in addition to these presented projects. Organizations or investors are interested in these projects can address the author (http://Bolonkin.narod.ru , aBolonkin@juno.com , abolonkin@gmail.com).
The closed ideas are in [1]-[5]. Researches and information related to this topic are presented in [6]-[9].

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