

Electrostatic Discharge Power Transformation – An Approach to Understand the Working Principles of the “Thestatika” Free Energy Device

Dipl.-Ing. Sven Bönisch

Dipl.-Ing. Sven Bönisch, Schubartstrasse 61, D-13509 Berlin, Germany
Email: sven.boenisch@tu-berlin.de

Abstract: The construction of the Swiss ML-Converter “Thestatika”, a power generation system using an unknown working principle, has been investigated. One major part, possibly used for transformation of high voltage electrostatic discharge power to low voltage level is described. The construction and working principles are discussed in detail. Measurement results in frequency and time domain are presented and compared to theoretical considerations. The high voltage transformation device is set into the complete context as a part of a new power generation system.

Keywords: electrostatic discharge, free energy device, power transformation, transmission line transformer, thestatika, thestatica, wimshurst machine, influence machine, influenzmaschine, electrostatic generator, spark gap, overunity, helical transmission line, ml-converter

1. Motivation

The energy crisis demands for new clean and cheap power sources. The power generators used, should work with an efficiency equal to or better than known technologies (i.e. solar energy) and should amortize within about 20 years. From the little information available, I assume that the Swiss ML-Converter “Thestatika” fits the requirements for future power generation. These investigations have been carried out helping to understand the working principles of that device and to propose realization possibilities.

The “Thestatika” is assumed to be a so called “free energy device”, a power generator which behaves like a heat pump which utilizes dissipated energy by collection and compression and which delivers a huge amount of usable electric power to a common load (i.e. a light bulb). It is assumed that this device uses these dissipated energy as input power to run without any other visible input power source. The since 20 years in Switzerland existing prototype (Fig. 1), is assumed to be able to utilize about 1kW at a voltage level of about 230V DC [1], [2], [4]. The construction of the prototype however is unknown. Some information about is available through a 25 years old video tape [5], produced by the inventors and by a few people which were

allowed to visit. Patents to this device have not been found. A lot of misinformation and speculation are available via internet [7], [8].

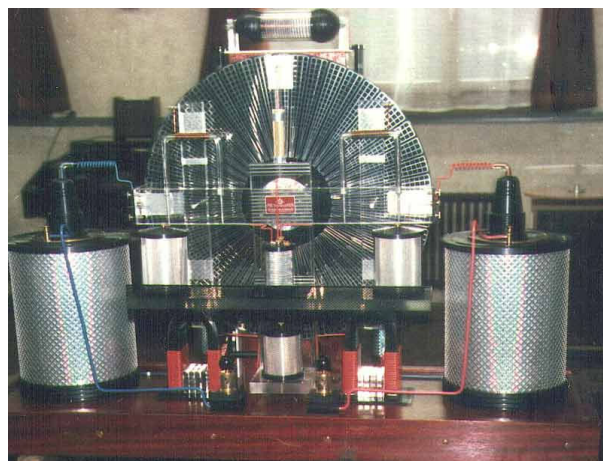


Fig. 1: “Thestatika” power generation system [6]

The “Thestatika” power generation system (Fig. 1) looks like an old electrostatic generator (i.e. Wimshurst type), connected to a high voltage (HV) transformation device which steps down the high voltage delivered by the generator. Our investigations have been focused to this transformation device as it is of interest as a part of new power systems as well as a sensor device for electrostatic discharge (ESD) and high voltage

measurement equipment in power transmission and switching. The HV transformation device described here, has been fully developed and optimized. Measurements in frequency and time domain range have been performed to study the behavior of the transformation device under different electrical and environmental conditions.

2. Power Generation System

The power generation system described in this paper consists of two parts: a special brushless electrostatic generator and a HV transformation device. A schematic diagram of the complete power generation system can be seen in Fig. 2. This power generation system is based on known principles in electrodynamics only (i.e. it should not exceed 100% efficiency). For laboratory measurements it is powered by rotating the electrostatic generator disks using a hand crank.

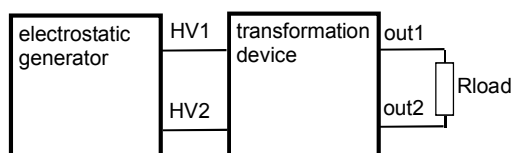


Fig. 2: Connections of the power generation system

3. Electrostatic Generator

The electrostatic generator has been developed and configured to achieve a continuous high voltage supply for the transformation device. To achieve brushless operation as described in [5] and to avoid charge loss at the sectors of the disks the configuration of the electrostatic generator is quite different from a standard influence machine (i.e. Wommelsdorf type) [11], [12]. In our investigation 6 electrode positions at each disk side have been electrical connected. The configuration can be seen in Fig. 3. For keeping the sector charge 2 leyden jar capacitors (each having approx. 140pF) have been used. The high voltage output terminals HV1, HV2 are not connected to these capacitors, as these points starts to oscillate with high frequency in operation. The output at the terminals HV1 and HV2 is not DC as described [5]. In our case single discharge events produce a high frequency oscillating voltage at the output terminals HV1 and HV2.

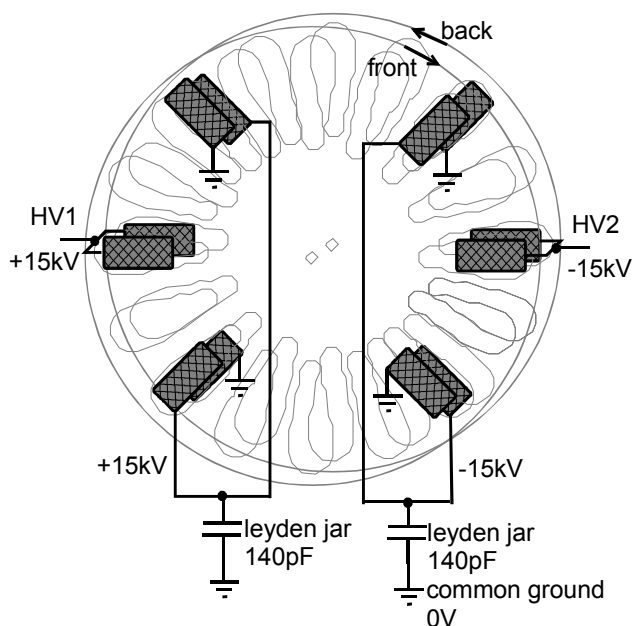


Fig. 3: Configuration of the electrostatic generator

The disks are constructed using standard single sided PCB material (1.5mm FR4 insulation, 35μm copper). The disk surface holds 16 copper sectors having approx. 10mm minimal distance in between to avoid spark over up to 30kV. The distance between the two disks is approx. 5mm. The dimensions of the disk are given in Fig. 4. All distances including the sector size and the distance between the two disks are influence the oscillation frequency of the transformation device.

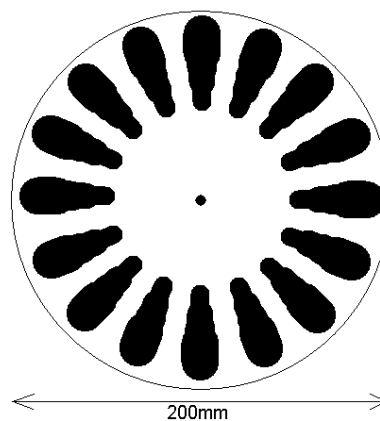


Fig. 4: Disk surface with metal sectors

All electrodes (Fig. 5) are constructed of brass metal plates (30mm x 12mm) with small tips at the inner surface, to reduce the discharge (spark over) voltage. They are mounted having approx. 1mm distance to the disk surface. The distance to the disk surface may be adjusted using a screw (Fig. 6).



Fig. 5: Electrode setup at the terminals HV1 and HV2



Fig. 6: Electrode setup from the side

Due to the brushless working principle, the leyden jars and the sectors of the disks need to be initially charged before operation of the electrostatic generator. The minimal charge voltage in our configuration was +10kV unipolar voltage at one leyden jar. After initial charging the electrostatic generator acts as known from other influence machines. The spark over from the disk sectors to the brass electrodes acts as brushes normally used in standard influence machines (i.e. Wimshurst type).

This electrostatic generator configuration needs mechanical power for the charge generation via influence. This is the reason to apply conventional electrodynamics and to assume an efficiency below 100%.

4. High Voltage Transformation Device

The transformation of high voltage electrostatic discharge power is one of the secrets of electrical engineering up to day. The problem to overcome is, that electrostatic discharge (ESD) power is delivered by a current source with extremely high input impedance at voltage levels of kV-MV. The time domain range of an ESD is in ns- μ s. On the other hand we have to match this to a low impedance load which should be driven continuously with low voltage and high current. Fig. 2 shows schematically the connections between the HV transformation device and high impedance input and low impedance output ports.

4.1 Transmission Line Transformer

A transmission line acts as a resonator device. A $\lambda/4$ long transmission line transforms an open circuit into a short circuit. The first step to impedance match is the connection of high impedance side (open circuit) and low impedance side (short circuit) through a $\lambda/4$ transmission line. However this device is able to work with sinusoidal signals only. Fig. 7 shows the construction of such an impedance transformation.

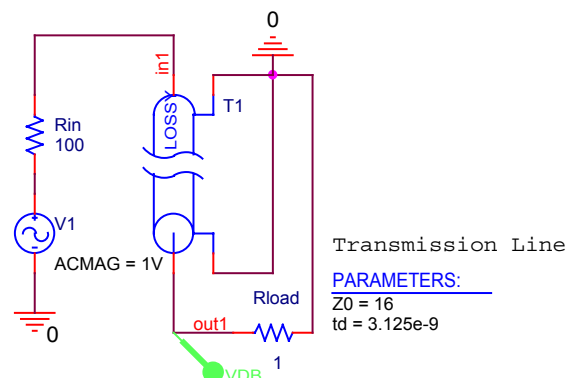


Fig. 7: Transmission line transformer

The characteristic impedance of the transmission line is 50Ω . It is fed by an input impedance of 100Ω . The delay time ($td=3.125ns$) describes the electrical length of the line. At the low impedance output port is a resistive load of 1Ω connected. The marker measures the magnitude of the voltage in decibels (dB) at the point out1.

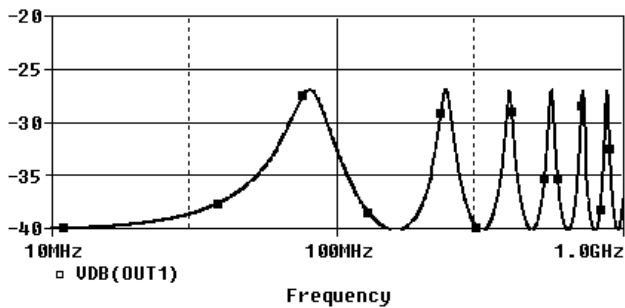


Fig. 8: Power transfer of a transmission line transformer

The power transfer of such a transformer can be seen in Fig. 8. The peaks shown at discrete frequencies are resonance frequencies where the transformer is able to transfer power from the high impedance input port to its low impedance output port.

4.2 Pulse Forming Input Network

The second step is to transform impulsive ESD events to sinusoidal signals to feed the transmission line transformer.

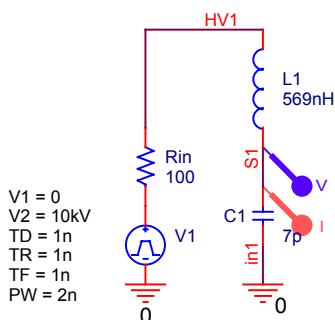


Fig. 9: Serial resonance circuit used for ESD pulse forming

The pulse forming network is constructed as serial resonant circuit (C1/L1) tuned to the first resonance frequency ($\approx 80\text{MHz}$) of the transmission line transformer (Fig. 9). It is excited by an air discharge current. The discharge current is simulated here by a pulse voltage source (V1). Fig. 10 shows voltage and current behavior of the pulse forming network. The voltage and current show damped oscillations due to circuit losses. Peak voltages up to 10kV and peak currents up to 30A may be reached. These extreme values should be taken into account while mechanical construction of the transformation device. Similar devices have been constructed by *Marconi* [9], [10] known as “spark transmitter” in the early times of radio transmission for radio carrier generation.

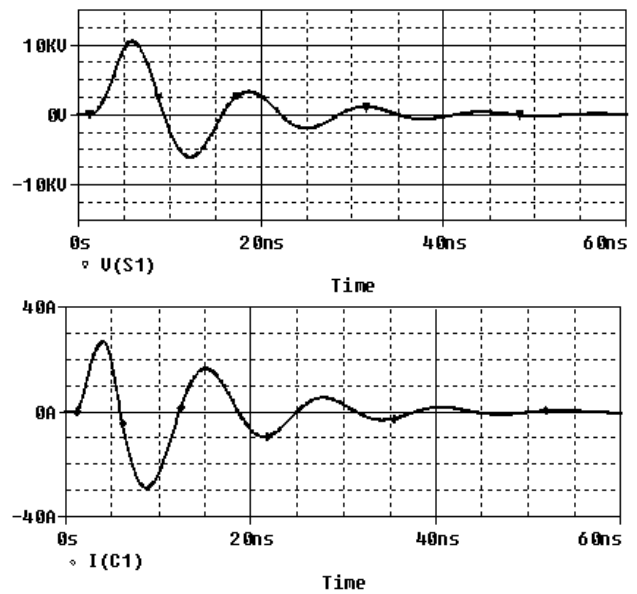


Fig. 10: Voltage and current at the pulse forming network

4.3 Push-Pull Operating Mode

As the photos available for the “Thestatika” power generation system [6] show a symmetrical construction, it has been assumed that the transmission line transformer consist of two identical parts which are driven by inverted input signals. The circuit of the complete push-pull transformation device can be seen in Fig. 11.

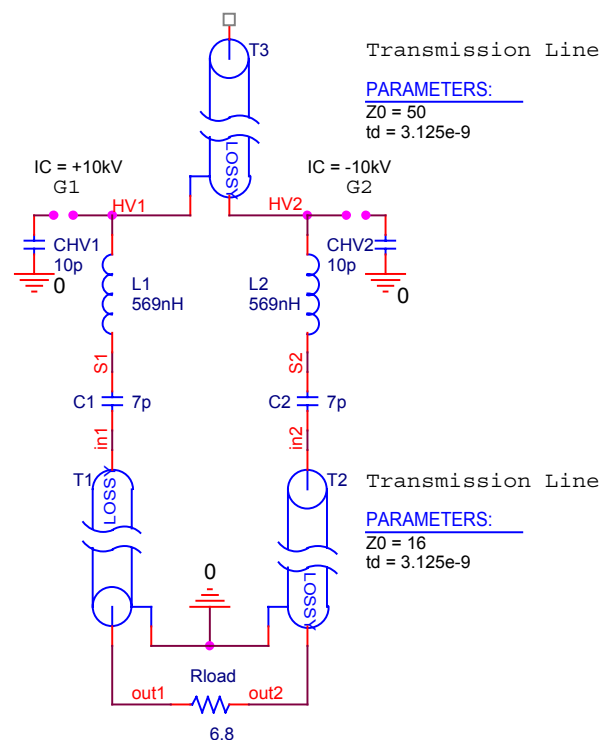


Fig. 11: Circuit of the complete push-pull transformation device

The circuit is excited by two inverted ESD pulses from the discharge of the capacitors C1 and C2. The switching elements are the spark gaps G1 and G2. The transmission lines T1 and T2 are connected via the pulse forming networks to drive the load from both sides by opposite voltages. The transmission line T3 is used to provide a RF short-circuit between both upper ends of the pulse forming networks. All lengths of the transmission lines (T1-T3) including the resonance frequencies of the pulse forming networks (C1/L1, C2/L2) are tuned to the same frequency ($\approx 80\text{MHz}$).

However the complete device is too complicated to be simulated by a standard circuit simulator (i.e. PSPICE). Moreover there are certain construction details which are not able to be simulated. The mechanical construction of that device will be discussed in detail in the next chapter.

4.4 Mechanical Construction

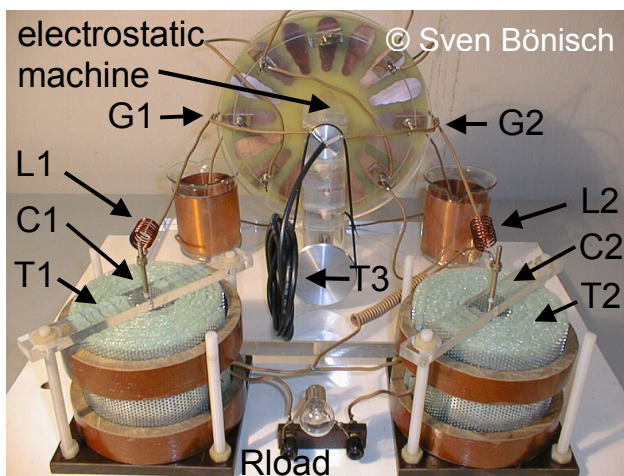


Fig. 12: Construction of the high voltage transformation system

The construction of the high voltage transformation device, build by the authors can be seen in Fig. 12. In the background an electrostatic machine can be seen. It has been used to excite the transformation device. The electrostatic machine is able to produce opposite voltages of about 10-20kV at its terminals (CHV1, CHV2). The terminals are machined as spark gaps (G1, G2) having a gap distance of 1mm. Thus they switch at $>5\text{kV}$ terminal voltage.

The terminals HV1, HV2 are connected to a 1.20m long RG-58 cable (T3). There are also connections between HV1 - L1 and HV2 - L2 respectively. L1 and L2 are constructed as air coils.

L1, L2:
7 windings of varnished copper wire

wire diameter: 1.5mm
coil length: 20mm
coil diameter: 18mm

The coils are connected to two brass rods (S1, S2) forming the inner electrodes of two cylindrical, air insulated high voltage capacitors (C1, C2). The outer electrodes are formed by the first layer of the helical transmission lines (T1, T2).

C1, C2:
foil and rod height: 100mm
inner electrode diameter: 4mm
outer electrode diameter: 28mm

The outer layers of the transmission lines (T1, T2), forming the end of the outer conductors of the transmission lines are connected to common ground (Fig. 13). The layer before the outer layer is connected to one terminal of the load resistance. A car light bulb (12V / 21W) has been used as load. All electrical connections have been made using PVC-insulated copper wire (diameter 2mm).

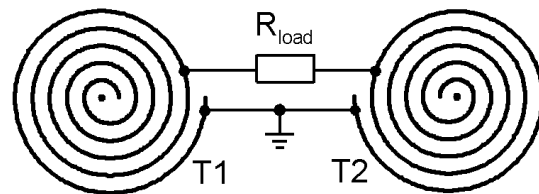


Fig. 13: Symmetrical load configuration

4.5 Helical Transmission Line

The construction of one part of the high voltage helical transmission line can be seen in Fig. 14. The dotted line marks the electrical length of the transmission line. The circle in the center marks the rod position (S1, S2).

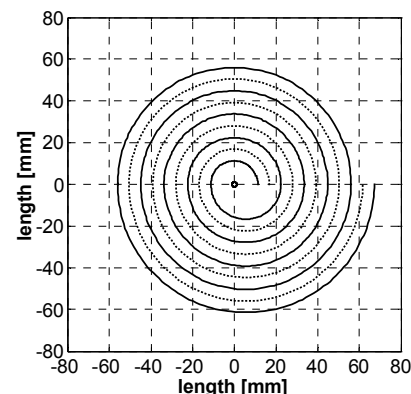


Fig. 14: Construction of the high voltage helical transmission line (one side)

As conductor a 0.8mm thick, 100mm wide, perforated aluminum foil has been wound around a big rod. The insulation in between is ordinary air. The distance of about 10mm between two adjacent layers has been kept by winding the foil together with a second layer made of air foam plastic, used by builders companies. The electrical length of the transmission line is about 910mm having a resonance frequency of about 80MHz. It acts as a parallel plate transmission line, having a characteristic impedance of about 16Ω . The transmission line and the input capacitor formed by the rod and the inner layer of the aluminum foil are capable to withstand a voltage up to 15kV without partial discharges.

In our opinion this construction principle is unique, it combines low cost, low mass and volume, high voltage capabilities with extremely low RF losses by an air transmission line.

5. Measurement Results

Measurements to estimate the performance of the transformation device are quite difficult. The input path (HV1, HV2) is extremely sensible to input impedances and parasitic capacitances added during measurements by 50Ω lines and high impedance probes etc., which detune the resonant circuit. Furthermore the high voltage path requires special high voltage probes with sufficient bandwidth to measure excitation in time domain range. Due to that only two measurements have been taken.

The most appropriate point for measurements is the low impedance load resistance. It won't sufficiently change its value by connecting a 50Ω line in parallel. Fig. 15 shows the measurement setup.

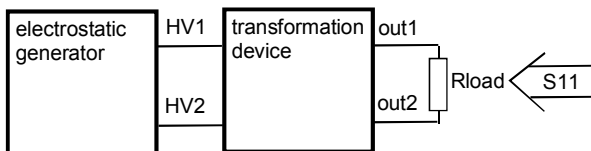


Fig. 15: Setup for resonance frequency measurement

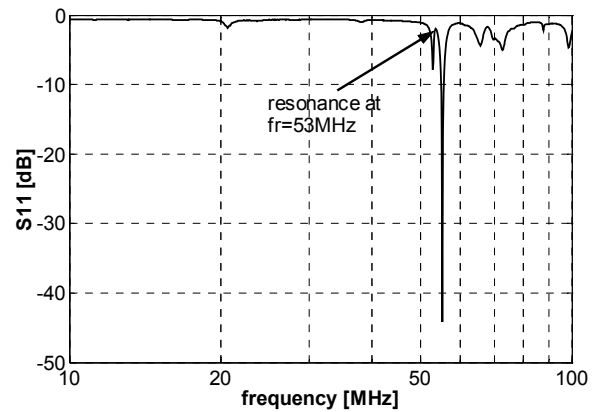


Fig. 16: Tuned resonance frequency

The complete power generation system (i.e. electrostatic generator, transformation device and load resistance) has been measured. Several steps have been performed to tune the system to one resonance frequency for the power to be transmitted only at that frequency. The result is shown in Fig. 16. The tuned resonance frequency ($\approx 53\text{MHz}$, peak marked in Fig. 16) is build up by the resonance of the helical transmission line T1, T2 ($S_{11}=0$, maximum at resonance) and the resonance of the two input networks ($C1/L1$, $C2/L2$) including transmission line T3 ($S_{11}\rightarrow\infty$, minimum at resonance). The resonance frequency shifts from 80MHz down to 53MHz due to electrical extension of the transmission line (T1, T2) by the pulse forming networks ($L1/C1$, $L2/C2$).

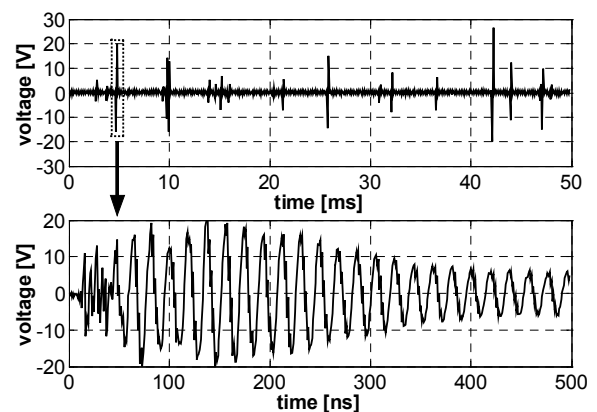


Fig. 17: Measured output voltage at the load

Fig. 17 shows the measured output voltage at the load with high voltage excitation by the electrostatic generator (2 disks rotating in opposite directions, 200mm disk diameter, 16 sectors per disk, approx. 10 turns per second, output voltage dc-voltage approx. 30kV). It can be clearly seen that the system oscillates at the tuned resonance frequency. The oscillation is damped due to power dissipation at the

load. The repetition rate of these oscillation packets is determined by the high voltage discharge pulse repetition rate, which is in this case irregular between 100-400Hz. The mean power dissipation at the load is approx. 10mW. Considering the losses in the spark gap and the transformation device, this value is in agreement with theoretical considerations, which predict an output power of the electrostatic generator of about 80mW.

6. Summary

The transformation device presented here fulfills the energy conservation law. An "over unity effect" as assumed for the power generation system "Thestatika", could not be detected. The "Thestatika" device may use different methods to utilize power than the device discussed here. However the construction and working principles of the device discussed here are quite unique. The construction is cheap and easy to be build. The stability of the high voltage transformation device at this time is good enough to perform laboratory measurements. For usage in power conversion or sensor devices it should be increased.

The work presented here should help to develop new power generation systems for future requirements. Future work should help to increase the efficiency and stability of the complete power generation system. The unknown input power source and the special brushless construction of the electrostatic generator are another important parts to study in the future.

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