

Space, Propulsion & Energy Sciences International Forum - 2011

Experiments with Coler magnetic current apparatus

T. Ludwig*

*German Space Energy Association (DVR) and Berlin Institute for Innovative Energy and Propulsion Technologies (Binnotec),
Bouchéstr.12, 12435 Berlin, Germany*

Abstract

Experiments with a replica of the famous Coler “Magnetstromapparat” (magnetic current apparatus) were conducted. The replica was built at the same institute at the Technical University of Berlin where the original was tested by Prof. Kloss in 1925. The details of the setup will be presented in this paper. The investigation of the Coler device was done with modern methods. The output was measured with a digital multi meter (DMM) and a digital storage oscilloscope (DSO). The results of the measurements will be presented. Did Coler convert vacuum fluctuations via magnetic, electric and acoustic resonance into electricity? There is a strong connection between magnetism and quantum field radiation energy. The magnetic moment of the electron is in part an energy exchange with the radiation field. The energy output of the Coler apparatus is measured. Furthermore the dynamics of the ferromagnetic magnets that Coler reported as the working principle of his device was investigated with magnetic force microscopy (MFM) and the spectroscopy mode of an atomic force microscope (AFM). The magnetic and acoustic resonance was investigated with magnetic force microscopy (MFM). The connection between ZPE and magnetism will be discussed as well as the perspective of using magnetic systems as a means to convert vacuum fluctuations into usable electricity.

© 2011 Published by Elsevier B.V. Selection and/or peer-review under responsibility of Institute for Advanced studies in Space, Propulsion and Energy Sciences

PACS: 41.20.Gz, 75.20.En, 75.25.-j, 75.30.-m, 75.30.Ds, 75.30.Fv, 75.30.Kz, 75.80.+q, 88.90.+t

Keywords: Magnetism; Coler; Magnetic Force Microscopy; MFM; Vacuum Fluctuations; Zero Point Energy; ZPE; Atomic Force Microscopy (AFM)

1. Introduction

This article will explore a new type of electrical generator which was invented by Hans Coler. First the history and the general description of the device will be given. The historical part will also mention the early tests of the device by the well known German Professors Schumann and Kloss, which are the

* Corresponding author. Tel.: +491716280357; fax: +0-000-000-0000 .
E-mail address: DrLudwig@thorstenludwig.de .

main reason why this invention is not forgotten. Another important historical fact is the investigation of the device by the British Intelligence Objectives Sub-Committee (B.I.O.S.) and the confidential, later disclosed, positive report of this agency. The investigation was conducted by Hurst and Sandberg. Hans Coler was contracted in 1947 to rebuild his magnetic current apparatus. This work will present the technical design of a replica of such a Coler device and measurements on that replica. The replica was built by students of the Technical University of Berlin in 1998 and 1999 under the supervision of Dipl. Ing. Andreas Manthey. The construction of the Coler device was part of a course in interdisciplinary innovation learning. The student group took up the Coler device because there is a rich source of technical information on the device and another important reason was that the original device was positively tested at the same institute in 1926. An investigation to retrieve the original documents in the archives of the Technical University revealed that the documents were a toll taken by a British firebomb during a air raid on Berlin in 1943. Since Coler also presented some theoretical hints on the working principle of his device, this work will also deal with the fundamental properties of magnetism and the feasibility of using electrical and magnetic resonances of ferromagnetic magnets to construct a generator. This article will also present an experimental technique that allows testing Coler's statements on magnetism. The work on magnetism is still ongoing. This work on the Coler generator was taken up because of the credible witnesses for a proof of principle for a device that works with permanent magnets and no other input power. Since the magnetism of the electron can be explained as a relativistic quantum effect with corrections due to the exchange of energy with the zero-point energy quantum fluctuations and permanent magnetism is today seen as a collective electron phenomenon, Coler seems to be good starting point for practically testing the possibility of using magnetism to convert ZPE into useable electric energy. This connection will be laid out in more detail in a later part of this paper.

A major part of the work presented here is the investigation into the nature of magnetism with modern methods such as magnetic force microscopy (MFM) and the origin of magnetism [1]. Permanent magnets are today understood as a collective phenomenon of the electron spin and the magnetic moments of the electrons involved [2]. The magnetic moment of the electron is a quantum field phenomenon [3].

In order to unveil the working mechanism of the Coler generator two approaches are combined in this paper. On the one hand it was tried to replicate Coler's magnetic current apparatus and to conduct modern measurements on the replica. In addition another avenue was followed to single out the working principle with modern methods to find the resonance between ferromagnetism and electrical oscillations that Coler gives as a reason for output energy of his device.

2. The Coler Generator

Hans Coler was the inventor of two devices by which electrical energy may be derived without a chemical or mechanical source of power. The devices are called the "Magnetstromapparat" (magnetic current apparatus) and the "Stromerzeuger". The "Magnetstromapparat" was developed by Coler and von Unruh early in 1933. With this device, consisting only of permanent magnets, copper coils, and condensers in a static arrangement he showed that he could obtain a tension of 450 mV for a period of some hours. This device consists of six permanent magnets wound in a special way so that the circuit includes the magnet itself as well as the winding. These six magnet-coil combinations are arranged in a hexagon and connected in a circuit which includes two small condensers, a switch, and a pair of solenoid coils, one sliding inside the other [4].

The "Stromerzeuger" consists of an arrangement of magnets, flat coils, and copper plates, with a primary circuit energized by a small battery. Coler and von Unruh made up a slightly larger model with an output of 70 watts. This was demonstrated to Dr. F. Modersohn, who obtained from Prof. Schumann and Prof. Kloss confirmation of their tests in 1926. The device was seen by the professors Schumann (Munich), Bragstad (Trondheim) and Knudsen (Copenhagen). Reports by Prof. Kloss (Technical University Berlin) and Prof. Schumann (Technical University Munich) are credential evidence that the device was real and worked. Prof. Schumann is still widely known for the discovery of the Schumann

Resonances in the earth atmosphere. Coler then in 1937 built a larger version with an output of six kilowatts.

Since an official interest was taken in his inventions by the German Admiralty the British intelligence started an investigation, although normally it would be considered that such a claim could only be fraudulent. Coler was visited and interrogated. He proved to be co-operative and willing to disclose all details of his devices. He built a "Magnetstromapparat" in 1947 using material supplied to him by the British intelligence (Ministry of Supply), and working only in their presence. The greatest tension obtained with this "Magnetstromapparat" was stated to be 12 volts.

Coler had no complete scientific explanation for the working of his device. He stated that his researches into the nature of magnetism had lead him to conclude that ferromagnetism was an oscillating phenomenon, of a frequency of about 180 kilohertz. This oscillation took place in the magnetic circuit of the apparatus, and induced in the electrical circuit oscillations the frequency which of course depended on the values of the components used. These two phenomena interacted, and gradually built up the tension. Coler stated that the strength of the magnets did not decrease during use of the apparatus; and suggested that he was tapping into a new sort of energy hitherto unknown -"Raumenergie" (Space-energy).

3. Technical details of the Coler replica used in this work

The Coler generator consists of six permanent magnets with coils wound around it and connected to it in a special way. The electric circuit therefore includes the magnets as well as the windings. The six magnet-coil combinations are arranged in a hexagon and connected as shown in Figure 1.

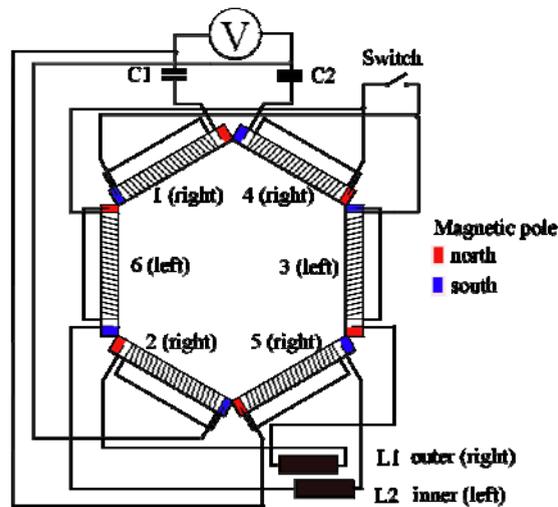


Figure 1. Electric diagram of the Coler magnetic current apparatus.

The circuit includes two small capacitors, a switch, and a pair of air coupled solenoids (L1 and L2) one sliding inside the other. The values of the capacitors were 4.7 nF each. The Coler replica used in this work is shown in Figure 2.

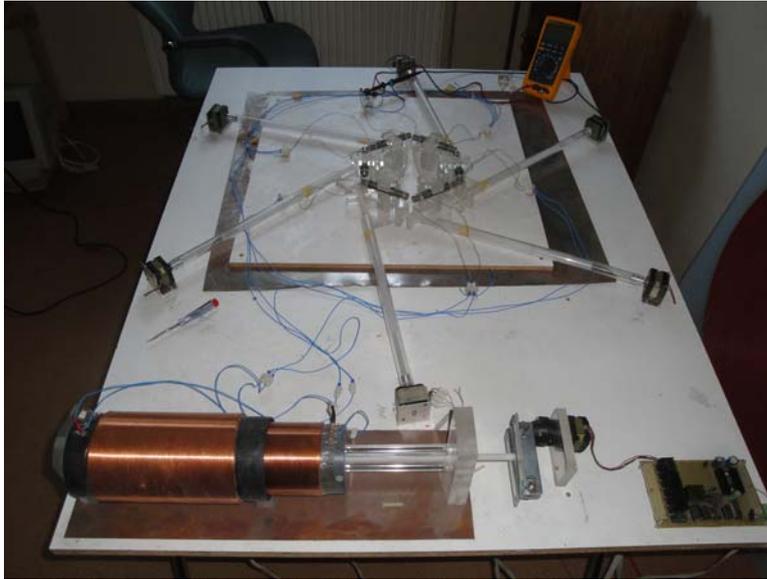


Figure 2. Coler replica used in this work.

One of the important uncertainties of the Coler generator are the material of the magnets and the construction and binding of the coil on the magnets. Some features seem to be schematic other not. It is unclear if the coils should be wound over most part of the magnets as in Figure 1 or only on the edges. The student team decided to wind a homogeneous coil that is soldered and bind as described in the British intelligence report, as seen in Figure 3. The Magnets were especially manufactured for the original TUB project by IBS Magnet in Berlin. The length of the magnets is 100 mm and the average remanent magnetisation is 200 mT. The magnets were cut and turned to a length of 100mm and a diameter of 15 mm out of a special pure iron. After machining the iron rods were magnetized by IBS Magnets.

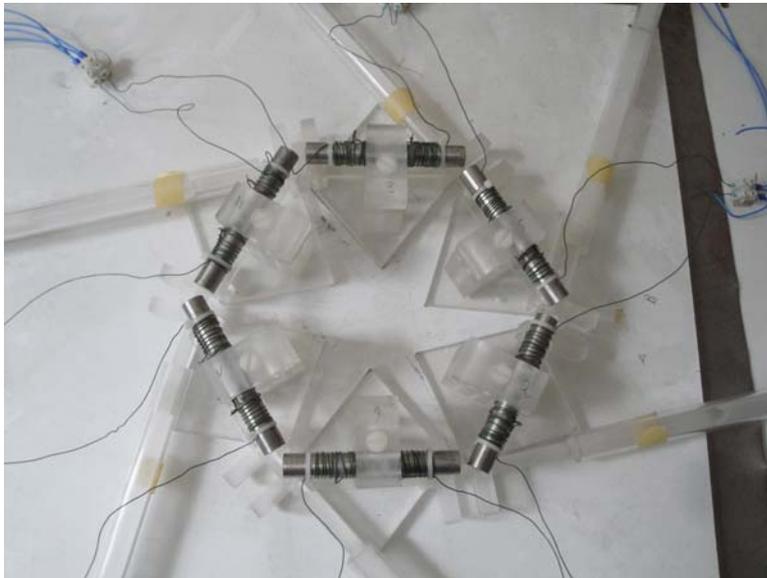


Figure 3. Close up of the magnet hexagon.

The stepper motors seen in Figure 2. are part of the original concept design of the Coler replica. It was planned in 1998 at the TUB to let a computer program find the optimal position of the magnets automatically. The computer and the program could not be retrieved. Electrical and magnetic properties of the permanent magnets and coils used in these experiments are shown in Table 1. Numbers correspond to numbers of the magnets-coil combinations in Figure 1.

Table 1 Electrical and magnetic properties of the permanent magnet-coil combinations.

Magnet-coil	Resistance	Magnetic field at pole
1	0.386 (0,001) Ω	N: 200, S: 180 mT
2	0.232 (0,001) Ω	N: 180, S: 180 mT
3	0.440 (0,001) Ω	N: 170, S: 200 mT
4	0.310 (0,001) Ω	N: 200, S: 180 mT
5	0.385 (0,001) Ω	N: 200, S: 200 mT
6	0.416 (0,001) Ω	N: 180, S: 200 mT

4. Investigation Of Magnetic And Electric Properties In The Coler “Magnetstromapparat”

In the report of the British intelligence the following normal start up procedure for the Coler apparatus is given. Before the device is used, it is kept in the zero position for some time. In this position the switch is open and every magnet is touching the next one. To bring the device into operation, the switch remains open, the magnets are moved slightly apart, and the sliding solenoids are set into various positions, with a pause of several minutes between adjustments. The magnets are then separated still further, and the sliding solenoids are moved again. This process is repeated until at a critical separation of the magnets a reaction in form of a higher voltage is seen on the voltmeter. The switch is then closed, and the procedure is continued more slowly. The tension is then suppose to build up to a maximum where it remains.

A maximum voltage of 133 mV was observed. In the closed position the output voltage was 0.012 mV ac and below 0.00 mV dc. In most positions of the magnets the output voltage was 2-3 mV ac and dc. In a few cases the voltage went up for some minutes to 15 mV, 20 mV, and 46 mV ac with 6 mV DC. In one case the voltage remained for about 5 minutes at 133 mV. An overview of exceptional high output voltages is given in Table 2.

Table 2. Output voltages.

Time	Output Voltage AC	Output Voltage DC
Closed loop	0.012 mV	0.00 mV
Usual output	2-3 mV	2-3 mV
2-3 min	15 mV	
3 min	20 mV	5-10 mV
3 min	46 mV	6 mV
5 min	133 mV	

The exceptionally high output voltages did not last long enough to close the switch and to go on with the next run up stage. The magnetic field strength at the time of the highest output voltage is shown in Table 3.

Table 3. Magnetic field strength

Position, between	Magnetic Field Strength
1-6	310 mT
6-2	380 mT
2-5	210 mT
5-3	280 mT
3-4	310 mT
4-1	300 mT

The output voltage was measured with a Fluke 189 true RMS multi meter and recorded with digital store oscilloscope DSO-5200A from Voltkraft. The digitization rate was 250MS/s at a 9 bit resolution. The results of the measurements with the Fluke DMM are shown in Table 2. The recording for the 46 mV case is shown in Figure 4.

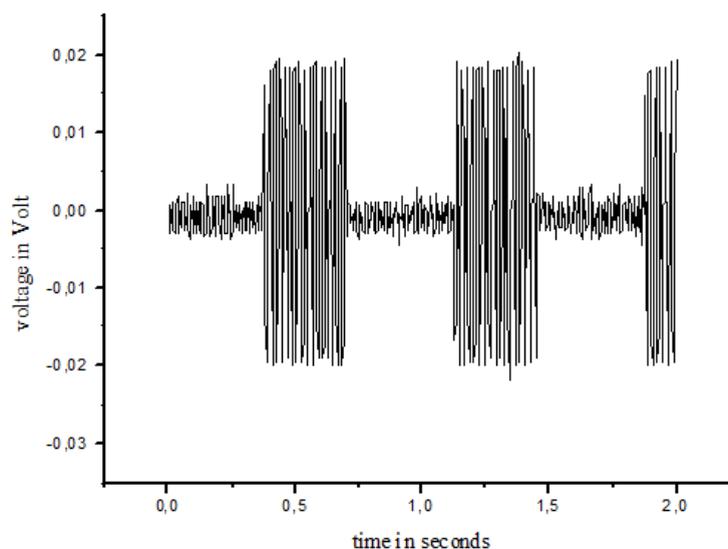


Figure 4. Output voltage over time in the case of 46 mV output voltage.

5. Magnetism and QED

The magnetic moment μ_s of the electron is given by

$$\mu_s = -g_s \frac{e}{2m_0} s \quad (1)$$

In equation (1) g_s is the gyromagnetic ratio, e is the elementary charge, s the spin quantum number and m_0 the mass of the electron. In the classical case g is expected to be 1.

The experimental value for g given by Dehmelt [5] is 2.02319304376(8).

It is one of the most important achievements of the relativistic quantum mechanics that the Dirac equation for an electron in an external field produces almost the right magnetic moment of the electron. The expert is not surprised by this as the magnetic field can be seen as a relativistic effect of the electric field [6]. The Dirac equation results with a g_s of 2. The difference of the experimental value to g_s is called $g-2$. The difference can be calculated to a high precision with QED. This process is called radiation correction, as the difference $g-2$ is the result of energy exchange with the vacuum fluctuations, also called

radiation field or zero point energy. Schwinger was the first one to show that the magnetic moment can be calculated from QED [7]. His result for $g-2$ is α/π , with α being the fine structure constant. Luttinger showed a simpler way to arrive to this result [8]. Masperi gives a more qualitative and understandable explanation [9]. These calculations have been experimentally verified for example by the single electron experiment of Dehmelt [5].

The modern view of the magnetic moment of the electron is that it can be calculated from quantum field theory. The magnetic moment of the electron is partly connected with the vacuum fluctuation because the $g-2$ part is caused by interaction with the radiation field. Permanent or remanent magnetism is today seen as a collective phenomenon of single electron magnetic moments [2]. It is therefore justified to investigate permanent magnetism as a means to convert vacuum state energy, into other forms of energy, *i.e.*, electricity. Puthoff and Cole [10] have shown that in principle this energy can be extracted from the vacuum. Coler might have found a mechanism that converts zero point energy into usable electricity. He points out that he uses a special resonance of magnetic and electrical vibrations in ferromagnetic material, especially iron. Since ferromagnetism is a collective effect, it can be seen as a self organized dissipative structure. This holds especially for the ferromagnetic resonance. Therefore ferromagnetic materials combine fundamentally vacuum fluctuations and dissipative structures. The self structuring process of the electrons in ferromagnetic material could be a way to cohere vacuum fluctuations. This would make ferromagnetic materials ideal candidates to fulfill the requirements laid out by King [11] for processes that extract energy from the vacuum state. In order to verify the connection between Coler magnetic current apparatus, magnetism and energy extraction from the quantum vacuum field it is planned to use Casimir force measurements [12].

In order to understand Coler's device and to engineer technology from it, a better understanding of the dynamics of ferromagnetism is needed. Research in magnetic nano-structures, ferrofluids, single spin magnetic resonance force microscopy and magnetic semiconductors promise to lead to these needed new insights.

6. Test of Coler's Theory of Ferromagnetism with Magnetic Force Microscopy (mfm)

Coler's suggestion that ferromagnetism is a fluctuation phenomenon with a frequency around 180 kHz was studied using magnetic force microscopy. In order to achieve this; an ANFATEC standard AFM was equipped with chromium-cobalt coated silicon cantilevers. With this method very small variations in the magnetic properties can be detected. The method is suitable to study changes in the magnets. Experimental method and data will be presented in this section.

6.1. Magnetic Force Microscopy

Magnetic force microscopy (MFM) is a special mode of atomic force microscopy (AFM). In MFM a ferromagnetic tip is scanned at a certain constant height of several ten nanometres above the surface. This mode is also called fly mode. In fly mode first the line is scanned in AFM dynamic mode and then the same line is scanned at a height of several ten nanometers above the topography just measured in the AFM mode. At that height there is no atomic force between the tip and the surface but the strength and orientation of the magnetic field of the surface can still create a force on the ferromagnetic tip. Figure 5 (a) shows the working principle of an AFM. A thin silicon cantilever is scanned line by line over a sample surface. The nm resolution for the scan is achieved with a piezo actuator. The piezo actuator can be positioned in 3 dimensions (xyz) with medium voltage. The force on the tip and therefore on the cantilever is measured with a laser beam that is reflected on the back of the cantilever and a segmented photodiode. If a force is applied to the cantilever, the cantilever bends, which lead to a shift of the position of the laser beam on the photodiode. If the image is acquired with the tip touching the surface it is called contact mode AFM. If the cantilever is vibrated with tip just above the surface and the force is measured as a change in amplitude or phase shift between driving frequency and photodiode signal it is

called dynamic mode AFM. For MFM the AFM is usually used in dynamic mode. Figure 5 (b) shows the MFM imaging with the fly mode. Figure 5 (a) shows the working principle of an AFM which is used in MFM to record the surface topology and Figure 5 (b) shows the working principle of the MFM mode of an AFM which is used for imaging the magnetic properties of the sample. To scan the magnetic properties the cantilever and tip are coated with a Cr-Co layer.

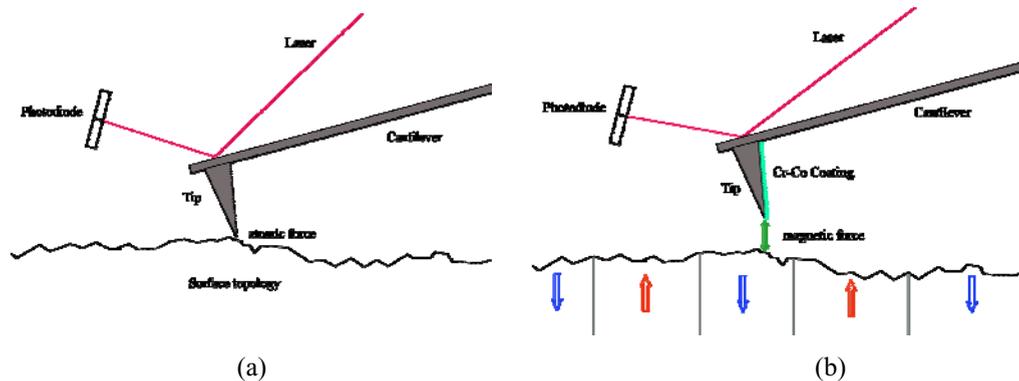


Figure 5. (a) Working principle of an AFM, and (b) of the MFM mode.

The AFM used for the here presented work is shown in Figure 6.

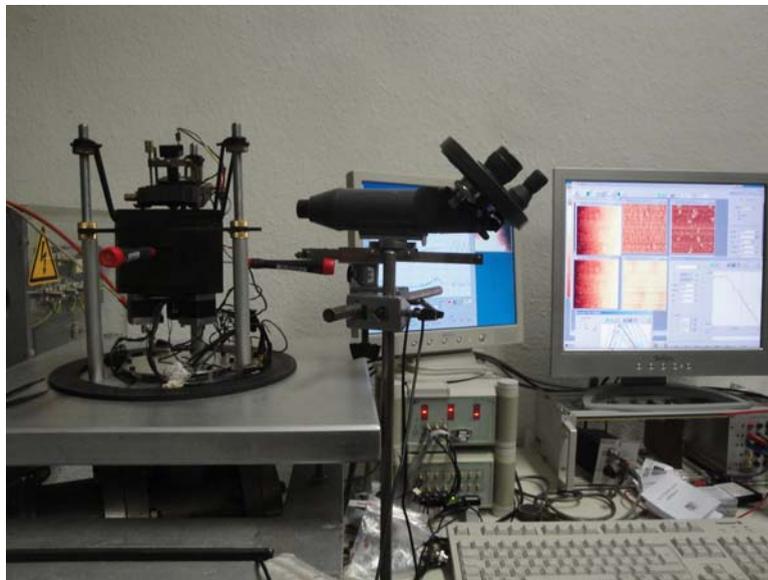


Figure 6. The atomic force microscope used in this work.

In our case the silicon cantilever is 230 μm long, 40 μm wide and 3 μm thick. The resonance frequency is 81 kHz and the force constant is 3.5 N/m. The tip and both sides of the cantilever are coated with continuous films of cobalt 1st layer with a thickness of 60 nm and a 2nd layer of chromium with a thickness of 20 nm. The Cr layer is for protecting the cobalt layer chromium. Figure 7 shows a MFM image of a test structure. In the MFM image there is no trace of the topography, which is shown in Figure 8. The topography image was taken with the normal dynamic mode of the AFM. The MFM image shown in Figure 7 was taken in fly mode at a height of 45 nm. The test structure was a piece of a ZIP 100 MB disk. The scanned area was 8 by 8 μm . The tip has a radius of less than 10 nm. The resolution of the

images is 5 – 10 nm.

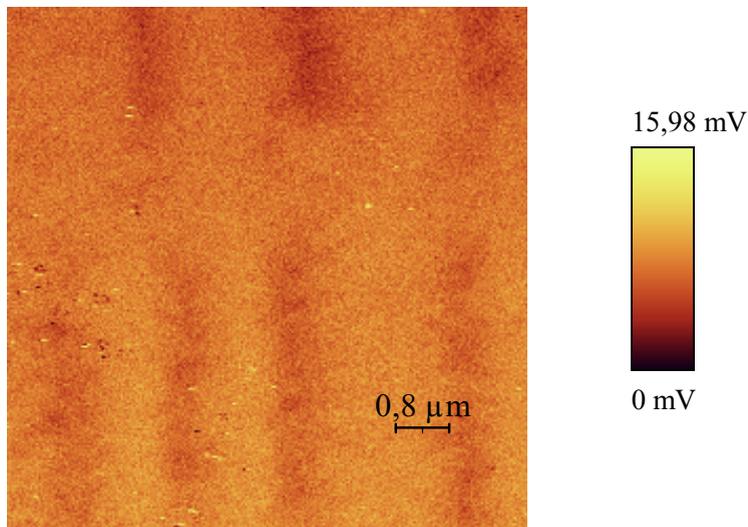


Figure 7. MFM image of the magnetic field strength of a test structure

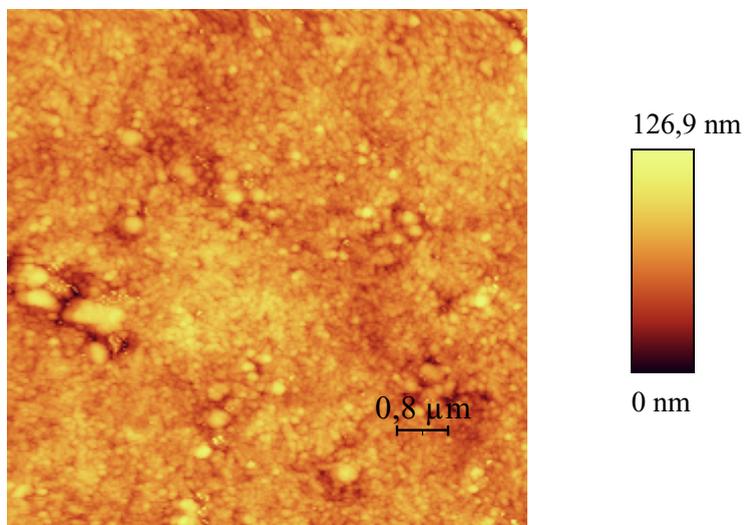


Figure 8. Topography image of the same area as in Figure 7 acquired with AFM in dynamic mode.

7. MFM Study Of Iron Samples

In order to study Coler's theory iron was scanned with MFM to acquire pictures of the magnetic strength distribution and its dynamics. In Figure 9 an image of an iron plate is shown. In this case the phase angle between driving force and the photodiode signal was used for contrast.

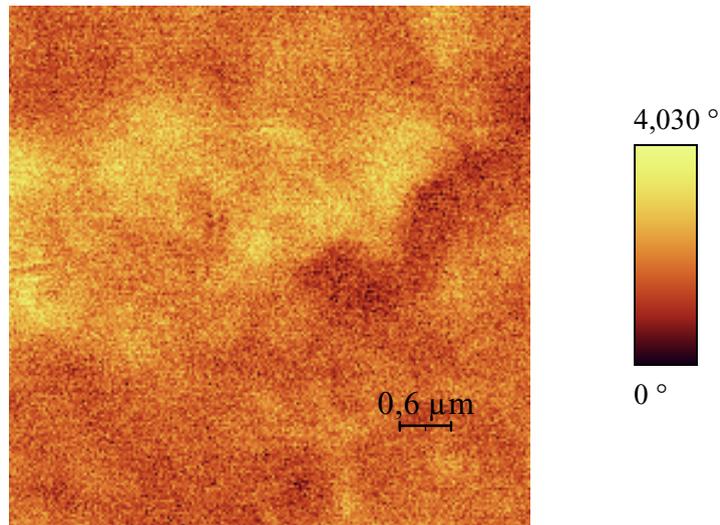


Figure 9. Magnetic field strength of iron in phase contrast.

In order to verify Coler's hypothesis of the 180 kHz oscillation in ferromagnetic material the spectroscopy feature of the AFM was used. In this case the tip with Cr-Co coating was positioned just above the surface and the photodiode signal was scanned from 20 kHz to 400 kHz. The result of this frequency scan is shown in Figure 10.

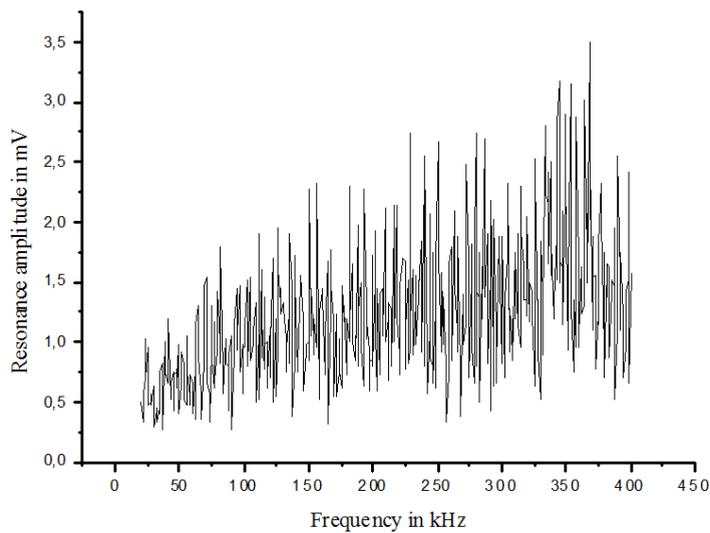


Figure 10. Frequency scan of ferromagnetic iron sample.

So far no clear evidence of a ferromagnetic oscillation phenomenon around 180 kHz could be found. The presented data are to be seen as samples to demonstrate the experimental methods used. It constitutes by no means a complete investigation of ferromagnetism. The investigation of iron samples and iron permanent magnets has to be continued. Of special interest is the measurement of permanent magnets in the magnetic and electrical resonance in Coler's circuit. This still remains to be accomplished.

8. Conclusions

The origin of excess power obtained via magnetic resonance was investigated in the case of a replica of the Coler generator. Even though a maximum of 133 mV and at times 20 to 40 mV could be detected the conclusion is that the Coler magnetic current apparatus could not be set into function as it was reported by Hurst in the British intelligence report. Since Hurst and Coler point out that it is difficult to hit the right resonance position this is not surprising. The work on the replica is not completed. There are still a number of parameters that can be varied. In addition it is planned to do the same measurements on another replica from a Technical University. The AFM and MFM measurements have also not brought a breakthrough insight into Coler's claims. The resonance frequency of 180 kHz was investigated by the means of magnetic force microscopy. Therefore no clear mechanism on how the quantum field fluctuations could supply the energy to drive the circuit via the magnetic moment of the electron could be identified to this day. It has to be mentioned that the work is still ongoing and it is hoped to refine the measurement techniques and sample preparation to find definitive results in the future. It is planned to study the same permanent magnet material with the MFM that is used for the magnets in the circuit. Furthermore it is planned to prepare smooth pure iron samples to study the ferromagnetic dynamics in iron. It seems promising to follow up the methods laid out in this work to learn more about the nature of ferro- and permanent magnetism and the possibility to convert radiation field energy into electricity.

Acronyms

AFM	–	Atomic Force Microscope
B.I.O.S.	–	British Intelligence Objectives Sub-Committee
DSO	–	Digital Storage Oscilloscope
DMM	–	Digital Multi Meter
MFM	–	Magnetic Force Microscope
QED	–	Quantum Electro Dynamics
RMS	–	Root Mean Square
TUB	–	Technical University of Berlin
ZPE	–	Zero Point Energy

Acknowledgments

The authors thank the Deutsche Vereinigung für Raumenergie (DVR) for support of this work. The author also thanks Tom Valone and Marco Bischof for helpful discussions and Andreas Manthey for providing the replica and documents on the earlier project.

References

1. Berman, P. G., Borgonovi, F., Gorshkov V. N. and Tsifrinovich, V. I., *Magnetic Resonance Force Microscopy and a Single-Spin Measurement*, World Scientific Pub., Singapore, 2006.
2. Auerbach, A., *Interacting Electrons and Quantum Magnetism*, Springer, New York, 1994.
3. Maggiore, M., *A Modern Introduction to Quantum Field Theory*, Oxford University Press, Oxford, 2005.
4. Hurst, R., The Invention of Hans Coler, relating to an alleged new Source of Power *B.I.O.S.*, Final Report No.1043, Target Number: **C31/4799**, [declassified], 1956.
5. Dehmelt, H., Experiments with an Isolated Subatomic Particle at Rest, *Rev. Mod. Phys.* 1990 **62**:525-530.
6. Schmueser, P., *Feynman-Graphen und Eichtheorien fuer Experimentalphysiker*, Springer, Berlin-Heidelberg, New York, 1988.
7. Schwinger, J. S., On Quantum-Electrodynamics and the Magnetic Moment of the Electron, *Phys. Rev.* 1948 **73**:415.
8. Luttinger, J. M., A Note on the Magnetic Moment of the Electron, *Phys. Rev.* 1948 **74**:893.
9. Masperi, L., Qualitative description of the electron's anomalous magnetic moment, *Revista Brasileira de Fisica* 1989 **19**:215.
10. Puthoff, H. E. and Cole D. C., Extracting energy and heat from the vacuum, *Phys. Rev. E* 1993 **48**:1562.
11. King M., *Tapping Zero Point Energy*, Paraclete Publishing, Provo UT, 1989.
12. Ludwig, T., Casimir force experiments with quartz tuning forks and an atomic force microscope (AFM) *J. Phys. A Math. Theor.* 2008 **41**:164025.