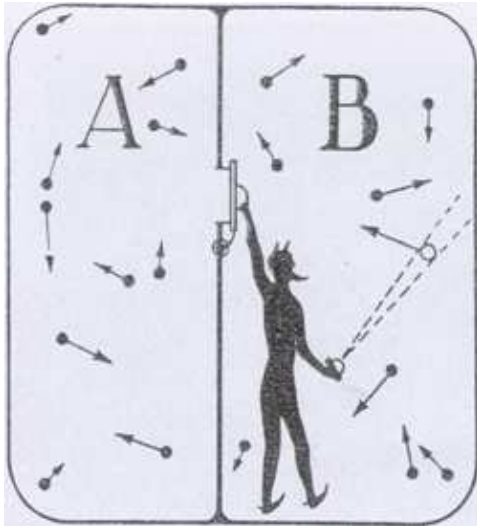


Chapter 26

From the Maxwell Demon to a T(Gr) Fairy: The Production of Energy out of a Heat Bath, Gravity Machines

In the middle of the 19th century thermodynamics was an important topic for the physicists and chemists of the time. More and more they became convinced that the atmosphere was filled with billions of gas molecules, moving around in a Brownian (random) motion, their speed being an indication of their internal energy and of the temperature of the gas. So the total of their internal energy represented a huge amount of energy. Transferring this idea to the water in an ocean, the question arose, whether we could use this energy, for instance, to drive an ocean liner across the seas?

The answer was “No, we couldn’t”! The Second Law of Thermodynamics, which was formulated during those years, forbade it. In order to produce work out of a heat bath, one always needed a temperature difference. And thinking about it, Maxwell and others invented the idea of a “Maxwell Demon”. This “Demon” was somehow able to measure the speed of individual molecules in a heat bath and to separate the fast moving ones from the slow ones, shown here in a figure from Wikipedia:



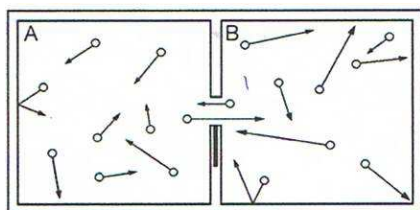
Maxwell devised a thought experiment as a way of furthering understanding of the second law. He described the experiment as follows [39]:

... if we conceive of a being whose faculties are so sharpened that he can follow every molecule in its course, such a being, whose attributes are as essentially finite as our own, would be able to do what is impossible to us. For we have seen that molecules in a vessel full of air at uniform temperature are moving with velocities by no means uniform, though the mean velocity of any great number of them, arbitrarily selected, is almost exactly uniform. Now let us suppose that such a vessel is divided into two portions, A and B, by a division in which there is a small hole, and that a being, who can see the individual molecules, opens and closes this hole, so as to allow only the swifter molecules to pass from A to B, and only the slower molecules to pass from B to A. He will thus, without expenditure of work, raise the temperature of B and lower that of A, in contradiction to the second law of thermodynamics....

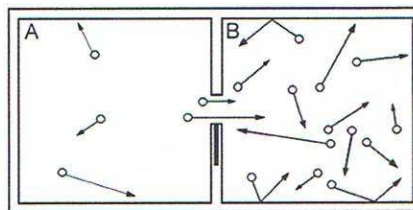
Xin Yong Fu describes the Maxwell Demon very nicely in his paper “Realization of Maxwell’s Hypothesis, An Experiment against the Second Law of Thermodynamics” [37]. In the following two figures, the Demon performs two different tasks. In the left picture he is separating the slow moving molecules from the fast moving ones into compartments A and B, thereby creating a temperature difference. On the right picture he is collecting the majority of the

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molecules into compartment B, thereby creating a pressure difference between A and B.



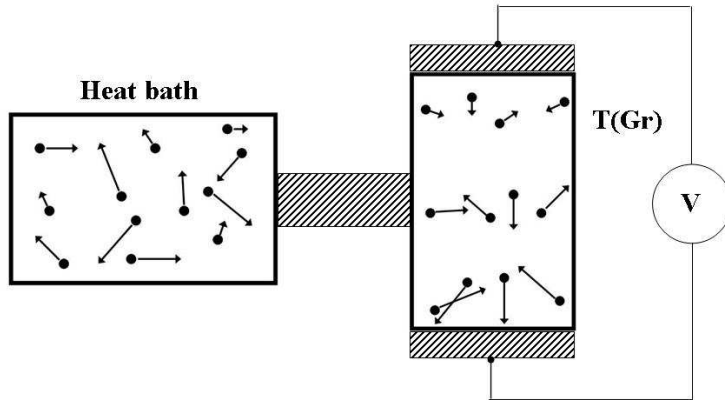
(a) By the first method, demon makes
An inequality in temperature



(b) By the second method, demon makes
an inequality in pressure

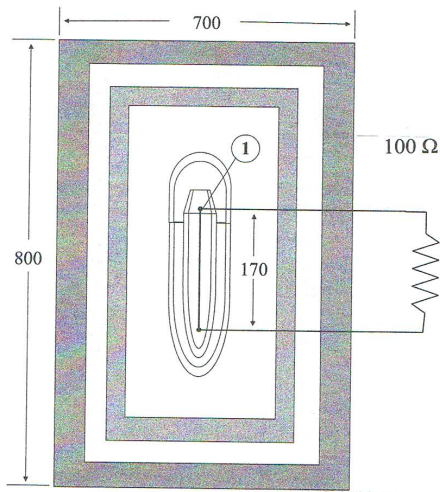
The trouble is that up to now, nobody has found such a “Demon”. This Demon would have to measure the speed of individual molecules arriving at his dividing flapper, make a decision as to what side of the dividing wall it should be placed, and then open his gate at the right moment to let this molecule pass from one side to the other. Slowly the fast molecules would be separated from the slow ones, producing compartments with differences in temperature or in pressure. These differences could then be used to produce work, like driving our steamer across the ocean. Again, such a demon hasn’t been found. One reason is that even if one could think of such a contraption, it probably would need more energy than it could create through such a separation process.

The results of my experiments during the last 13 years could change this. I didn’t find a demon, but I realized that gravity has the effect of a demon. In a vertical column of gas or liquid, gravity makes sure that on the top the average speed of the molecules is lower than at the bottom. This is demonstrated in the following two pictures. On the left, we have a large heat bath with a narrow height, where in all parts the average speed of the molecules is identical. On the right side, the container is a vertical column of gas or liquid, where the effect of gravity had created a vertical temperature gradient. This gradient can be used to produce electricity through a thermocouple, connecting the top and the bottom. When we generate electricity out of this container, then the temperature in it will decline. By making a heat-transmitting connection between the heat bath and this vertical column, we can raise the temperature of the gas or the liquid in the column again, up to the temperature of the heat bath. This arrangement represents the model for a continuing production of electricity out of a heat bath.



Production of electricity out of a heat bath

This is not just a theoretical option! This production of electricity really works!

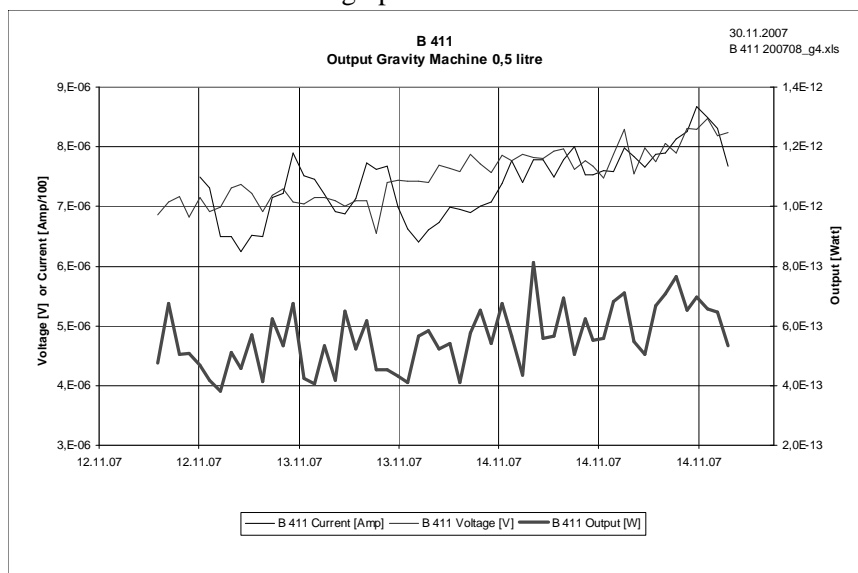


The above picture shows the sketch of a typical setup that I call “Gravity Machine”. In the inner one of two nested Dewar flasks, filled with glass powder and air, a thermopile (1) is mounted along the vertical axis. This arrangement is heavily insulated on the outside, in order to reduce the influence of the temperature from the outside environment. Under the influence of gravity, a negative vertical temperature gradient of about -0.07 K/m develops in the air

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within the inner Dewar flask, very similar to experiment B76, described in Chapter 16 and in Appendix 4.

The thermopile is connected to a 100 Ohm resistor. As shown in the following graph we measured the current through the resistor and the voltage of the thermopile continuously for 2 days in November of 2007, the values being shown on the left side of the graph.



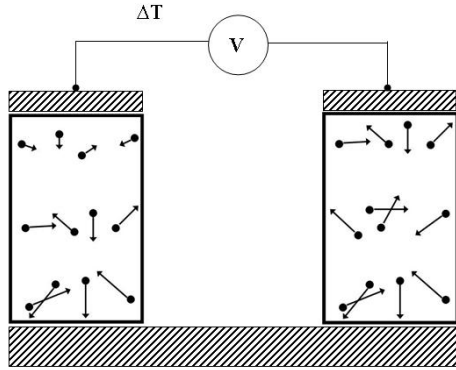
Gravity machine B411 producing electricity out of a heat bath.

The wattage, obtained as Ampere times Volt, is shown on the right hand scale. As can be seen, the output of this machine, around 6×10^{-13} W, is extremely small. Nevertheless, it is still very meaningful, because this power has been produced without the addition of outside energy, based on a negative temperature gradient generated by the influence of gravity. Furthermore, all of this took place within an outside environment having a positive temperature gradient.

This gravity machine has only a working volume of 0.5 liter and is, therefore, too small to generate enough power to drive a machine or an electric light. But it demonstrates the principle that heat can flow under the influence of gravity from a cold reservoir to one with a higher temperature and produce work.

The following setup might be even more impressive or useful in convincing the skeptics: I arranged two identical containers to stand next to each other on the

same thick metal plate, representing a heat bath. These containers are filled with different gases or liquids, which, due to their specific heats and numbers of degrees of freedoms, have each a different temperature gradient $T(\text{Gr})$. While the temperatures are equal at the bottom, they are different at the top. Now we can connect these tops through a thermo-element or, for instance, a Stirling engine, and so produce work.



In order to motivate others to repeat my experiments, we now offer seminars, where we explain the building of these electricity-producing Gravity Machines in all details. The participants can purchase all parts necessary for themselves to put together such a machine, or take one along that is already fully assembled.

The dream of Loschmidt has become reality.



Gravity Machine type 1 - 2010