

Perpetuum mobile II

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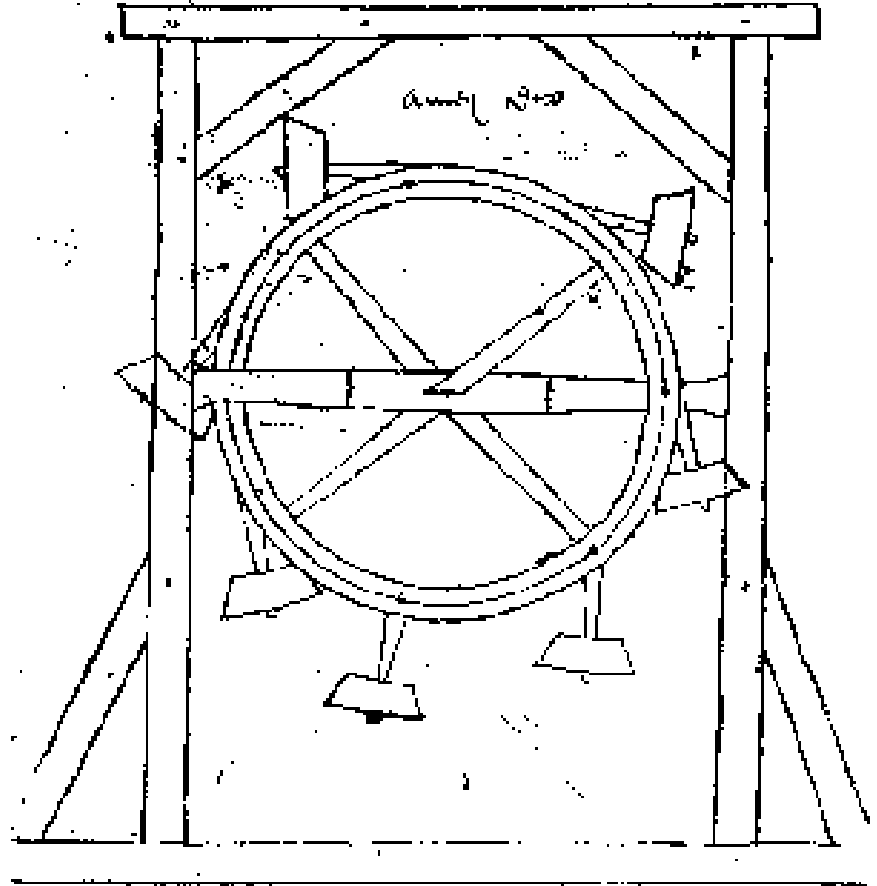
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Villard de Honnecourt (around 1235)

- The middle ages' architect and master-builder Villard de Honnecourt (around 1235) seemed puzzled by the unsuccessful attempts of other perpetual motion machine inventors. To close the discussion and end the ignorance of others, he drew a machine both simple as ingenious, whose operating principle is based on an odd number of moveable heavy hammers mounted to the rim of a wheel:

Villard Honnecourt II

- Villard de Honnecourt's famous unbalanced wheel. The original comment reads "*Maint ior se sunt maistre dispute de faire torner une ruee par li seul. Vesent si con en puet faire par mailes non pers ou par vif argent*"

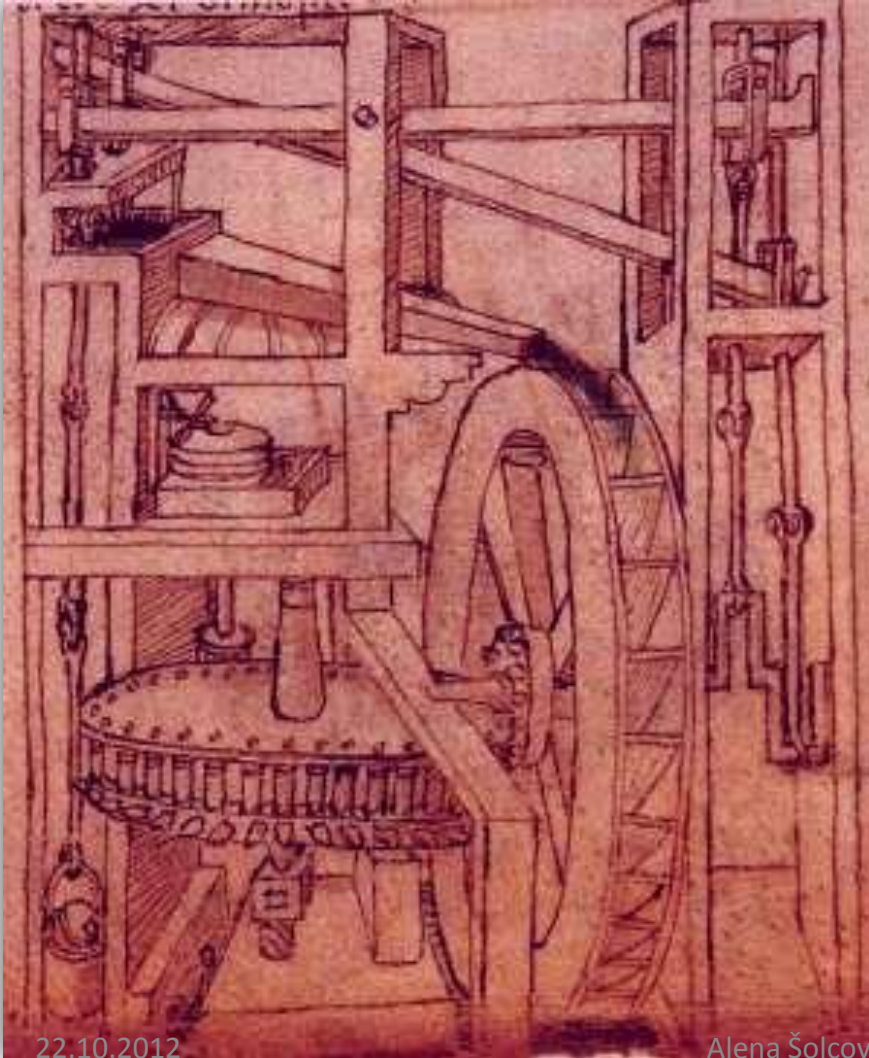


Renaissance Ideas

Francisco di Georgio

- During the Renaissance interest in perpetual motion machines was widespread.
- For example, some drawings of perpetual motion machines by the architect and master-builder Francisco di Georgio have survived.
- A very fine example is this water-driven mill with an additional pump engine.

Francisco di Georgio



- This machine uses closed water circulation. Such machines are called *recirculation mills* or *dry water mills*. Since the water does not come from external sources, it was called *aqua morta* i.e. "dead water".
- In this example, falling water turns a water-wheel which drives the corn mill through a gear mechanism. To raise the water up again, a crankshaft and two levers drive a two-cylinder piston pump which lifts the water to the feeding canal of the water wheel.

Francisco di Georgio II

- Di Georgio gave more than one example of these machines but we have to be careful.
- Some of the machines are impractical, but they may work.
- And of course, machine drawings like these also were made to impress the reader and to demonstrate the combination of many construction elements in a single device.

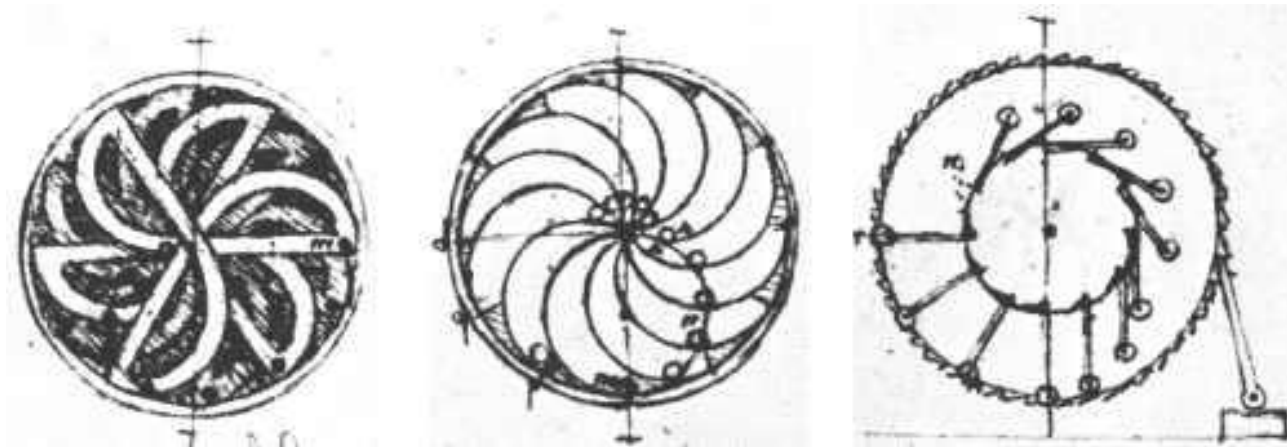
Robert Fludd

- In 1618 the English physicist and mystic Robert Fludd (1574 - 1637) described a recirculation mill, which raised the water with a chain pump powered by a water wheel, driven by the same water!
- However, Fludd added his disclaimer, stating that this was the invention of a "certain Italian" which was "being the unworkable repetition of an aged idea".

Leonardo da Vinci

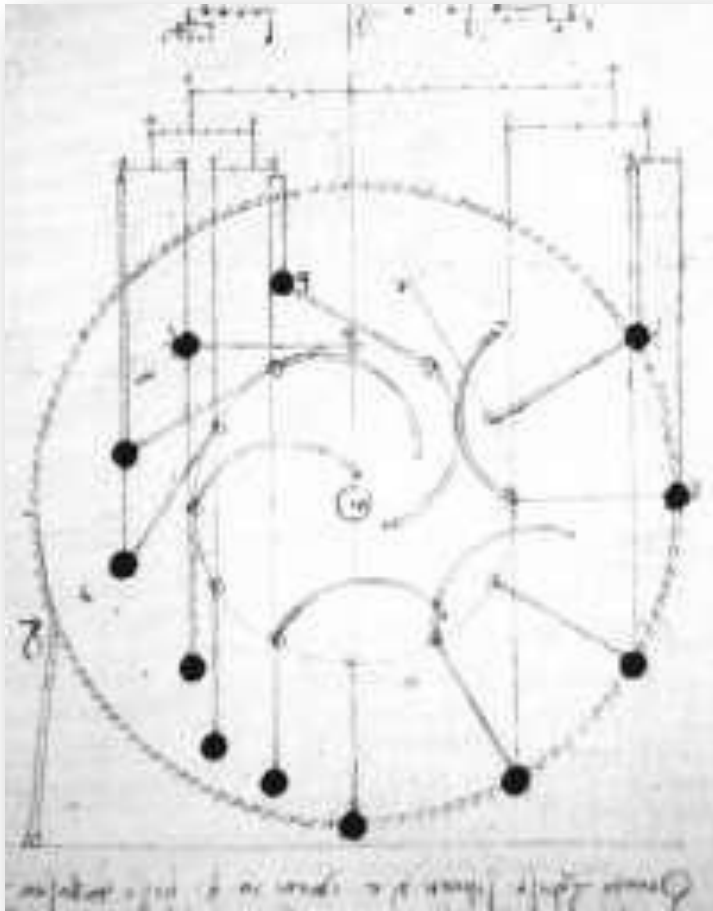
- Apparently, di Georgio's machines were known to Leonardo da Vinci who had a life-long interest in machines of all kinds, including perpetual motion machines.
- Some of his drawings of recirculation mills with Archimedian screws have survived. He described a complex mechanism using a wheel with mercury-filled containers.
- The Deutsches Museum in Munich has a reconstructed model on display.
- Leonardo was an excellent observer and knew the theory of machines quite well.
- Although the principle of conservation of energy was unknown at his time, Leonardo had a clear concept which came very close to it:
"Falling water lifts the same amount of water, if we take the force of the impact into account [...], but from the power of the machine we have to subtract the friction losses in the bearings."

Leonardo Sketches



Sketches by Leonardo's hand of pure mechanical perpetua mobilia, which use rolling balls, are also known.

Vinci's Proof of Impossibility



- Although Leonardo had a continuing interest in perpetual motion machines.
- He held a very skeptical opinion about the possibility of their practical implementation.
- In one of Leonardo's sketchbooks we find a drawing illustrating Leonardo's proof of the impossibility of an overbalanced wheel PM.

Leonardo's Views

This drawing shows excellent insight into forces, torques and levers.

The analysis of forces can be regarded as almost modern.

Leonardo closed his considerations with the words:

"O you researchers of perpetual motion, how many harebrained ideas have you created in this search. You may as well join the alchemists."

A Machine not being built

Agostino Ramelli

- Even today, Agostino Ramelli (1531[?]-1608[?]) is regarded as an important engineer.
- His great opus *Le diverse et artificiose machine* is a rich treasure for historians of technology.
- There we find many modern mechanisms which are attributed to later times.
- E.g. **Ramelli invented ventilators and a pump**, which today is named after its "inventor" *Gaede's capsule pump*.

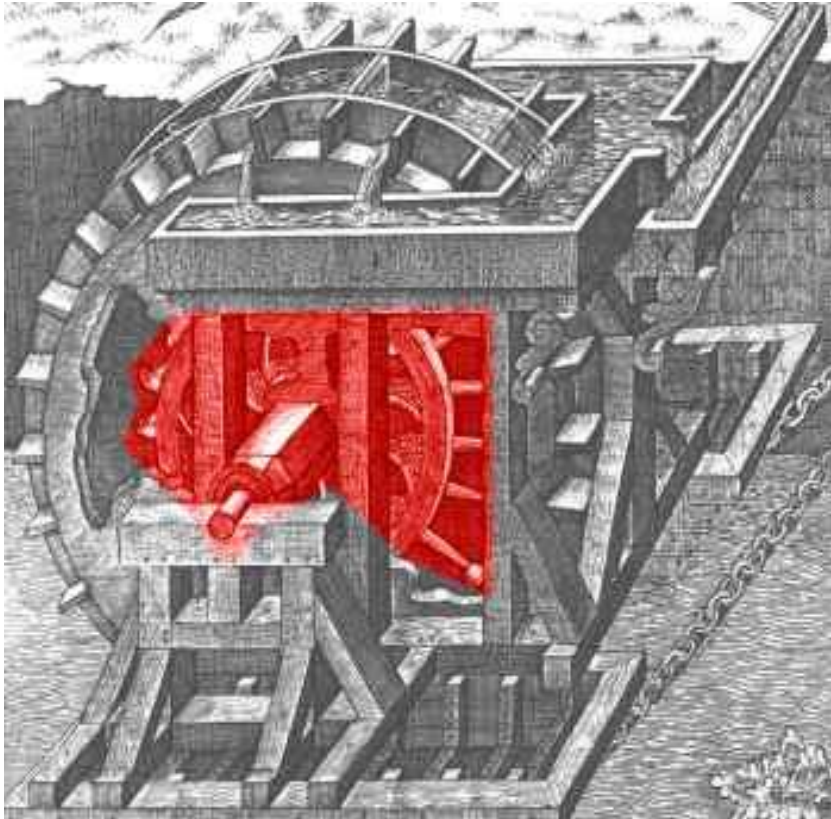
The end of the renaissance and the baroque period were the heyday of perpetual motion proposals.

But Ramelli was too much a practical engineer to fall victim to the idea. We find no mention of it in his works. Or to be more precise, *almost* no mention of it.

In chapter 43 he describes a wheel for raising water, which contains a mechanism to improve the power of the device.

This mechanism is the classic overbalanced wheel.

Description of machine



After a short description of the machine, Ramelli adds this disclaimer:

"You should know that the interior of this wheel was designed to please a gentleman who requested me to do it because he thought that since the current of the river was too slow it should be aided by a wheel. Thus anyone can make use of it if he judges it suitable."

A machine for levering water
with a perpetual energy amplifier

First systematic research

- In the middle of the eighteenth century the first systematic research on water powered machines was made in order to improve these devices.
- 250 years after Leonardo, machines driven by aqua morta were relegated to the scrapyard of technology.
- It wasn't until the mid 1950s, until these were resurrected by **Viktor Schaubberger**. Under the name of "trout turbines" or "vortex turbines" they are still discussed today by Schaubberger's followers.
- **I've never heard of a working example...**

Magnetic Perpetua Mobilia

- Perpetual motion machines need not be purely mechanical.
- Between the middle ages and the present time many devices have been proposed which make use of magnetic, hydraulic, electrical or other forces.
- And of course, often several principles have been combined in attempts to construct a successful perpetual motion machine.

Pierre de Maricourt - 1269

- The first known magnetic PM proposal dates back to 1269. Pierre de Maricourt (also named Petrus Peregrinus) described a rotating device which uses the attraction force of several magnets.



Analogy of a natural phenomena

- As magnetic effects were poorly understood at this time, this idea seemed plausible.
- Maricourt explained that he wasn't proposing a machine to produce useful work, but rather a model **to help understand how the planets move in their orbits.**
- Here, the PMM is to be interpreted **as a pure model or analogy of a natural phenomena.**
- Pierre de Maricourt thought that the magnetic lodestone was the ***lapis* for which the alchemists searched.**

The Goal – Explaining Planetary Motion

- As often happens in the history of science, in the process of doing one thing, even doing something misguided, one discovers other things which are useful or important.
- Pierre's goal of explaining planetary motion did not prevent him from discovering that little iron wires put onto a magnetic ball arranged themselves in lines comparable to the imaginary longitude lines of the celestial sphere.
- Pierre **also observed that magnetic lodestones** which were put on little swimming wooden pieces always aligned in north-south direction.
- Pierre de Maricourt coined the expressions of the magnetic "north" and "south poles" and **he was the first who wrote that opposite poles attract each other and like poles repel.**



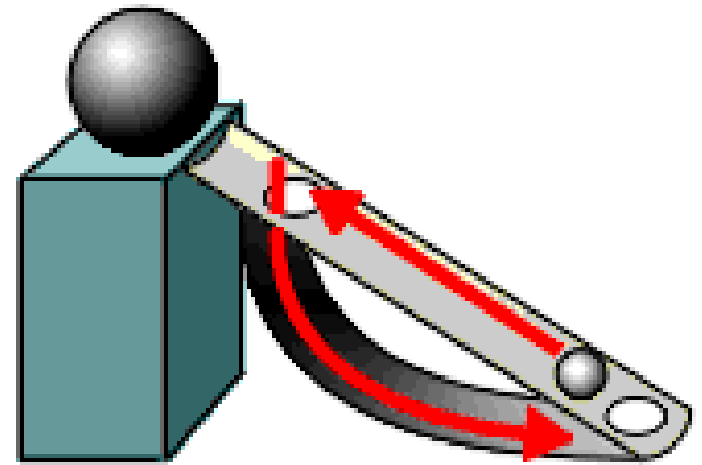
John Wilkins, 17th Century

Bishop John Wilkins (1614-1672) who was a founder of the Royal Society, described in his book *Mathematical Magick or the wonders that may be performed by mechanical geometry* a simple magnetic PM, which was suggested by **Johannes Taisnierus**.

- At the upper end of a ramp a magnetic lodestone is mounted.
- The ramp has two openings; one which allows an iron ball to enter the upper ramp at the bottom and another hole at the top through which the ball can drop to a lower ramp which guides it back to the bottom of the upper ramp.

John Wilkins II

- Wilkins also provided an explanation, why this mechanism cannot work.
- Why should the ball drop through the upper opening instead of eventually flipping to the lodestone?
- Why should the ball on the lower ramp roll down against the attraction of the magnet, if it does not on the upper ramp?
- How does the iron ball find out that it must change the direction of movement at the bottom end of the ramps?

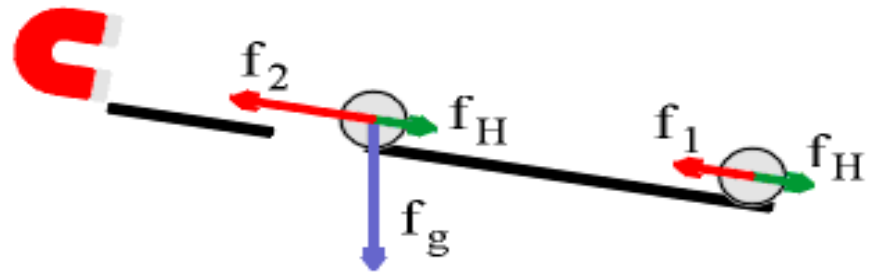


These questions and the implied explanation can be found in many articles and apparently **is the most natural approach to deflate Taisnierus' idea.**

- If we do a careful analysis of the device in modern terms, we find out that things are not so simple as they seem. Look at the forces which act on the iron ball.
- Of course, the position of the magnet, the slope of the ramp and the location of the openings must be carefully adjusted.
- To our surprise, this device does not violate the law of energy conservation - but it does violate the second law of thermodynamics!

Check this out and explain how it works!

- m mass of the iron ball
- f_1 attracting magnetic force at the lower end of the ramp
- f_2 attracting magnetic force at the upper end of the ramp
- f_H down force of the ball, $|f_H| < |f_1|$
- f_g $f_g = m g$ weight force of the ball, $|f_g| < |f_2|$; thus the ball can drop through the opening in the upper ramp



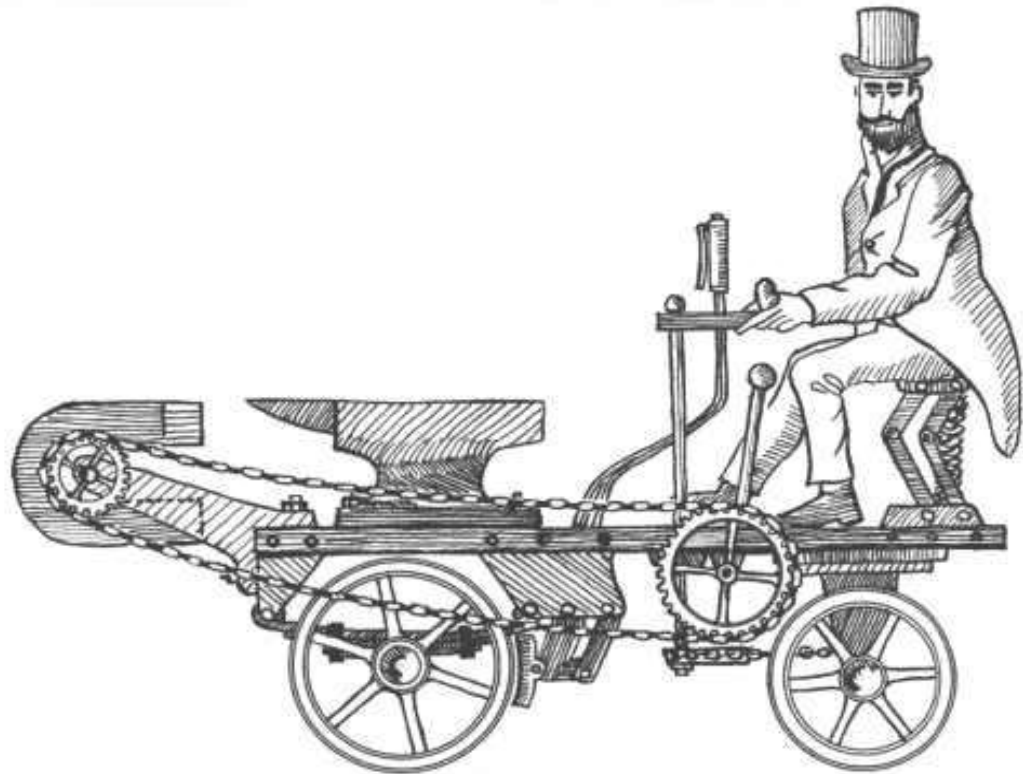
Wilkins – Father of Modern Science

- We should keep in mind that Wilkins was one of the first scientists who did a great step forward in science, as he replaced many speculations by experiment.
- However, this did not hinder him to make very witty considerations about the (possibly) living beings on the moon.
- It should take some more years until an Isaac Newton stated: *Hypotheses non fingo*.
- John Wilkins' scientific work also addressed educated common people - an aspect which shall not be underestimated if we regard the common scientific culture in Europe at his time, most scientists communicating in Latin language.
- Thus Wilkins can be named one of the fathers of modern science.

A Magnet Car

Here's a machine which embodies the fallacies of the magnetic PMM.

Occasionally in cartoons or recreational physics we find drawings like this, which illustrates how a magnet can be used to propel a ship or car. I don't know when this idea originated nor if the concept ever was seriously suggested.



William Gilbert (1544 - 1603)

- William Gilbert was Elizabeth I's royal physician.
- Moreover, Gilbert was the first to systematically study phenomena caused by the earth's magnetism;
- he was the one who proved that the compass needle always points to the *magnetic* north pole of the earth.
- At Gilbert's time the research of magnetic phenomena was thoroughly performed, as scholars expected many new ideas and findings.
- But the theory of magnetic fields was not developed and the hope to invent the PMM by using magnets was fed by dreadful tales like those about *the fate rock or magnet mountain* which ruined every ship coming too close by pulling out all nails due to its terrible magnetic power.

Gilbert's book *De Magnete* (1600) was widely read and extremely influential.

- Gilbert was no follower of perpetual motion concepts.
- Actually, in chapter XXXV, he cites some names and explicitly denies the possibility of these devices.



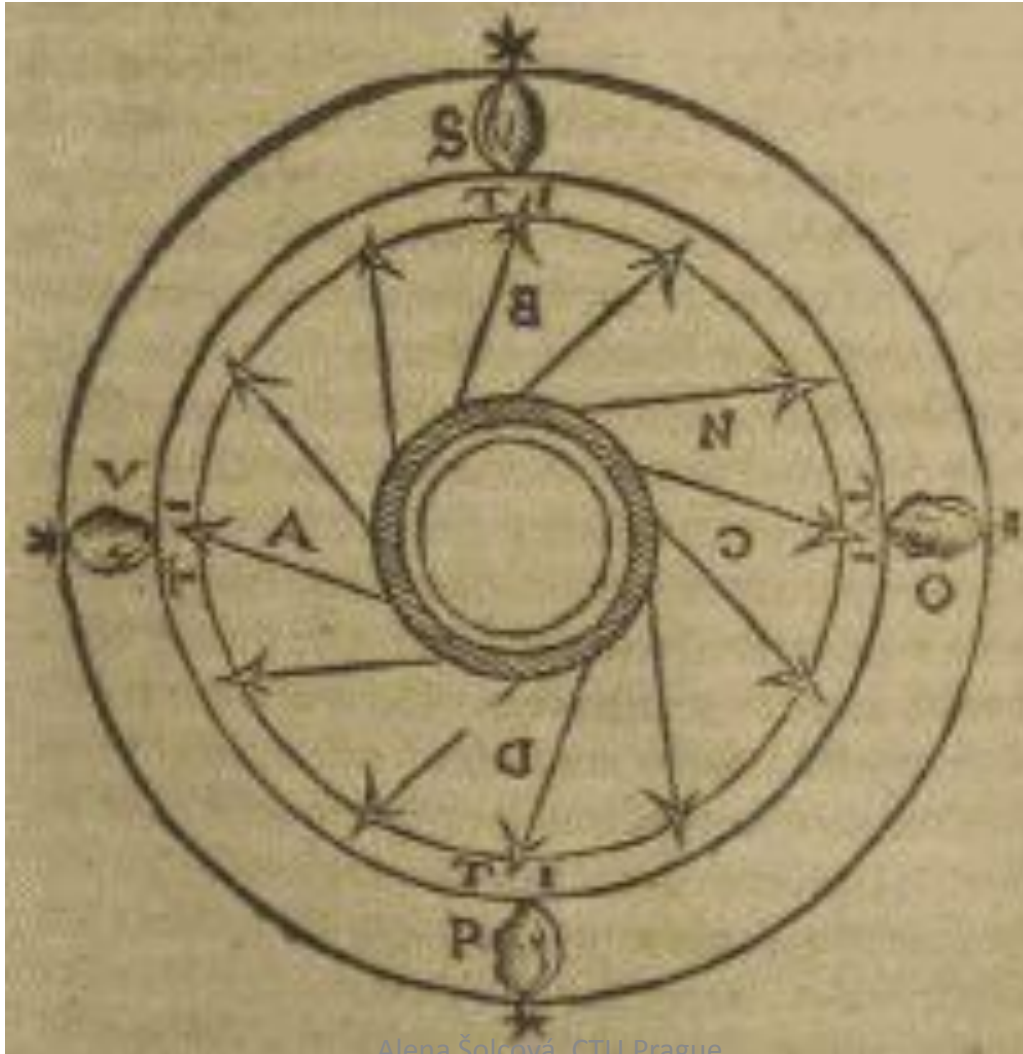
The Jesuits

- Some Jesuits, amongst them some of the most outstanding scholars of the seventeenth century, **Athanasius Kircher** (1601- 1680) and
- his pupil **Caspar Schott** (1608- 1666) studied the creation of perpetual motion on earth by man's hands.

Athanasius Kircher

- Athanasius Kircher explored the effects of the magnetic lodestone, as **William Gilbert** did before him. The universal scholar Kircher seemed to have an ambivalent opinion about perpetual motion devices, which did not prevent him from inventing several PM machines.
- One of his constructions is a wheel with radial iron points rotating in the field of four magnets. Technically speaking, this was a further development of Pierre de Maricourt's idea. But the genius Kircher also did not succeed in inventing an operable PM device.

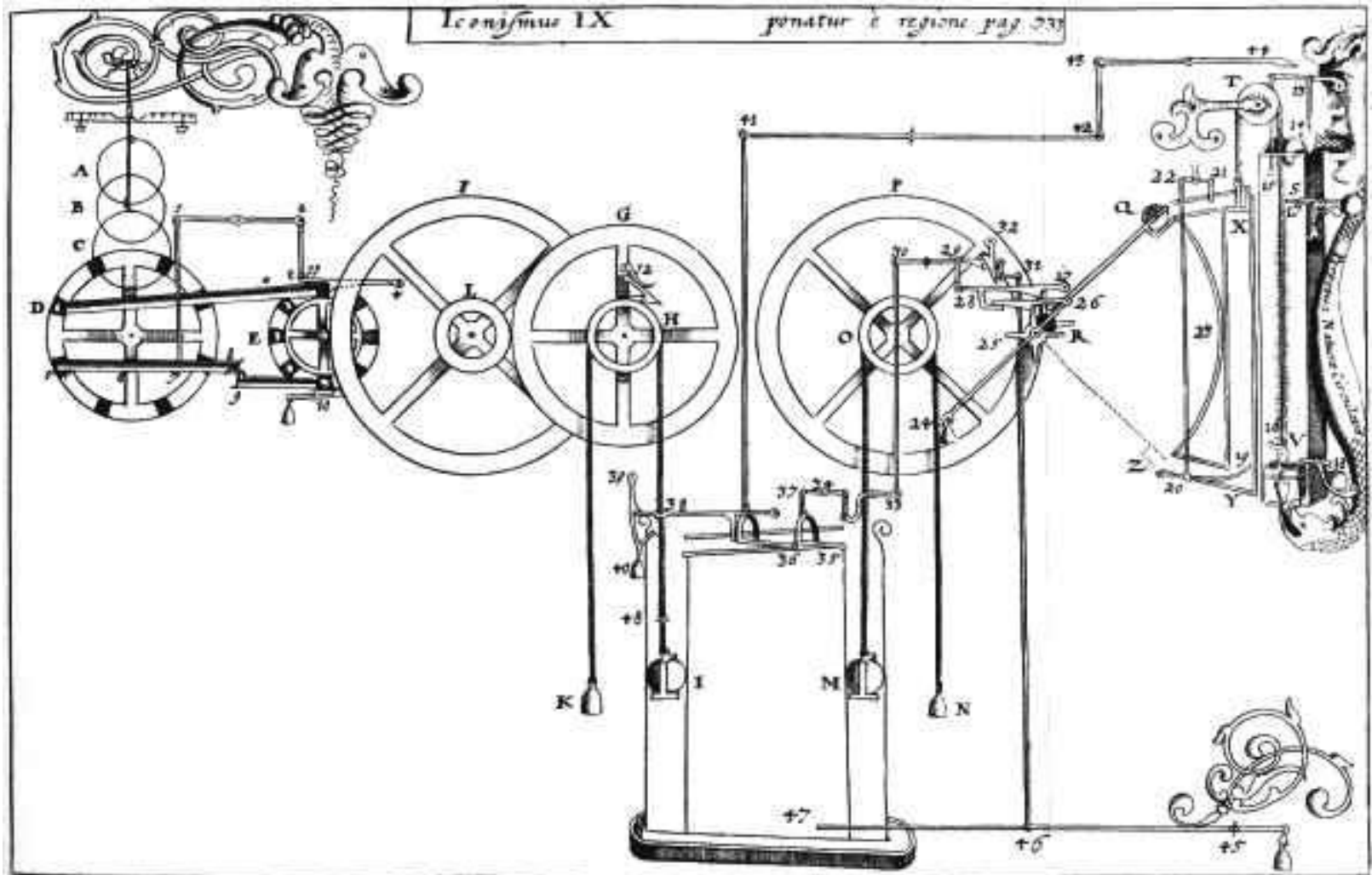
Kircher's device



Caspar Schott

- In Schott's 1664 magnum opus *Technica Curiosa* we find not only descriptions of the sensational experiments performed by **Otto von Guericke**, but also numerous images and descriptions of the most recent perpetua mobilia of mid-seventeenth century.
- Not all of these devices were regarded as operable. Schott gives the example of a stunningly complex mechanism being invented by **Johann Joachim Becher** (*Technica Curiosa*, p.732).

Hans Joachim Becher



Motus perpetuus is impossible!

- The elector of Mainz, Hans Philipp von Schönborn, even erected a tower to house the whole machine and set it into operation. The gigantic effort was performed to keep a clockwork running!
- The machine's inventor closed his project after many unsuccessful years of work with the words: *"Ten years I've pursued this foolishness, and have wasted much time, money and reputation, but I can announce without fame [sic] that the motus perpetuus is impossible."*

Next inventors

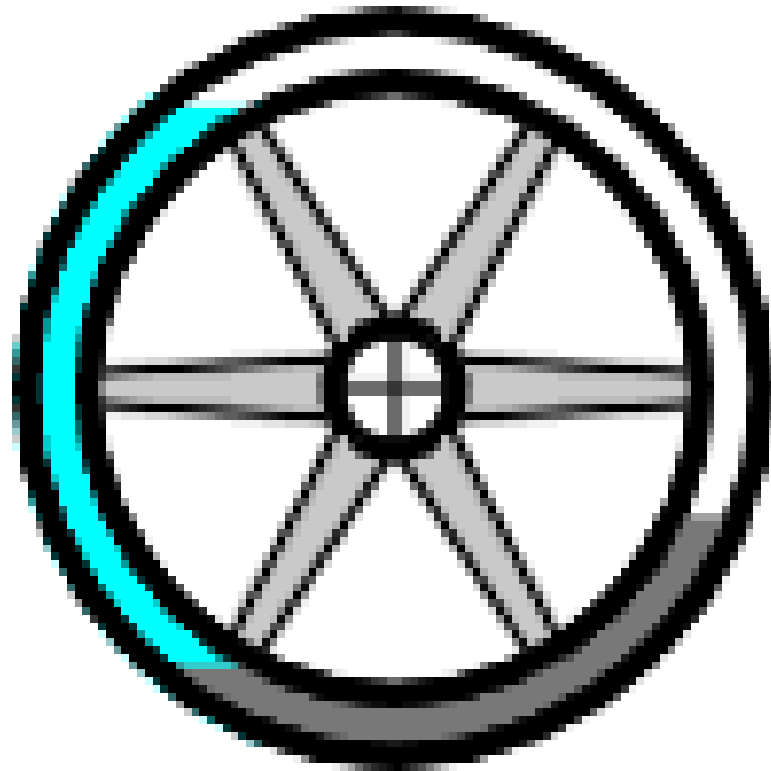
Besides the best known members of the Jesuit order were others who fell addict to the search of perpetual motion:

- **Christoph Scheiner**, who discovered sunspots (independently from Galilei and at the same time) invented a primitive "Gnomon Scheineriani", for which he earned derisive laughter and malicious comments.
- **Stanislaus Solski**, who described around 1610 a complicated oscillating machine to lift water with ropes, levers and buckets.
- **Christoph Grünberger(us)**, who was A. Kircher's predecessor mathematician of the Jesuit order at the Collegio Romano gave the theory of a PM based on spiral shapes which were calculated in a tedious way.
- The already abovementioned **Johannes Tainierus**.
- Schotts *Technica Curiosa* contains so many references to Jesuits that one can easily get the impression that in the seventeenth century the whole *Societas Jesu* was infected by the perpetual virus.

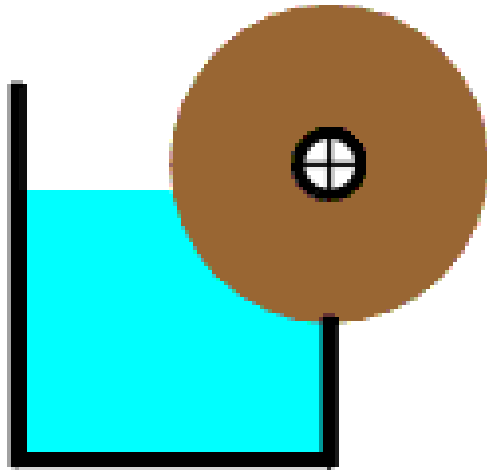
Hydrodynamic PM

- A very simple PMM consists of a tubular ring filled with two liquids of different density. The difference of the levels is expected to provide an asymmetric force, thus causing the wheel to rotate. Unfortunately, the two liquids are always in balance, whatever the densities of the liquids are. This principle can be traced back to the year 1150 to *Bhaskara's Siddhanta Siromani*.

A two-liquid perpetuum mobile



Perpetuum stabile



- Even simpler is the next device. A wooden wheel is at one side only partially immersed in a water tank. The asymmetric buoyancy force was supposed to keep the wheel rotating.
- The inventor of this machine did not take in account that pressure in liquids always acts from all sides and exerts forces perpendicularly on the surface of the submerged object.
- This is a common misunderstanding about the way upward buoyant forces are generated.
- The wooden wheel proved to be a *perpetuum stabile*, which is not surprising at all.

Blaise Pascal



- **Denis Papin** should have known better. Years earlier, the french philosopher, physicist and mathematician **Blaise Pascal** (1623-1662) invented a device to measure the hydrostatic pressure.
- This device even today is named after its inventor *Pascal's apparatus*(?).
- But long before both, **Simon Stevin** made first experiments of this type.

Denis Papin (1647 - 1712)

- **Denis Papin** was a French physicist who made the first reasonable designs for steam engines.
- He also invented the **steam cooker (pressure cooker)**.
- Papin suggested the simplest hydraulic PM one can imagine. It had no moveable mechanical parts and its function should be based on the pressure excess in the large container that forces the liquid column in the thin tube upwards.

A similar suggestion was made by **Robert Boyle** (1627 - 1691), who thought that a very narrow bore tube would allow a liquid to rise continually by capillary effects. Although both concepts frequently are illustrated by the same schematic image, their intended principle of operation is completely different. Nevertheless, none of these ideas worked.

Vittorio Zonca

- Based on ideas of **Giovanni Battista della Porta** (1535-1615), the Italian renaissance engineer Vittorio Zonca (1568? - 15 Nov 1602) invented a PM that used the effect of the siphon. Siphons only work when the outlet opening is lower than the inlet.
- At Zonca's time this fact was not correctly known which made the construction seem to be a realistic option to obtain a perpetual energy source. Look at the strange belly shape of the siphon!
- It is not caused by poor skills of the draftsman, but by the idea, that a larger cross-section at the outlet will compensate the lack of height. The whole idea seemed plausible, as the siphon effect was not explained by air pressure but by the Aristotelian *horror vacui*. I.e. nature "abhors a vacuum", meaning "nature cannot produce a vacuum."

Siphon perpetuum mobile

- Zonca's instrument

