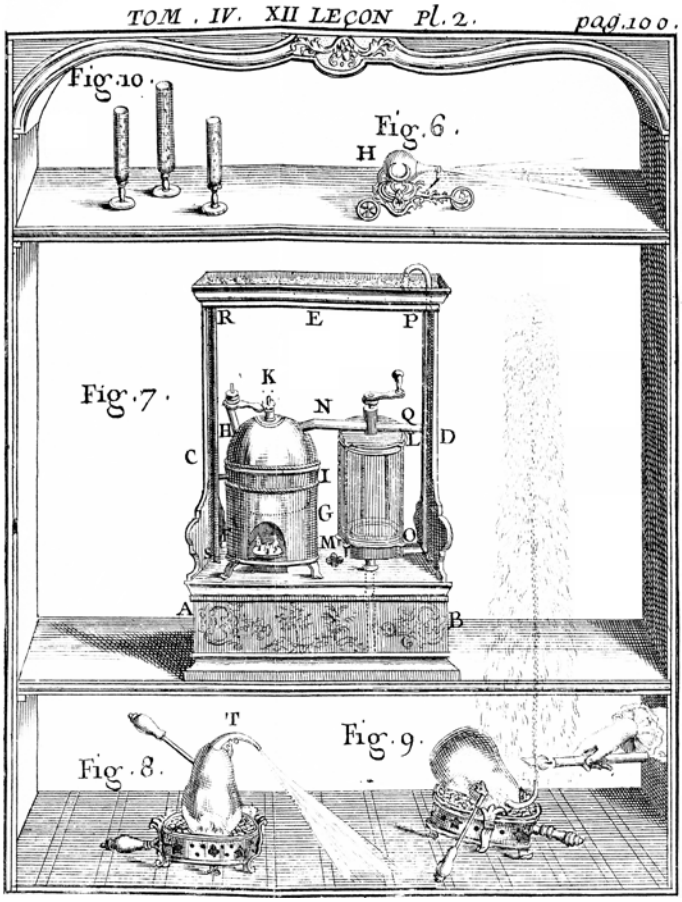
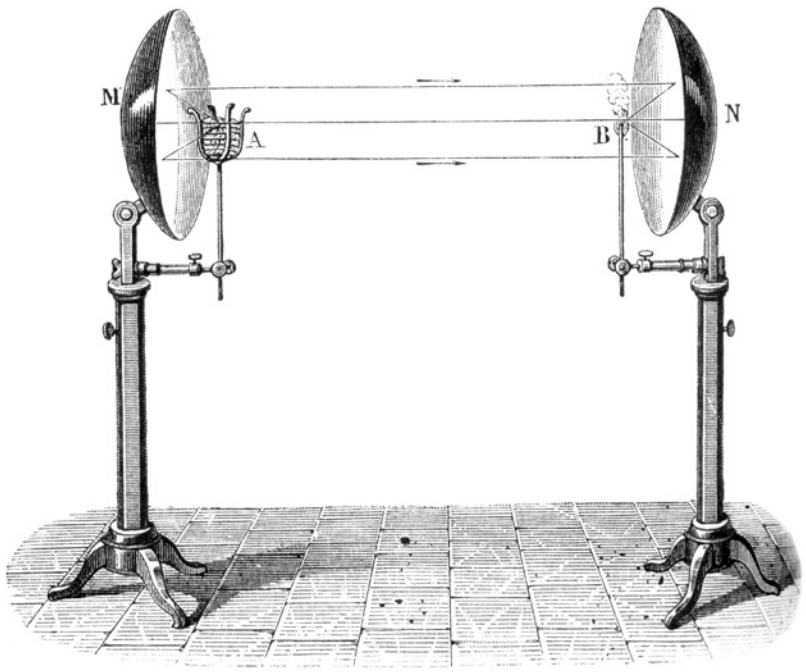
The Pictet Cabinet

The art of teaching science through experiment





Pair of parabolic mirrors in brass
Traité de physique, Ganot, Paris, 1884
Library of the Musée d'histoire des sciences

At the beginning of the 19th century, Marc-Auguste Pictet used a pair of parabolic mirrors placed 4-5 metres apart in order to experimentally verify that heat is reflected in the same way as light.

Glowing coals are placed in a small metal basket at point A attached to the first mirror. A flammable substance, such as wood kindling is placed at point B in front of the second mirror. The heat given off by the coals is reflected initially on the first mirror (M) before spreading to the second mirror (N). There, it is reflected for the second time before being concentrated at B where the kindling is set alight.

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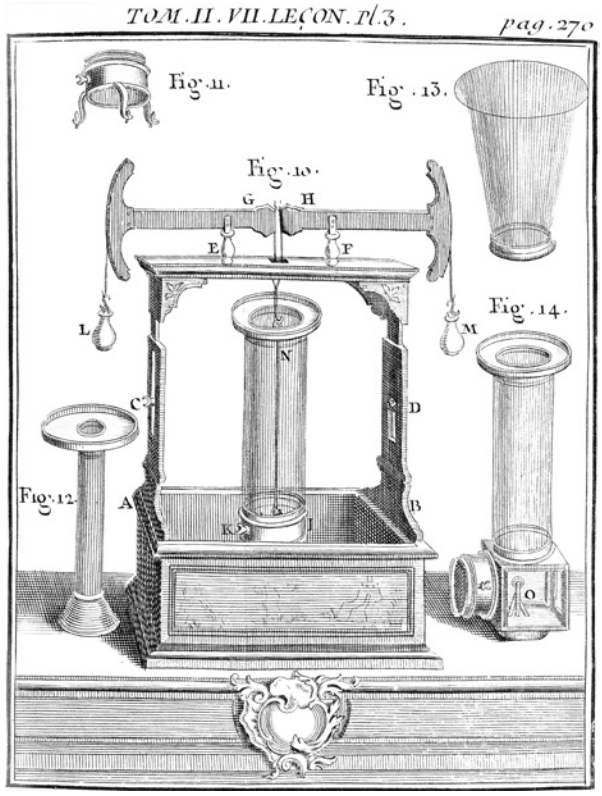
Cover : Fire pump
Leçons de physique expérimentale, Jean-Antoine Nollet, Paris 1749-1755
Library of the Musée d'histoire des sciences

The art of teaching science through experiment

This booklet presents a summary of a selection of instruments from the physics laboratory of the Geneva astronomer Marc-Auguste Pictet (1752-1825) displayed in the new "Pictet Cabinet" room in the Musée d'histoire des sciences of Geneva. The instruments were used for teaching experimental physics at the Geneva Academy, the forerunner of the present University. They were made by the best-known craftsmen of the time and demonstrate the importance Pictet attached to experiment in his physics courses, a ground-breaking approach in Geneva at the time.



Equipment for measuring pressure in water
Leçons de physique expérimentale, Jean-Antoine Nollet, Paris 1749-1755
Library of the Musée d'histoire des sciences

From debate to demonstration

The early days of experimental physics

Until the Renaissance, science was developed through reasoning, discussion and debating contests on the basis of ancient philosophy and Christian theology. However, at the end of the 16th century, Galileo and other scholars dared to test received ideas through experiment. In their determination to understand how the world around them functioned, they made the first measuring instruments: barometers, thermometers, hygrometers.

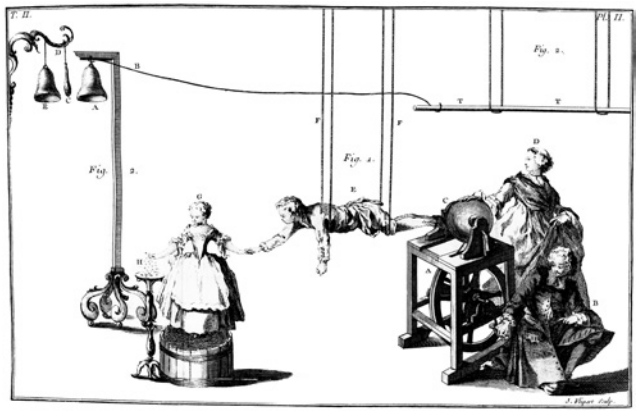
Telescopes and microscopes allowed Galileo and others to begin exploration of the sky and of much smaller features of the natural world. They worked together in learned societies supported financially by the aristocracy and royalty. They built new instruments to observe phenomena hitherto hidden, such as electricity and vacuum. Numerous new instruments designed to demonstrate natural or physical laws appeared in the 18th century. This was the golden age of scholarly salons. Experimental physics taught by skilled experimentalists became a discipline in its own right in English and Dutch universities.

An 18th century physics salon
Leçons de physique expérimentale, Jean-Antoine Nollet, Paris 1749-1755
Library of the Musée d'histoire des sciences

Abbé Nollet's instruments

Aesthetics in the service of science

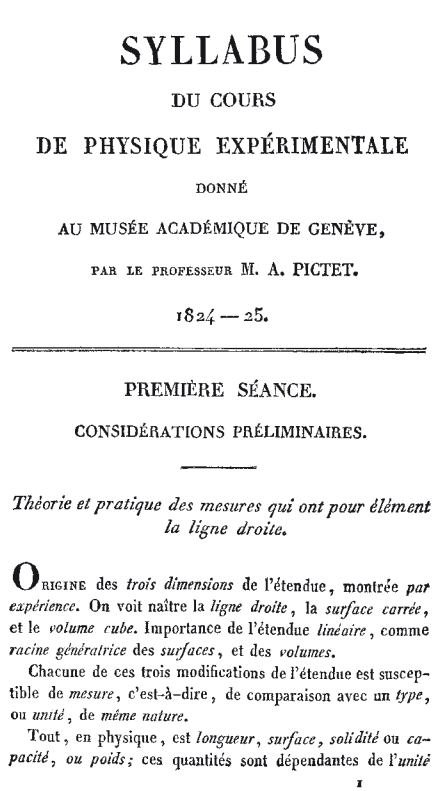
One of the great personalities of 18th century experimental physics is undoubtedly Abbé Jean-Antoine Nollet (1700-1770). He was a physicist and accomplished electrician who gained a reputation for his spectacular public demonstrations on static electricity and his skills as a builder of scientific instruments. In *Leçons de physique expérimentale* (1738), he described details of experiments using 345 carefully selected instruments. Nollet himself trained the craftsmen in his Paris workshops to build innovative apparatus for physics experiments. Instruments made in his workshops are easy to identify. Lacquered, polished and decorated with care, they resemble objects for a drawing room rather than scientific instruments. For Nollet, aesthetics made no difference to scientific performance but helped to capture the interest and admiration of the public. In 1770, the year of his death, he published a final work, *l'Art des expériences,* which deals with the materials, techniques and decoration of scientific instruments.



Abbé Nollet's spectacular demonstrations of static electricity
Essai sur l'électricité des corps, Nollet, Paris, 1753
Library of the Musée d'histoire des sciences

The experimental physics syllabus

In 1824, the Geneva physicist and astronomer Marc-Auguste Pictet published *Syllabus du cours de physique expérimentale* which he had prepared for his last year of teaching in 1824 -1825. The 224 pages present each course followed by a list of the equipment used for demonstrations most of which were from Pictet's own cabinet of physics. This was the first publication of its kind in Geneva.



SYLLABUS

DU COURS

DE PHYSIQUE EXPÉRIMENTALE

DONNÉ

AU MUSÉE ACADÉMIQUE DE GENÈVE,

PAR LE PROFESSEUR M. A. PICTET.

1824 — 25.

PREMIÈRE SÉANCE.

CONSIDÉRATIONS PRÉLIMINAIRES.

Théorie et pratique des mesures qui ont pour élément la ligne droite.

ORIGINE des *trois dimensions* de l'étendue, montrée *par expérience*. On voit naître la *ligne droite*, la *surface carrée*, et le *volume cube*. Importance de l'étendue *linéaire*, comme *racine génératrice* des *surfaces*, et des *volumes*.

Chacune de ces trois modifications de l'étendue est susceptible de *mesure*, c'est-à-dire, de comparaison avec un *type*, ou *unité*, de *même nature*.

Tout, en physique, est *longueur*, *surface*, *solidité* ou *capacité*, *ou poids*; ces quantités sont dépendantes de l'*unité*

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The *Syllabus* includes 38 courses dealing with the main physics subjects of the time : measuring systems, geometry, astronomy, laws of motion, measurement of time, thermometry, hydrostatics, electricity, magnetism, optics, etc.

Many of the instruments mentioned in the *Syllabus* are conserved at the Musée d'histoire des sciences and can be seen in the Pictet or other rooms. Several are described in the following pages.

First page of the Syllabus
Syllabus du cours de physique expérimentale, Pictet, Genève, 1824
Library of the Musée d'histoire des sciences

The power of steam

The invention of the aeolipile is attributed to the Greek engineer Heron (or Hero) of Alexandria. Initially, the apparatus consisted of a hollow copper bowl fixed onto an axel and equipped with bent tubes. The steam produced by heating water in the ball escapes through the tubes making the sphere spin on its axis.

It was not until the 17th century, when the possibility of steam as an energy source was beginning to be recognised, that the aeolipile was equipped with wheels. The jet of steam was then used to propel the trolley in the opposite direction. This machine was the origin of steam engines which appeared at the end of the 17th century.

The aeolipile trolley
(MHS inv. 1198) © MHS

Nollet's fire pump

A mine pump

In his experimental physics courses of 1738, Nollet described a fire pump without a piston which functioned in a similar way to certain machines used in England to evacuate water from mines. He was probably referring to the "engine to raise water by fire" invented by the Englishman Thomas Savery at the end of the 17th century. Water was sucked up by a vacuum created by condensation then expelled through steam pressure.

Several machines were installed in English mines but their performance was disappointing. They were unreliable, required large quantities of steam and could only raise water from a depth of some 15 metres. Nollet mentions that a machine of this type had been installed in London to distribute Thames river water to some parts of the city. But the attempt had to be abandoned because a large fire was needed and smoke engulfed the surrounding areas.

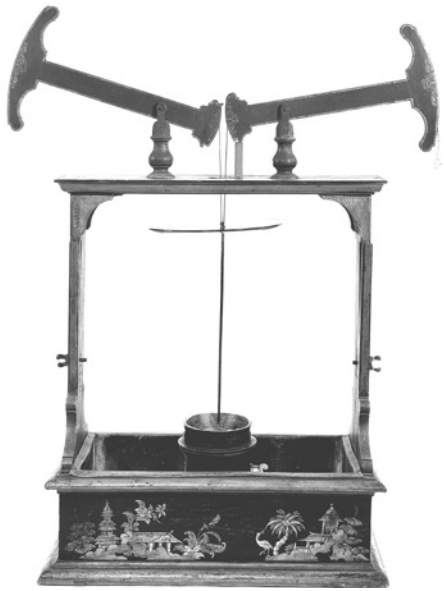
Fire pump
(MHS inv. 77) © MHS

Apparatus to study water pressure

The weight of a water column

The apparatus for studying water pressure, a wooden frame lacquered red and black decorated with gilded flowers and leaves, is an excellent example of an instrument from Nollet's workshops. It was used to demonstrate the principal developed by Pascal whereby the pressure exerted by a liquid on the base of a container is not proportional to the quantity, but to the height of the column, of liquid.

A glass container is screwed onto a metal tube, the upper part being closed by a plug. The plug is supported by a rod attached to the ends of two levers from which weights can be suspended to counterbalance the effects of the weight of water at the base of the container. If the wide container is replaced by a glass cylinder (with the same diameter at the base) filled with water to the same level, it can be seen that the weight required to maintain the plug remains identical.



Apparatus for the study of water pressure
(MHS inv. 568) © MHS

Hydrostatic balance

Verification of Archimedes' principle

Built by the famous Dumotiez workshops in Paris, this hydrostatic balance demonstrated Archimedes principle which stated that an object immersed in a fluid is buoyed up by a force equal to the weight of the fluid displaced by the object.

An empty cylinder is placed on one of the trays ; a full cylinder of equal volume is placed underneath it. The scale is balanced by placing weights on the second tray. If water is added to the empty cylinder, the balance tilts. The cross-bar is lowered using the rack in order to plunge the full cylinder into the container of water below it. It can be observed that balance is restored. The full cylinder appears to have lost some of its weight during its immersion. In reality, pressure is being exerted on it equal to the weight of the water transferred into the hitherto empty cylinder.

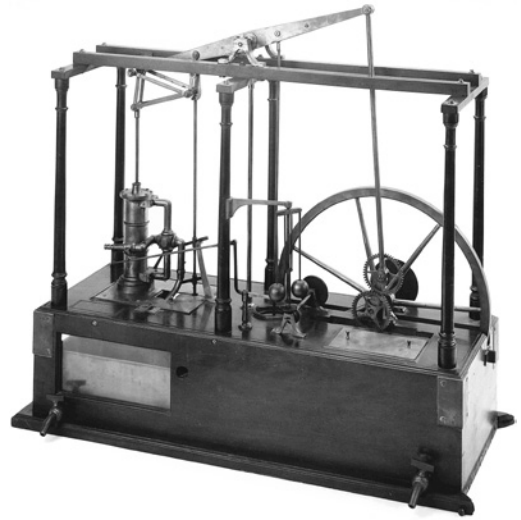
Hydrostatic balance
(MHS inv. 194) © MHS

Watt's steam engine

The engine of the industrial revolution

In 1782, the Englishman James Watt developed the first double-action steam engine. The steam propelled the piston up and down in the cylinder producing much greater power than had been possible before. He further improved performance by attaching a steam condenser which no longer cooled the cylinder as was the case in older machines. Finally, he designed a mechanical system (piston rod, balance, connecting rod, crank, drive wheel) which converted the piston movement from alternative to circular.

The final improvements meant that the steam engine definitively replaced traditional mill wheels as the source of energy for industry. It was henceforth possible to site factories away from rivers.



Watt's steam engine
(MHS inv. 78) © MHS

The vacuum takes centre stage

Since the invention of the first vacuum pumps in the 17th century, experiments using vacuums had always been very popular with the public and students. Amongst the most spectacular were the Magdebourg hemispheres which show the action of atmospheric pressure in relation to a vacuum, or the swelling of a pig bladder as air thins.

Other experiments are more original such as those which use a double wind machine designed to study air resistance on the angle of the blades. The wind machine is placed in a vacuum under a cloche which is pierced on the side by a small hole. Taking care to cover the hole with a finger, a few pumping actions create a partial vacuum. When the finger is removed air enters quickly through the hole causing the blades of the wind machine to turn.

Double wind machine
(MHS inv. 66) © MHS

Other demonstration instruments in the Museum

Other demonstration instruments from the Pictet cabinet are conserved at the Museum. They are either on show in other rooms or are stored. We present some of the more unusual instruments below.

The instant artist

This is a small magnetic demonstration apparatus featuring an artist copying any one of four paintings which is placed in the same box. The small portraits which appear on the artist's canvas are drawn on a cardboard disc, underneath which is a magnetic needle. The disc orients itself according to the position of the metal bar glued underneath the large painting.

Magnetic recreation of a painting
(MHS inv. 682) © MHS

The exploding house

This apparatus was intended to demonstrate the chemical effects of an electric spark. The small house in painted metal contains a Volta pistol and a small tin flask containing an explosive mixture of hydrogen and oxygen closed with a cork. The mixture explodes in contact with a spark generated by an electrostatic machine. The force of the explosion blows off the roof of the house and the walls collapse.

The metal house for explosive demonstrations of electricity
(MHS inv. 1405) © MHS

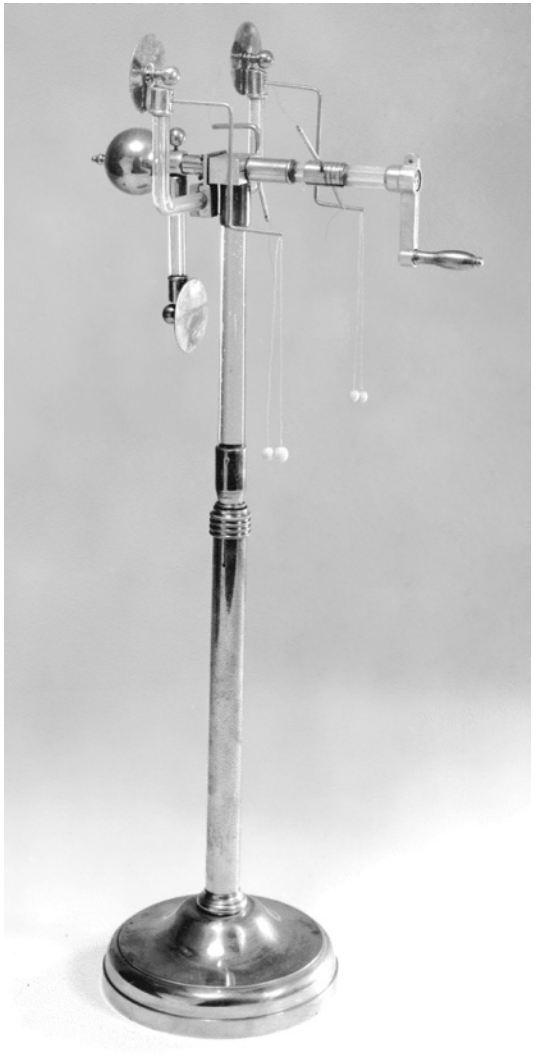
Anamorphoses

The origins of these extraordinary optical objects, anamorphoses, are in the Renaissance. They are deliberately distorted drawings which must be viewed in a specific mirror (cylindrical or pyramidal) to reveal their true proportions.

An anamorphose and its cylindrical mirror
(MHS inv. 193) © MHS

Electricity enhancer

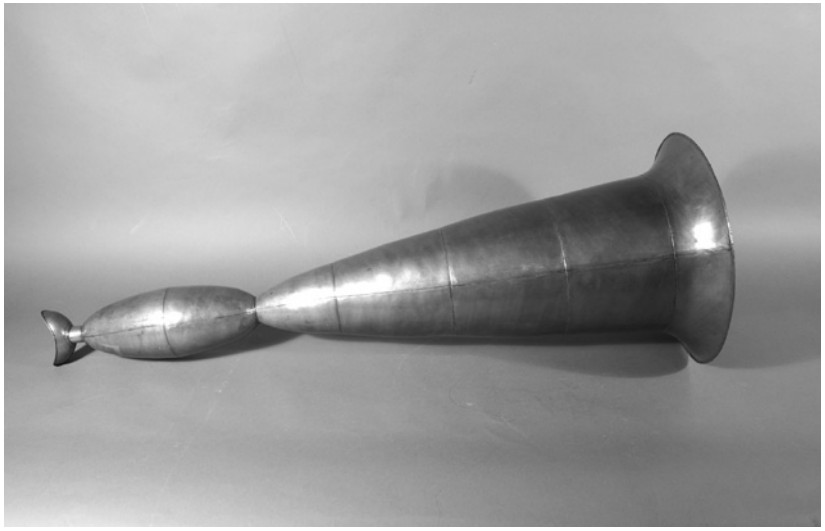
Invented in England at the end of the 18th century, this instrument increased very low electrical charges and allowed them to be observed with the help of two balls of elder wood (indicator).



The electricity enhancer
(MHS inv. 714) © MHS

Megaphone

In contrast to the traditional conical speaking trumpet, it was claimed that this object shaped into two bulbs maintained a constant sound intensity over all distances.

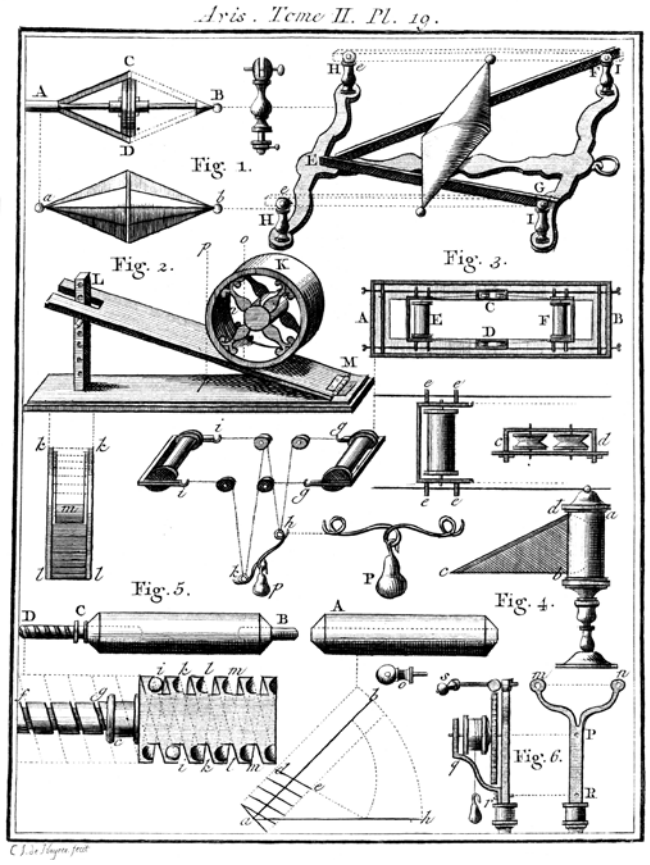


The speaking trumpet
(MHS inv. 1124) © MHS

Further reading

L'Art d'enseigner la physique, Pyenson et Gauvin, éditions Septentrion, Montreal 2002
MHS 500.08.(06) MON, Bibliothèque du Musée d'histoire des sciences.

Syllabus du cours de physique expérimentale, Pictet, Genève, 1824
MHS 530 PIC, Bibliothèque du Musée d'histoire des sciences



L'art des expériences
Antoine Nollet, Paris 1770
Library of the Musée d'histoire des sciences

Other guides to the permanent collection available:

- Révolution(s) – A brief history of celestial measurement told through some of the astronomical instruments in the Musée d'histoire des sciences of Geneva. September 2011
- The skies of Mont Blanc - Following the traces of Horace-Bénédict de Saussure (1740-1799) pioneer of Alpine meteorology. September 2011
- Through the looking glass: once upon a time, there was electricity - The story of electricity told through the collection of instruments of the Musée d'histoire des sciences of Geneva. September 2011
- Sun time: Description and use of the main types of sundial exhibited at the Musée d'histoire des sciences of Geneva. September 2011
- Seeing the infinitely small: Instruments at the Musée d'histoire des sciences of Geneva trace the history of microscopy. September 2011
- Observing the sky: A brief introduction to astronomy and presentation of instruments from the first Geneva Observatory. September 2011
- From foot to metre, from marc to kilo: The history o weights and measures illustrated by objects in the collections of the Musée d'histoire des sciences of Geneva. September 2011

This booklet can be downloaded at www.ville-ge.ch/mhs

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