

Original Science Apparatus Preserved in Science Museums and Universities in Free Europe

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Original science apparatus is where you find it: Florence, Leyden, Glasgow, or Cambridge. A search during the spring of 1968 for original apparatus behind present-day physics and astronomy led the author through many interesting by-ways of free Europe.

Using *World of Learning* and *American Ephemeris and Nautical Almanac* as sources for addresses, one hundred scientists and museum directors and/or curators were contacted in fifty observatories and museums. All persons were cordial in their response concerning a visit. Original pieces of science apparatus were located in twenty museums in fourteen countries. The number of items ranged from one or two to an entire room dedicated to a single scientist. It was observed that there was twice as much stored away as there was on display. This probably accounted for the overcrowding observed in most museums. Some pieces of apparatus were displayed in a regular museum, some in the seminar room of a university department, and others along corridors.

In 1657, Cardinal Leopoldo de 'Medici together with his brother, the Granduke Ferdinando II—both followers of Galileo—founded in Florence the Accademia del Cimento, the first modern scientific institute in Europe. In the Museum of the History of Science, situated in the medieval Castellani Palace in Piazza dei Guidici near the Arno River, many of the most interesting and valuable relics of Galileo and his pupils of the Accademia del Cimento are preserved.

Many scientific objects in the outer rooms tend to divert the visitor, however one pushes forward to the blue velvet lined room of Galileo Galilei. There are two of the telescopes with which he studied the skies, discovering the valleys of the moon, the phases of Venus, and four of the satellites of Jupiter; his campassec; pendulum diagrams and weights; air thermometer; astrolab; and publications. Some of these were related to his "swinging lamp" and "leaning tower" experimentation in Pisa, about fifty miles to the west.

Instruments of one of his famous pupils, Evangelista Torricelli, are there: a metal case telescope and his 1643 mercury tube barometer. Several rooms are filled with later dated telescopes of unusual designs and mountings. Others contain case after case of astrolabs and measuring devices. In the center of one room was a large 16th century armillary sphere made by the Florentine instrument maker, Volpaja. Elsewhere in the museum were located a lens grinder, ruling machine, and spectroscope.

Three weeks later a large collection was photographed in the Rijksmuseum voor de Geschiedenis der Natuurwetenschappen at Leyden, Holland. The name brings to mind windmills and capacitors. They had both.

However, it was also the home territory of Huygen, Leeuwenhoek, and Onnes.

There, in 1656, Christian Huygens made the important invention of the pendulum clock, which had been conceived independently by Galileo fifteen years earlier but had never been expanded to its basic capabilities. Huygens also applied the clock principal to a plate-type planetarium.

Antony van Leewenhoek in the 1670's made the first study of the miniature water-world with single lens microscopes. He taught himself to grind lenses and made microscopes capable of magnifying up to 270 times. An entire room is given over to his microscopes and later improvements in the field of microscopy.

From a much later date there is the apparatus of Heike Kamerlingh Onnes, the 1913 Nobel prize for physics winner. With it he discovered a method of liquefying helium.

Across the English channel science history was also made, and many pieces of apparatus are still preserved. A very fine collection from Lord Kelvin and James Joule was found in the new Physics Building of the University of Glasgow, Scotland.

Early in life Lord Kelvin became fascinated with the possibilities of electrical currents for signalling over long distances and soon was personally involved in the company that was trying to lay the first Atlantic cables. In one display case were many pieces of apparatus from that association: a high voltage electrostatic voltmeter; the "cable" galvanometer used to receive the first message, "Europe and America are united by telegraphic communication! Glory to God in the Highest and on earth peace and good will to all men," which was sent by cable under the Atlantic Ocean; a Centi-ampere Balance with which Lord Kelvin originated the principle of "weighing" electric current by balancing the attraction between sets of coils against weights; and a Mouse Cage Electric Motor.

Kelvin was also noted for some of his teaching devices: the French horn which he himself played in the classroom to illustrate problems in acoustics; a ballistic momentum-impulse firearm; pitch glacier started 1890; and Call Box with its three compartments nick-named by his students as "purgatory, heaven, and not passed."

James Prescott Joule carried out much scientific research in his own private laboratory. However, some of his discoveries were made with Lord Kelvin. It is fitting that several pieces of his apparatus are also included in the collection. A Joule Magnetic Engine, an electric motor made by Joule in 1840-3, is one of the earliest motors in existence. It was undoubtedly used in his studies on electrical energy. A Joule Calorimeter made of brass was used by Joule in the final determination of the mechanical equivalent of heat.

In England one would expect to find science "originals" at Oxford and Cambridge. Henry Gwyn Jeffres Moseley, while a lecturer at Ox-

ford, proved the existence of a simple relationship between the X-ray spectrum of an element and its atomic number, thereby showing that the properties of an element are determined, not by its atomic weight, but by its atomic number. He thus provided a new method of chemical analysis which has since aided immeasurably in solving various outstanding problems of atomic structure. Several of his X-ray spectrometers are located in the Museum of the History of Science.

At Cavendish Laboratory, just off of Free School Lane in Cambridge, are located several items used in their research by many famous scientists of the late 19th century and the beginning of the 20th. Found there on the third floor in cases along a hall are J. J. Thomson's positive ray apparatus (complete parabolae were first recorded with this model); Aston's original mass spectrograph (without the magnet); and C. T. R. Wilson's cloud chamber, which was used without any major alterations for all the photographic work he did.

The thinking which was behind these originals is very impressive. It is hoped that all students, in future classes where various pieces of apparatus will be used, will recognize and be inspired by our scientific heritage.