Some Scientific Instrument Makers of the 18th Century.*

By ROBERT S. WHIPPLE.

ADAMS appears to have given a great deal of consideration to the method of measuring magnification of microscopes, and illustrates in detail in the "Micrographia Illustrata" (Plate 14), fourth edition, various micrometers for this purpose, amongst others the micrometer he made in 1761 for the silver microscope of George III. This instrument originally formed part of the King's collection and is now in the Lewis Evans collection. It has been described by Messrs. Clay and Court at some length.¹ Although the details of workmanship in this instrument are excellent, the instrument as a whole must be regarded as an ornament rather than a serious contribution to microscopy. Such is not the case with the earlier instrument made for the King when Prince of Wales, and known as the "Prince of Wales" microscope (see Fig. 2). It is particularly interesting as embodying the method of mounting a microscope on trunnions; perhaps, as Clay and Court remark, the first microscope so supported. There are three stages, one of which (shown in the bottom of the illustration) is of great interest, having micrometers registering in two directions at right angles. The screws have 100 threads to the inch, and the scales on the heads are divided into 100 parts, so that the micrometers read to 1/10,000 inch. The stage shown in position on the microscope was intended to carry a frog for demonstrations of the circulation of the blood. It is a matter of general knowledge that King George III. was keenly interested in scientific matters, and wished that his family should be instructed in science. Dr. Demainbray commenced to teach the Royal family in 1754, and appears to have used for this purpose the apparatus which formed the major part of what is known as the King George III. collection. The instruments in the collection were catalogued in a manuscript book which is still preserved in the Kew Observatory, and also in a catalogue which is now in the Science Museum at South Kensington. The instruments were housed at the Kew Observatory until 1841, when they were transferred to King's College, London. In 1925 they were removed to the Science

Museum at South Kensington, where the majority of them can be studied. The story of the collection was told in some detail in a paper before the Optical Convention of 1926.² The majority of the instruments intended for instructional purposes were made by George Adams, although few of them

FIG. 2.—Microscope by Adams, generally known as the "Prince of Wales" microscope.

bear his name. Fortunately two books of instructions have been preserved, and it is by means of these that it is possible to state that the majority of the instruments were made by Adams.[†]

The instructions consist of two manuscript books about 19 in. × 13 in., with two small books about 12 in. × 9 in. The pages of the latter are of blue paper, on which are pasted white sheets on which the illustrations have been drawn. One book is entitled :

[†] It is by the courtesy of the Delegacy of King's College and the Director of the Science Museum that I have been able to examine these books.

* Continued from p. 246.

"A Description of an Apparatus for explaining the Principles of Mechanicks made for His Majesty King George the Third by George Adams, Mathematical Instrument Maker to His Majesty. In Fleet Street, London, 1762." The second book is entitled: "A Description of the Pneumatic Apparatus made by George Adams in Fleet Street, London, 1761." In the case of the "Mechanicks" the final sheets of drawings were in course of pre-

rough covers—but this was never done. The two books containing the comparatively rough drawings appear to have been the centre around which Adams built up the experimental courses. In the case of the "Mechanicks" a little mathematical work is also included, although the course is essentially experimental and based on Desagulier's translation of the classical work of 's Gravesande, the distinguished professor of mathematics at Leyden.³

Adams apparently cut out many of the illustrations from Desaguliers' book, and added pencil or ink modifications to guide the workman. Fig. 3 is an example of a modification of this kind. The apparatus is intended to demonstrate experiments on pendulums and the impact of bodies; it is generally known as "'s Gravesande table". The central illustration in Plate 25 of Desaguliers' book has been cut out and modified. The additions are shown by the cross hatching, but the parts removed have been carefully cut away before mounting. The finished instrument can be seen at South Kensington, and comparing the original design with that made by Adams, one has to admit that the latter is more graceful than the original. The workmanship of the whole of this piece of apparatus is excellent. Adams evidently considered the cost of making apparatus, because several modifications are introduced with the view of reducing labour. The drawing of a table is shortened in pencil, with the words "Too long" written against it, and there are small pencil sketches at the side showing alterations. A ring is made to take the place of a fairly elaborate handle, and a simple glass basin is used instead of a brass bowl.

There can, I think, be little doubt that, judging from the large number of sketches that are

dimensional, they must have formed the actual drawings from which the apparatus was built. Not improbably the workman had made some of the instruments previously for other customers, so that he did not require detailed drawings. The work of making the instruments may have spread over a few years. In the case of one of the pneumatic instruments mention is made of apparatus previously supplied and now "in one of the Cabinets of the Palace at Richmond".

All through both books references are made to various scientific authors; for example, when discussing the Archimedian screw five references are given.

FIG. 3.—'s Gravesande table for pendulum experiments, as modified by Adams.

One of the most interesting instruments shown in detail is the rotating speculum suggested by Searson as an artificial horizon. Full details of the construction are given, and a manuscript copy of Emmerson's paper in the *Philosophical Transactions*, vol. 47, p. 352, is included with the manuscript papers of the collection. Adams commences the description of the instrument with a short introduction:

"I received this invention from the late Sir Jacob Ackworth, first Commissioner of his late Majesties Royal Navy; soon after the inventor Mr. Searson was unfortunately lost on board His Majesties Ship the 'Victory'."

Adams's mechanical ability shows itself in his instructions as to lubrication:—"It is necessary to put a drop of sweet Oil into the concave Steel polished segment of a sphere, for if the speculum be whirled without Oil it does not spin much above ten or twelve minutes, with Oil it will spin generally 36 minutes."

Only two of the illustrations are actually signed by Adams, although there is little doubt that the various notes are in his writing. There is a short four-page manuscript slipped into one of the books, which is a sheet of instructions with regard to some details of an instrument. Adams presumably wrote his notes out in this manner, and they were afterwards transcribed in the elaborate copy-book writing of the instructions.

The fourth edition of the "*Micrographia Illustrata*" is dated 1771, and Adams died in 1773. He must have lived a full life, as, judging by the large number of instruments that may be found bearing his name, and by the "*Catalogue of Mathematical, Philosophical and Optical Instruments*" published in the end of the "*Micrographia Illustrata*", he must have had a large and flourishing business. Adams left it to a son—George (born in 1750)—who added greatly to the prestige of the firm. He was a cultured man, and a favourite at Court. He wrote a large number of books, the majority of which passed through more than one edition. The most famous of his books was his "*Essays on the Microscope*" published in 1787. In the preface he states frankly that he had intended to confine himself to a republication of his father's work the "*Micrographia Illustrata*", but that knowledge of the subject had increased so much since his father wrote that he felt the book had to be rewritten. Discussing the natural history side of the subject, he states that he has endeavoured to correct some of the faults in arrangement, etc., "by arranging the subjects in systematic order, and by introducing the microscopic reader to the system of Linnæus, as far as it relates to insects". Chapter i. is an extremely interesting history of the microscope, as observed by one who lived close to many of the inventions. In it he mentions that he invented an improved form of the lucernal microscope in 1774. In Chapter iii he mentions that "this microscope was originally thought of, and in fact executed by my father; I have, however, so improved and altered it, both in construction and form, as to

render it altogether a different instrument". He also mentions that "the great demand I have had for them, has fully repaid my pains and expences [*sic*] in bringing it to its present state of perfection". The lucernal was a simple compact form of projection microscope which met with general approval as an instrument which could be conveniently demonstrated to a number of people at the same time.

A second and enlarged edition of the "*Micrographia Illustrata*" appeared in 1798, edited with great care by F. Kanmacher. This editor in a footnote dwells on the fact that Adams had not given full credit to Benjamin Martin for what he had done to develop the microscope. Adams's "*Geometrical and Graphical Essays*", first published in 1790, was an extremely useful text-book for surveyors, civilian and military. The lectures on "*Natural & Experimental Philosophy*" first published in 1794, in five volumes, very nearly cover the range of physics as then understood—or in the words of the sub-title "describing in a familiar and easy manner the principal phenomena of nature and shewing that they all co-operate in displaying the goodness, wisdom and power of God". One is much impressed with the immense amount of work involved in the preparation of these books, for they are all full of individuality. The lectures were evidently written under difficulties. In the preface the author mentions: "During the composition of these Lectures I have had to attend to the grateful calls of daily business, and have struggled with much weakness and languor". He passed away on August 14, 1795. We learn from an editorial note to the second edition of the "*Essays on the Microscope*" that Adams at the time of his death was preparing a new edition and that he had other books in view. After his death his books and instruments were sold by auction, and the stock and copyright of his books were purchased by the brothers W. and S. Jones. William Jones was responsible for the editorial work and the republishing of several editions of Adams's books. The firm also continued to make instruments to the Adams's design for many years.

The manuscripts and plates of Adams the elder were inherited by his widow, who gave them to her younger son Dudley. He edited a thirtieth edition of the treatise on the globes, published in 1810. It is said that he had intended to publish another edition of the "*Micrographia Illustrata*", but it is not improbable that the revised edition (1798) of his brother's "*Essays on the Microscope*" rendered this unnecessary. Dudley Adams appears to have continued in the instrument business, as Mr. Court possesses a statement written on the back of a shop print, about 1800, of the wholesale trade terms for telescopes. These were evidently of the short brass draw-tube type which Dudley Adams had developed. The note attached to the price-list states that "the object glasses not being single but achromatic" shows that non-achromatic glasses were sometimes sold.

Time has only allowed me to dwell in detail on

four instrument makers in this century so full of scientific development. Their names are not so well known to the general public as those of Dolland, Herschel, and Ramsden. Nevertheless, the men whose work I have briefly described did an immense amount to popularise science, and to raise the standard of scientific instrument craftsmanship. How world-wide this reputation for good work became is best seen by the number of

instruments of English eighteenth century workmanship treasured in the Continental museums.

¹ "Two Microscopes made by G. Adams for King George III." By R. S. Clay and T. H. Court. *Jour. R. Micr. Soc.*, pp. 268-273; 1926; and Supplementary Note, *Jour. R. Micr. Soc.*, p. 255; 1927.

² "An Old Catalogue and what it tells us of the scientific instruments and curios collected by Queen Charlotte and King George III." By R. S. Whipple. *Proc. of the Optical Convention*, Part II, 1926.

³ "Mathematical Elements of Natural Philosophy, confirmed by Experiments: or an Introduction to Sir Isaac Newton's Philosophy." Written in Latin by the late W. James's Gravesande, LL.D., Professor of Mathematicks at Leyden and F.R.S. Translated into English by the late J. T. Desaguliers, LL.D., F.R.S., and Published by his son J. T. Desaguliers. Sixth Edition 1747.

Obituary.

MR. A. E. SEATON.

THE death of Mr. Albert Edward Seaton, which occurred at Hemel Hempstead on Aug. 8, robs British shipbuilding and marine engineering circles of one of its oldest and best known representatives. For nearly half a century Seaton's "Manual of Marine Engineering"—now in its twentieth edition—has been familiar to marine engineers, while his "Pocket Book," compiled in collaboration with Mr. H. M. Rounthwaite, is to be found in every drawing office. His "Manual" would alone cause his name to be remembered, but he had an almost lifelong association with the Institution of Naval Architects, and during the course of his long career enjoyed the friendship of many of the most distinguished members of his profession.

Born at Padstow, Cornwall, in 1848, Seaton entered Devonport Dockyard in 1864 as an engineer student with the object of following a naval career, and four years later, as a result of his success in a severe competitive examination, he gained a scholarship to the once well known Royal School of Naval Architecture and Marine Engineering at South Kensington, which had been established by the Admiralty in 1864. During its existence of nine years, the School occupied a unique position in Great Britain, and from it came not only future chief constructors and engineers-in-chief of the Navy, but also men who rose to important positions in private firms. In Seaton's time, Woolley, Merrifield, Cotterill, and Unwin were members of the staff; the occasional lecturers included Airy, Froude, Rankine, and Scott Russell, while among the students were Elgar, White, Watts, Biles, Sennett, Durston, Pratten, Corner, and others, whose important work during the last decades of the nineteenth century and the first of this century were of the greatest value to the country in building up our great naval and mercantile fleets.

Passing out in 1872, Seaton immediately left the public service and became technical secretary to Reed (afterwards Sir Edward Reed), who in 1870 at the age of forty had resigned his position as Chief Constructor at the Admiralty. Through Reed, Seaton became associated with Earle's Shipbuilding and Engineering Co., Hull, and during the next twenty-nine years was responsible for the design and construction of not only the machinery of many vessels but also of the ships themselves.

Leaving Hull in 1901, Seaton set up in Westminster as a consulting engineer, and in 1905 succeeded his former fellow-student and lifelong friend,

Alfred Morcom, as chairman of the well-known Birmingham engineering firm, Messrs. Belliss and Morcom. But much of Seaton's best work was done in connexion with the Institution of Naval Architects and other societies. He was elected a member of Council of the Institution in 1888, a vice-president in 1919, and represented it on various important committees. His knowledge of the progress of marine engineering design was probably unique, and for some years he was chairman of the British Marine Engineering Design and Construction Committee. He also took part in public life, served as a County Councillor for Hertfordshire, and was made a Justice of the Peace. His funeral took place on Aug. 12, at St. Marylebone Cemetery, East Finchley.

THE issue of the *Physikalische Zeitschrift* for June 1 contains a short account by Prof. F. A. Schulze of the work of Prof. Wilhelm Feussner, who died in 1928 at the advanced age of eighty-five years. He was born in Hanau in 1843, and studied at Heidelberg under Kirchhoff and at Marburg under Gerling. He took his doctor's degree in 1867 and became lecturer, in 1880 additional professor, and in 1908 honorary professor of theoretical physics at Marburg. He retired in 1918, but still kept in touch with modern research, and contributed to the section on interference in the new "Handbuch der physikalischen Optik".

WE regret to announce the following deaths:

Prof. A. R. Crook, for many years chief of the Illinois State Museum at Springfield, Illinois, known for his work on Cretaceous fossil fishes and geology generally, on May 30, aged sixty-five years.

Dr. J. Walter Fewkes, fellow of the U.S. National Academy of Sciences, who was chief of the Bureau of American Ethnology from 1918 until his retirement in 1928, on May 31, aged seventy-nine years.

Dr. W. S. Franklin, who retired last year from the professorship of physics and electrical engineering at the Massachusetts Institute of Technology, vice-president (Section B) of the American Association for the Advancement of Science in 1902, on June 6, aged sixty-six years.

Capt. J. T. Ainslie Walker, widely known by his work on disinfectants, who was associated with the late Dr. Samuel Rideal in perfecting the Rideal-Walker test for potency, on July 27.

Sir William Walker, C.B.E., late Director of Health and Safety in Mines Department, Board of Trade, and formerly Chief Inspector of Mines at Home Office, on Aug. 17, aged sixty-six years.