Early Scientific Worthies of America.

IN 1661, John Winthrop, son of John Winthrop the first governor of Massachusetts, visited England for the purpose of securing from Charles II. a royal charter for Connecticut, of which colony he had himself for many years held the governorship. Born in 1606, he had travelled and studied, was a capable physician, possessed a knowledge of chemistry and metallurgy, and had promoted the iron and other industries of the American colonies. Twice before he had visited England, but his third visit coinciding with the birth of the Royal Society, at a meeting of the Society in the old Gresham College in December 1661 he was chosen one of the members, and in May 1663, after the Society had secured its charter, his name was included in the list of original fellows.

Already known to many European men of science, after his return home Winthrop became the western correspondent of the Royal Society, and it was mainly through his letters from Newton, Boyle, Hooke, Barrow, and others, and the *Transactions* of the Society that the mathematicians and naturalists in the colonies learnt of the progress of science in Europe. Winthrop's active and useful life came to a close on April 5, 1676, and he was buried in King's Chapel, Boston, where his famous father and some of his distinguished descendants also lie.

Such, briefly, is the biography of the earliest of the scientific worthies of America, to whom Mr. F. E. Brasch refers in two historical articles on the Royal Society of London and its influence upon scientific thought in the American colonies, published in the *Scientific Monthly* for October and November. When Winthrop lived, the colonies were still but sparsely populated, and the conditions of life could have provided little opportunity for the pursuit of knowledge for its own sake. Yet long before he died Harvard College was a flourishing institution, and, as Mr. Brasch shows, with the growth of the college, the effects of the intercourse between the Royal Society and America, which began with Winthrop, were more and more fully felt, with advantage to both the Society and the colonies. To this intercourse may be traced, among other things, the founding of both the American Philosophical Society and the American Academy of Arts and Sciences.

Mr. Brasch's review covers the latter half of the seventeenth and the whole of the eighteenth century, and in that period he recalls no fewer than eighteen fellows of the Royal Society who were connected with American science in one way or another. Among these were Thomas Brattle, a successful merchant and treasurer of Harvard, whose astronomical observations of the comet of 1680 were of use to Newton and Halley; William Brattle, his brother, the first tutor of philosophy in the colonies; William Byrd, who sent plants and minerals to Sir Hans Sloane; John Leverett, president of Harvard; Cotton Mather, who corresponded with John Woodward and sent him fossils; Paul Dudley, Chief Justice of Massachusetts, who communicated to the Royal Society papers on natural history and is regarded as the first horticulturist in America; and John Winthrop (1681–1747), a diligent collector, to whom the fortieth volume of the *Transactions* of the Royal Society was dedicated.

Valuable as were the efforts of these individuals in furthering the claims and interests of science, of still greater importance was the work of Benjamin Franklin, John Winthrop (iv.), Dr. John Morgan, and David Rittenhouse, who were admitted to the Royal Society in the years 1756, 1766, 1765, and 1795 respectively. Franklin is rightly regarded as the foremost American man of science of the eighteenth century, and not the least of his services was the constant solicitude he showed when abroad for the reputation of his fellow-workers at home. He was "virtually the intellectual ambassador of his fellow-beings".

Mr. Brasch calls John Winthrop (iv.) the first real scientific astronomer and the first Newtonian disciple in America. Born in 1714, eight years after Franklin, Winthrop at the age of twenty-four years was chosen professor of mathematics and natural philosophy at Harvard, a post he held with distinction until his death in 1779. He introduced the study of fluxions, he established a laboratory for experimental physics, for more than thirty years he made astronomical observations, he contributed eleven papers to the Royal Society, and to him can be attributed the founding of the American Academy of Arts and Sciences.

Of John Morgan (1735–1789) it is sufficient to say that he was the founder of the first medical school in America; while David Rittenhouse (1732–1796), who as a boy drew mathematical figures on fences and barn-doors, planned the first observatory in the colony and was the successor of Franklin as president of the American Philosophical Society.

The Physics Workshop at the Imperial College.

ON Wednesday, January 6, during the special session for members of the Annual Exhibition of the Physical and Optical Societies, Prof. C. V. Boys, in the presence of about a hundred subscribers, presented Mr. W. J. Colebrook, formerly superintendent of the physics workshop of the Imperial College of Science and Technology, with a cheque for £100 on the occasion of his retirement. Mr. Colebrook had been connected with the workshop for forty years, and in addition he had acted during the War as workshop consultant to the War Office X-ray Committee, and from 1914 to the present time had been superintendent of the Air Ministry workshop. The testimonial represented the good wishes and appreciation of a large number of scientific workers.

During the course of an interesting address, extracts from which are subjoined, Prof. Boys outlined the early history of the physics workshop, with which he himself had been closely associated, and described how he had 'discovered' Mr. Colebrook.

Lord Rayleigh, who occupied the chair, added that during the years in which he had worked at the Imperial College he had been impressed by the efficiency of Mr. Colebrook's workmanship and his capacity for organising his department with a complete absence of friction and ostentation. Further appreciations were expressed by Lieut.-Col. K. Edgcumbe and Mr. Watson Baker, representing the British Electrical and Allied Manufacturers' Association and the British Optical Instruments Manufacturers' Association respectively, and the former presented Mr. Colebrook with an additional cheque on behalf of fifty-seven exhibitors at the Annual Exhibition of the Physical and Optical Societies, of which he had been organiser during the twenty-one years since its establishment. Mr. Colebrook, acknowledging the testimonials in an interesting and appropriate speech, expressed his gratitude for the invariably friendly relations which had always existed between him and those with whom he had worked.

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In the course of his speech, Prof. Boys said :

"We have met to-day to express our appreciation of the valuable services which have been rendered by Mr. Colebrook during the last forty years. During this time he has made us all his debtors on account of his industry, his good temper, his willingness and desire to help, and, above all, by his consummate skill as a craftsman.

"When I see now the magnificent collection of tools which in the present century has grown up under his guidance, and contrast it with the meagre equipment of my time, I feel that the early history of the workshop—which no one else but myself can give—and of the introduction of Mr. Colebrook is of sufficient general interest for me to recount.

"About the year 1873, Prof. Guthrie made out an order for a small general purpose lathe, but this order was stopped when it got to the museum, and the official answer, put colloquially, was—'Lathe? What can you possibly want with a lathe in a physical laboratory? If you have anything which you want to be turned, let us have it and we will get it turned in the museum workshop.' Well, Prof. Guthrie was Scotch and very persistent, and General Festing, R.E., the engineer in charge of the museum and workshops, was a delightful, genial, and jovial friend of all who came his way. The result was, skipping intermediate steps, that a little 4-inch Cotton and Johnson lathe was acquired, and, though a poor little thing, it was in constant use and proved itself invaluable.

"Coming now to the second chapter, about the year 1890, Prof. Rücker and I felt that we must have something better, and it was left to me to select a suitable lathe, but with the strictest attention to cost. There was very little money, and we did not want to draw a second refusal similar to the first. I selected what I considered the best possible lathe for physical laboratory requirements that was not too expensive. This was the Barnes $5\frac{1}{2}$-inch centre lathe, and after forty years I still consider that I could not have done better. I got the identical lathe for myself a few years later, and this is all I have for my own use to the present day. It may be interesting to state that when Prof. Mendenhall came to see me, he said—'Why, that is the lathe on which Rowland cut his famous screw—the screw of his diffraction grating machine'.

"Having now a suitable lathe, it was essential that there should be a skilled mechanic to use it and to protect it from misuse, and again I was asked to find him. I heard of Mr. Colebrook, and got him to come for a preliminary discussion. I asked him to do something with the new lathe and with a file, and, being a bit of a mechanic myself, I saw with half an eye that his handling of these tools showed him to be a skilled craftsman.

"This was the time when I was preparing my apparatus for weighing the earth, which I did at Oxford. The main apparatus was made by the Cambridge Scientific Instrument Co., but much had to be done besides, and this construction was done partly by Colebrook (I must now drop the Mr.) and partly by myself. It was then that I learned to appreciate not only Colebrook's skill but also his conscientious devotion to the work. About the same time I was photographing bullets, and I required a very perfect revolving mirror to analyse the sparks that I used in order to get one bright enough, small enough, and of short enough duration so that the bullet should not travel more than $\frac{1}{500}$ inch while it was being photographed. I designed this to be made in dead-hard tool steel. Colebrook made it to perfection, and it was figured by Hilger. We ran this at 500 revolutions per second for ordinary use, but we did run it up to 1500 revolutions per second, at which it ran well. This is nearly twice the speed at which Foucault ran his mirror when determining the velocity of light, and my mirror would have shown the time taken by light to traverse the length of this lecture table. It was to Colebrook that I owed the success of this mirror."

A New Method of Measuring High Frequency Voltages.

IN the *Elektrotechnische Zeitschrift* for Aug. 13, L. Pungs and H. Vogler describe a new electro-optical method of measuring voltages of very high frequencies. In practice, some type of electrometer is generally employed, but with very high frequencies its readings are untrustworthy. The authors made a test on a good electrometer of a type usually employed, and found that up to one and a half million cycles per second it gave accurate and consistent results, but at twelve million cycles its readings were incorrect by errors lying between thirty and forty per cent. As these instruments are largely used in radio work for making investigations on the dielectric behaviour of insulating materials, it was necessary to find the cause of the inaccuracies and either correct their design or try to invent a new method. The errors of the instrument were found to be mainly due to the fact that its capacitance varied with its deflexion, for this led to resonance effects which made the readings quite irregular.

The authors have found a practical solution applicable to many cases. They utilise the well-known Kerr effect in electro-optics, which has been studied carefully by many physicists. The physical basis of their method is to use a monochromatic source of light, a Nicol's prism as polariser, a cell containing nitrobenzene subjected to electric stress between two parallel metal plates, maintained at the voltage to be measured, and a second Nicol's prism as analyser. The field of view is first extinguished by crossing the prisms when the voltage is not applied. On applying the voltage, light comes through owing to the Kerr effect. If the voltage be alternating, the intensity of the light is a periodic function of the time.

The authors obtain a mathematical formula for the mean intensity of the light passing through, showing that, on the supposition that there is no inertia effect, it is independent of the frequency of the alternating voltage. Making sine wave assumptions also, they prove that it is proportional to the maximum value of the electrostatic field. With the help of tables of Bessel's functions they calculate the maximum voltage, which can be found in terms of the mean light intensity. Since the mean light intensity is independent of the frequency, the instrument can be calibrated with low frequency voltage.

The main difficulties that had to be overcome in connexion with the method are, first, that the Kerr constant varies very appreciably with temperature. Hence unless the temperature remains constant it has to be measured and a correction applied. The calibration also depends on the intensity of the source of light; it is therefore necessary to specify accurately the source of the light. The calibration is only accurate for light of a definite wave-length. The authors, therefore, were led to develop a comparison method which enables a higher accuracy to be obtained.

In this method the Kerr arrangement is adjusted so that the field is dark with zero voltage, a photoelectric cell being employed. The voltage is then applied to the Kerr cell, and the illumination of a second photoelectric cell is adjusted to a balance by

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