The Open Court

A MONTHLY MAGAZINE

Devoted to the Science of Religion, the Religion of Science, and the Extension of the Religious Parliament Idea

Founded by Edward C. Hegeler.

VOL. XXX. (No. 2) FEBRUARY, 1916 NO. 717

CONTENTS:

The Open Court Publishing Company

CHICAGO

Per copy, 10 cents (sixpence). Yearly, $1.00 (in the U.P.U., 5s. 6d.).

Entered as Second-Class Matter March 26, 1897, at the Post Office at Chicago, Ill., under Act of March 3, 1879

The Open Court

A MONTHLY MAGAZINE

Devoted to the Science of Religion, the Religion of Science, and the Extension of the Religious Parliament Idea

Founded by Edward C. Hegeler.

VOL. XXX. (No. 2) FEBRUARY, 1916 NO. 717

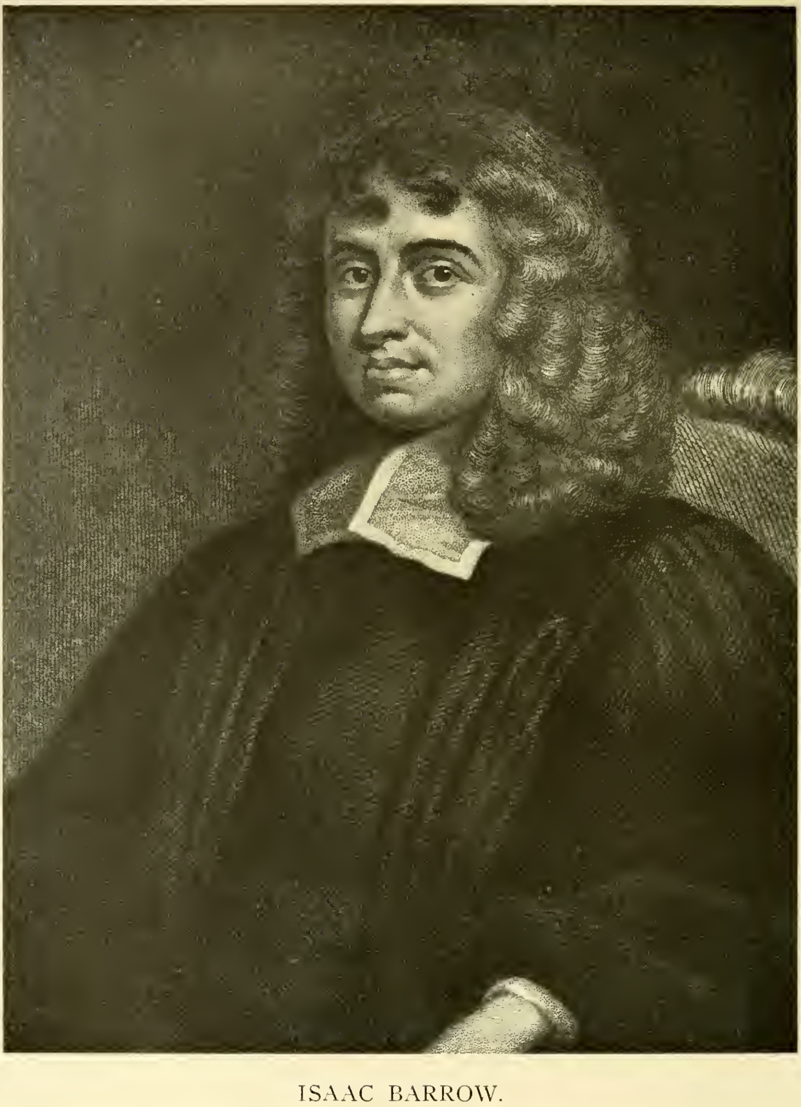
CONTENTS:

The Open Court Publishing Company

CHICAGO

Per copy, 10 cents (sixpence). Yearly, $1.00 (in the U.P.U., 5s. 6d.).

Entered as Second-Class Matter March 26, 1897, at the Post Office at Chicago, Ill., under Act of March 3, 1879



ISAAC BARROW.

Frontispiece to The Open Court.

THE OPEN COURT

A MONTHLY MAGAZINE

Devoted to the Science of Religion, the Religion of Science, and the Extension of the Religious Parliament Idea.

VOL. XXX (No. 2) FEBRUARY, 1916 NO. 717

ISAAC BARROW: THE DRAWER OF TANGENTS.

BY J. M. CHILD.

ISAAC BARROW was born in 1630, the son of a linen-draper in London. He was first sent to the Charter-house school, where inattention and a predilection for fighting created a bad impression. One reads in Rouse Ball's *Short Account of the History of Mathematics*:[1] "At Charterhouse, Barrow was so troublesome that his father was heard to pray that if it pleased God to take any of his children, he could best spare Isaac." Later he seems to have turned over a new leaf, and in 1643 we find him entered at St. Peter's College, and afterwards at Trinity College, Cambridge. He had now become exceedingly studious, and he made considerable progress in literature, natural philosophy, anatomy, botany, and chemistry,—the latter with a view to medicine as a profession,—and later, chronology, geometry and astronomy. He then proceeded on a sort of "Grand Tour," through France, Italy, to Smyrna, Constantinople, back to Venice, and then home through Germany and Holland. His stay in Constantinople had a great influence on his after life; for he there studied the works of Chrysostom, and thus had his thoughts turned to divinity. But for this his undoubtedly great advance on the work of his predecessors in the matter of the infinitesimal calculus might have been developed to such an extent that the name of Barrow would have been inscribed on the roll of the world's famous mathematicians as at least the equal of his mighty pupil.

Immediately on his return to England he was ordained, and a year later, at the age of thirty, he was appointed to the Greek professorship at Cambridge, his inaugural lectures being on the *Rhetoric* of Aristotle, a choice of subject which also had a distinct effect on his later mathematical work.

[1] Fourth edition, 1908, p. 309.

In 1662, two years later, he was chosen as professor of geometry in Gresham College, and in the following year he was elected to the Lucasian chair of mathematics, just founded at Cambridge. This professorship he held for five years, and his office created the occasion for his *Mathematical Lectures,* which were delivered in the years 1664-66, and published in 1670.

It was in 1664 that he came into really close contact with Newton; for in that year he examined Newton in Euclid, as one of the subjects for a mathematical scholarship at Trinity College, of which Newton had been a subsizar for three years; and it was owing to Barrow's report that Newton was led to study the *Elements* more carefully and to form a better estimate of their value. The connection thus started must have developed at a great pace, for not only does Barrow secure the succession of Newton to the Lucasian chair, which Barrow relinquished in 1669, but he commits the publication of the *Lectiones Opticae* and the *Lectiones Geometricae,*[2] which were published together, to the foster care of Newton and Collins. He himself had now determined to devote himself entirely to divinity, and in 1670 he was created a doctor of divinity, in 1672 he succeeded Dr. Pearson as Master of Trinity College, in 1675 he was chosen as vice-chancellor of the university. In 1677 he died, and was buried in Westminster Abbey, where a monument, surmounted by his bust, was soon afterwards erected by the contributions of his friends.

The writer of the unsigned article, "Isaac Barrow," in the *Encyclopaedia Britannica,* from which most of the above facts have been taken, states:

"By his English contemporaries Barrow was considered a mathematician second only to Newton. Continental writers do not place him so high, and their judgment is probably the more correct one."

I have recently had occasion to study the *Lectiones Geometricae,* perhaps the only one of Barrow's voluminous works that is of really great historical interest; and I fail to see the reasonableness of the remark in italics. Of course it was only natural that contemporary continental mathematicians should belittle Barrow, since they claimed for Fermat and Leibniz the invention of the infinitesimal calculus before Newton, and did not wish to have to consider an even prior claimant. We see that his own countrymen placed him on a very high level; and surely the only way to obtain a really adequate opinion of a scientist's worth is to accept the unbiased opinion that

[2] An article by the present writer on "The 'Lectiones Geometricae' of Isaac Barrow" will appear in *The Monist* of April next.

has been expressed by his contemporaries, who were aware of all the facts and conditions of the case; or, failing that, to try to form an unbiased opinion for ourselves by putting ourselves in the position of one of his contemporaries. Most modern criticism of ancient writers fails because the critic himself is usually a man of great ability, and compares, perhaps unconsciously, their discoveries with facts that are now common knowledge to himself and others of his attainments; instead of considering only the advance made beyond what was then common knowledge to his antetypes. Thus the designers of the wonderful electric machines of to-day are but as pigmies compared with such giants as Faraday.

Further, in the case of Barrow there are several other things to be taken into account. We must consider his disposition, his training, his changes of intention with regard to a career, the accident of his connection with such a man as Newton, the circumstances brought about by the work of his immediate predecessors, and the ripeness of the time for his discoveries. His disposition was pugnacious, though not without a touch of humor; he sets out with the one expressed intention of simplifying and generalizing the existing methods of drawing tangents to curves of all kinds; and there is distinct humor in his glee at "wiping the eye" of some other geometer whose solution of some particular problem he has not only simplified but generalized. Remembering too that these were lectures delivered in his capacity as professor, one can almost imagine the proud, though more or less repressed, chuckle that accompanied:

"Gregory a St. Vincent gave this, but proved (if I remember rightly) with wearisome prolixity."

"Hence it follows immediately that all curves of this kind are touched at any one point by one straight line only......Euclid proved this as a special case for the circle, Apollonius for the conic sections, and other people in the case of other curves."

This comparison of himself with the giants of ancient days may by some be considered to be conceit on the part of Barrow, but I think it is only the glee, part and parcel of the man, who has accomplished the end he had in view. "I've done it; I've got 'em beat to a frazzle," or the equivalent to this in the best Aristotelian Greek, Ciceronian Latin, or the ponderous English of his Sermons.

His early training was promiscuous and could have had no other effect than to have fostered an inclination to leave others to finish what he had begun. One can imagine the man, satisfied at solving a problem, and not caring "tuppence" whether any one saw or even knew of his solution; resembling somewhat in this respect that other eminent mathematician, Fermat, with his: "I have just discovered the following most beautiful and remarkable property of numbers; if you wish to see the proof I will send it to you." His Greek professorship and his study of Aristotle would tend to make him a confirmed geometer, reveling in the "elegant solution" and more or less despising Cartesian analysis because of its then (frequently) cumbersome work, and using it only with certain qualms of doubt as to its absolute rigor. For instance he almost apologizes for inserting, at the very end of Lecture X, which is the finish of his work on the drawing of tangents, his "*a* and *e*" method,—the prototype of the "*h* and *k*" method of the ordinary beginners' text-book of to-day—with the words:

"We have now to some extent finished what we suggested was to be the first part of our subject. To this, in the form of supplements or appendices, we will add a method for finding tangents by calculation, frequently used by us" [*a nobis usitatus,* the last word meaning customary or familiar; the only other occasion in which Barrow uses this word in the book is to designate things that are well-known or familiar facts]; "although I hardly know, after giving so many well-known and well-worn methods of the kind above, whether there is any advantage in doing so. But I do so on the advice of a friend, and all the more willingly because it seems to be more profitable and general than the others which I have discussed."

The word "familiar" should be noted, showing that Barrow was in possession of a method which he probably used continually, as a clue to finding out his general constructions for tangents; indeed it is not beyond the bounds of probability to assume that this method was the source from which he got all his constructions in the first place; and yet it was a method which he thought little of in comparison with the more rigorous demonstrations of pure geometry. Nevertheless the last paragraph allows that it is more general than anything that he has already given. Note the implied sneer in the words "by calculation"; Barrow allows himself the same latitude when alluding to the work of Wallis: "deduced by calculation, and verified by a kind of induction, yet not anywhere proved geometrically, as far as I am aware." The friend was undoubtedly Newton.

Another light is thrown on the matter of Cartesian geometry, or rather the application of it, by lecture VI; in this, for the sake of establishing lemmas to be used later, Barrow gives fairly lengthy proofs that

$$\text{(i)}\quad my \pm xy = mx^2/b\,;\quad \text{and}\quad \text{(ii)}\quad \pm yx + gx - my = mx^2/r$$

represent hyperbolas, instead of merely stating the fact on account of the factorizing of

$$mx^2/b \pm xy,\ \ mx^2/r \pm xy.$$

The lengthiness of these proofs is to a great extent due to the fact that, although the appearance of the work is algebraical, the reasoning is almost purely geometrical. It is also to be noticed that the index notation is not used except where it is quite unavoidable, although Wallis had used even fractional indices a dozen years before. In a later lecture we have the truly terrifying equation

$$(rrkk - rrff + 2fmpa)/kk = (rrmm + 2fmpa)/kk.$$

From the above it is quite easy to see a reason why Barrow should not have turned his work to a greater account; but in estimating his genius one must make all allowance for this disability in, or dislike for, algebraic geometry, read into his work what could have been got out of it, and not stop short at what was actually published. Chiefly must it be remembered that these old geometers could use their geometrical facts far more readily than many mathematicians of the present day can use their analysis.

As has been stated, Barrow's published works were voluminous; his mathematical works were written in Latin, and have been edited by Whewell (Cambridge, 1860); his works in English have been published in four quarto volumes.