

III.

NOTES ON CLOCK AND WATCH MAKING ; WITH DESCRIPTIONS OF
SEVERAL ANTIQUE TIMEKEEPERS DEPOSITED IN THE MUSEUM.
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In man's first and pure estate he measured his day by only two epochs, the morning and the evening. But he soon saw that the shadow cast on the surface of the earth from a fixed body moved in obedience to the apparent motion of the sun ; and so the dial of Ahaz became the first chronometer, and the day was measured into hours. Through a long series of centuries the necessity for a more accurate mode of measurement was not felt, and therefore not attained. The varying positions, however, of the planets to the fixed stars must, at an early period, have attracted the attention of man, and his insatiable curiosity must have urged him to note their "times and seasons."

For this purpose it has, with considerable ingenuity, been maintained that Stonehenge was used as a grand Orrery by the Druids;¹ and as Cæsar, in his Commentaries,² states, that when he landed in Britain he found Clepsdræ; those ancient astronomers may have been enabled to ascertain their time to within an hour, when they were deprived by night of the indications of the sun-dial. Old Nehemiah Grew, in his "Cosmologia Sacra, or a Discourse of the Universe as it is the Creature and

¹ See Dr John Smith's "Choir-Gaur," published at Salisbury 1771.

² Lib. v. 13.

Kingdom of God," has given a quaint description of the progress of horology. He says—"The first conceit tending to a watch was a draw-well; for people of old were wont only to let down a pitcher with a hand-cord for as much water as they easily could pull up. But meeting with some deep wells put them on thinking of a draught-wheel; and seeing the pitcher or bucket to descend with its own weight, they perceived the movement applicable to a spit, if the motion of the weight could be made slow, which was done by adding more wheels and the flyer, which made a jack. Upon which men began to see that if the motion were yet slower, it would serve to measure time as well as turn a spit; and so in the room of the flyer put the ballance, which makes a clock; which being so useful, thinking men considered how it might be made portable by some means answerable to a weight, and so instead of that put the spring and fusee wheel, which made a watch." We do not know (for the history of science is silent on the subject) to whom we owe the invention of the fusee of the watch. This at least is certain, that Robert Hooke was the first to announce that the force of the spring is as its angular distance from its position of rest. It seems, indeed, from his posthumous works, edited by Waller (whose copy I possess), that Hooke, as early as 1656, had, under the form of an anagram,¹ expressed the law *Ut pondus sic tensio*. I have therefore little doubt that to Hooke we owe the invention of the fusee, one of the most beautiful of the many contrivances required to make a perfect timekeeper.

In 1370 Charles V. of France had a large turret-clock put up at his palace in Paris. It was made by Henry Vick, a native of Germany. This clock had no pendulum, but was regulated by a horizontal bar (the equivalent of the balance of a watch), having a series of notches placed on each arm equidistant from the centre. Into these notches, by means of hooks, were hung two weights. If the clock went slow, each weight was shifted one notch towards the centre; and if fast, removed further from it. I have placed in the Museum a specimen of such a clock made about the year 1500, where, instead of the regulating notches, the time was kept by increasing or diminishing the force of the

¹ CDEIINNOOPSSSTTUU. Waller, who was his friend and understood his stenography, gives the above as the interpretation; but the context, even without his guidance, would lead us to infer the meaning.

mainspring. In Vick's turret-clock the regulation could only be accomplished by shifting the weights on the bar, as it had no mainspring, but was moved by the force of gravity.

For upwards of two hundred and fifty years this rude method of regulating clocks prevailed, until the accidental discovery of Galileo made precision possible. As the story goes, his mother had taken him to the Cathedral of Pisa, to vespers, one evening; but the choir and the prayers of the priest had on that occasion no interest for Galileo. From the high fretted roof swung a lamp, swayed to and fro by the wind, or the incautious hand that had lit it. The youthful Galileo was struck by the equality of the oscillations, and, placing his fingers on his pulse, found that the vibrations of the lamp were performed in unison with the pulsations; and also, he discovered, that the vibrations, when at their greatest extent, were performed in precisely the same interval of time as when they had nearly ceased to vibrate. On that night of unheeded prayer, Galileo had discovered the principle of the pendulum, and, with a sagacity rare at his years, he applied a weight to a cord of such a length that, when made to vibrate, it performed its oscillations in equal times with the beatings of his pulse. This instrument he called a *pulsilogas*; and as watches were not then in use, Galileo's string, measured into degrees, and with its weight attached, became, even in his youth, an aid to the physicians of Pisa. But he carried his discovery further, and was the first to apply a pendulum to a clock, by which it became the perfect instrument we now possess. At Florence I had the pleasure of seeing an original drawing of this instrument, placed beside his first telescope, in the magnificent Tribuna erected by the late Duke of Tuscany to the memory of Galileo. Nor was I less interested in the lamp in the Cathedral at Pisa, but found, on a careful examination, much to my disappointment, that from its style it must have been made after the great Tuscan's death.

The next great inventor and improver of the science of horology was Hooke. In the year 1658 he invented the balance-spring, an improvement of the first importance in the art of timekeeping. Before this most admirable invention, watches were regulated by increasing or diminishing the force of the mainspring by means of a wheel and endless screw attached to the spindle, which carried the cylinder, or, as it is technically called, the mainspring box. Examples of watches made before

this time I have deposited in the Museum. In each of them may be seen the endless screw and wheel applied to the arbor or spindle of the mainspring, by which its force was increased or relaxed. Immediately after the invention of the balance-spring by Hooke, it was found that as the watches to which the spring was adapted kept so much more accurate time than those formerly made, it became desirable to divide the hour into more minute portions, and so the motion work was invented and the minute-hand applied. In the year 1675 a watch was presented to King Charles II., bearing the inscription, "Robert Hooke, invenit; T. Tompion, fecit, 1675." This watch, I have no doubt, had a minute-hand, and fixes very nearly the date when this improvement was invented. It had the balance-spring and double balance, with a duplex escapement, also Hooke's invention, fifteen years before this period.

Hooke's duplex escapement is certainly one of the most beautiful of any of those yet applied to watches, except Earnshaw's marine chronometer, and, for pocket use, as accurate. For this invention Hooke applied for a patent, under the patronage of Lord Brouncker, Sir Robert Moray, and the Honourable Mr Boyle; and an agreement drawn up in Sir Robert Moray's handwriting is flattering to Hooke. This document states, "that Robert Hooke should discover to them the whole of his invention to measure the points of time at sea as exactly and truly as they are at land by the pendulum clocks invented by Mr Hugen's: that of the profit to be made thereby, not exceeding £6000, Robert Hooke was to have three-fourths: of whatever was made more of it, not exceeding £4000, Robert Hooke was to have two-thirds; of the rest, if more could be made of it, he was to have one half, and Robert Hooke to be publicly owned the author and inventor thereof." In this agreement Hooke is styled Master of Arts, proving that it could not have been drawn up prior to 1633, when that honour was conferred on him at Oxford by the patronage of Sir Edward Hyde, then Chancellor of that University. This scheme, which promised so much profit to the inventor and his friends, proved a failure, more perhaps through Hooke's constitutional irascibility than any want of faith in the invention. "Their treaty," says he, "with me, had finally been concluded for several thousand pounds, had not the inserting of one clause broke it off, which was—that if, after I had discovered my invention about the finding the lon-

gitude by watches or otherwise, they, or any other persons, should find a way of improving my principles, he or they should have the benefit thereof during the term of the patent, and not I. To which clause I could noways agree, knowing it was easy to vary my principles an hundred ways, and it was not improbable but that there might be made some addition of conveniency to what I should at first discover, it being *facile inventis addere*." Had Hooke foreseen that his duplex escapement would stand the test of upwards of two hundred years' experience, he would have closed with this agreement, and no doubt would have gained the prize of 100,000 florins offered by the States of Holland for ascertaining the longitude at sea. He might also have obtained some Government aid through the interest of Lord Brouncker and Sir Robert Moray, which afterwards, in the reign of Queen Anne, was proffered for the same object, to the amount of £20,000. After this disappointment Hooke concealed his invention of the duplex escapement for many years, as much, perhaps from the difficulty of obtaining correctness of workmanship as from chagrin. In 1660 he invented the wheel-cutting engine, without which Tompion could not have undertaken the manufacture of the watch presented to King Charles.

Before Hooke invented this engine, the art of watchmaking was by no means accurate. Every wheel had to be divided by compasses, and each tooth cut with files, the accuracy being mainly dependent on the eye of the artist; and as the smaller wheels were more difficult to divide and cut, we see at once the cause of the large size of the watches of the seventeenth century. Hooke's ingenuity contrived to divide a large disc, with the various numbers required for each wheel. To this disc he adapted a spindle supported on four pillars. To the spindle the wheels to be cut were fixed, and by means of a frame moving up and down, in which was placed a circular cutter, rotating with considerable velocity, he divided and cut the wheels at the same time, and also gave the proper cycloidal curve to each tooth by the shape of the cutter. By this method precision was insured, and rapidity of execution obtained; and it is worthy of note that no material change has been made on this machine from its invention in 1660 until now. The only improvement applied to the cutting engine of Hooke was made by Earnshaw, the celebrated inventor of the chronometer, about the end of the last cen-

tury.¹ It consists of a slide by which the rotating cutter is let down in a perpendicular plane. By this means the top and bottom of each tooth was straight and at right angles to the wheel; while in Hooke's they were curved as his frame moved in the arc of a circle. Hooke, nevertheless, has the credit of adapting the endless screw to the periphery of the disc, and thus paved the way for Ramsden, who obtained a Government grant for his machine for accurately dividing astronomical instruments.

The cutting engine very shortly revolutionised the art of clock and watchmaking. It was an expensive tool, and most watchmakers could not afford its cost; and so the cutting of wheels became a separate branch of the manufacture of watches. This was the first step towards the division of labour, by which accuracy and cheapness have been obtained. In the great seats of the manufacture of watches—London, Liverpool, and Coventry—this subdivision of labour was very soon carried to such an extent that no one engaged in the trade could singly make a watch. In Scotland this subdivision never obtained, and therefore the manufacture of watches ceased about the middle of the eighteenth century. But the Scottish workmen derived many advantages from this cause, as every one was trained to make every part of a watch, a practice still followed by all well-educated watchmakers.

The following are the watches which I now for preservation deposit in the Museum of the Society:—

The first of these was made by Paul Romeiu, and is a fine example of Scotch manufacture. It must have been made between 1670 and 1693, as he died in the latter year. The case is not stamped, so the exact date cannot be obtained. Paul Romeiu was a Frenchman, and was among the first watchmakers in Edinburgh. He resided in the West

¹ Earnshaw was decidedly the most ingenious artist of his time, and his marine chronometer, for which he was rewarded by Government, has not yet been improved. He was, however, most pompous and vain. While exhibiting his chronometer to the late Duke of York, Earnshaw imagined that his Royal Highness did not pay^d him that amount of deference which he deemed due to one who had invented the means of discovering the longitude. Before leaving the Duke he informed his Highness that he considered himself the greater man of the two, as he was Marquis of Latitude, Duke of Longitude, and Tom King of the Clockmakers.

Bow, where his house was distinguished by a globe, which, in its rotation, pointed the hours.

The Nuremberg egg watch was made about the year 1600. It has neither chain nor balance-spring—a piece of fine catgut supplying the former. This watch was regulated by increasing or diminishing the power of the mainspring by means of a wheel and endless screw. The dial shows hours, the days of the month and week, with the appropriate signs; also the moon's age and time of high water. Within the circle showing the day of the month is a representation of the Last Supper engraved on silver. The maker's name is Bouguet, Londini. It was bought at an auction in New York by the present Earl of Dalhousie, for four dollars, and presented by his Lordship to the late Robert Bryson.

The silver watch, No. 3, was made by Richard Wise about 1680. It has a balance-spring and regulator. Below the balance is engraved *Tempus fugit*.

The gilt Nuremberg egg watch, No. 4, was made by Michael Nouen in 1611. It is said to have been in the possession of Sir Walter Raleigh, but it bears the arms of Briscoe.

No. 5 is a fine specimen of a clock-repeating watch, by James Reith, Versailles. It strikes the hours, and also repeats hours and quarters. It was made about the latter end of the seventeenth century.

No. 6 is a cruciform gilt watch, made about 1600 by Hugues Pilard-Aollonge. It was long in the possession of the Strathallan family.

No. 7 is a melon-shaped gilt watch, made at Rouen by David du Chemin. It has no balance-spring, and has catgut instead of a chain. It was long in the possession of the Drummonds of Hawthornden, and is believed to have been the watch worn by the poet.

MONDAY, 21st May 1860.

PROFESSOR J. Y. SIMPSON, M.D., Vice-President, in the Chair.

The following Gentlemen were balloted for, and elected Fellows of the Society :—

WILLIAM EDWARD HOPE VERE, of Craigiehall, Esq., Linlithgowshire.

JAMES NEISH, of the Laws and Omachie, Esq., Forfarshire.

Mr DAVID LAING begged to call special attention to the loss which the Society has recently sustained by the decease of two of the Members. The first was WILLIAM WARING HAY, Esq., afterwards W. W. HAY NEWTON of Newton, Esq., one of the oldest Fellows of the Society, having been elected in the year 1814. He was a frequent benefactor to the Museum, and had formerly devoted considerable time in the rearrangement of its coins, being himself distinguished for his extensive and accurate numismatic knowledge. He had also filled the office of a Vice-President. The other was ALEXANDER CHRISTIE, Esq., A.R.S.A., and Director of the Department of Ornament in the School of Art, Edinburgh. He became a Fellow of this Society in 1848, and had in several capacities acted as one of its office-bearers. He died in the prime of life, aged 53.

Mr JOHN STUART reported that the circular to the Schoolmasters of Scotland, prepared by the Society, regarding objects of archaeological and historical interest, was ready for distribution, and called attention to the donation now announced of a collection of stone implements from Mr Gibb, schoolmaster at Aldbar in Forfarshire, as an earnest of the result which might be expected from the Society's appeal, and as an evidence of what might be accomplished by well-directed efforts. Mr Gibb has for some years collected, through the instrumentality of his pupils, any accessible objects of antiquity in his own neighbourhood, and had now presented to our National Museum a selection made by the Secretary. The meeting highly approved of this admirable method of training the young to observe and collect relics, which are so frequently lost from mere carelessness, and directed that their best thanks should be returned to Mr Gibb for his donation.

The Donations to the Museum and Library were as follows:—

Stone Hammer, 3 inches in length, with perforation, 1 inch in diameter, through the centre; and an oval-shaped stone, 4 inches long, and $3\frac{1}{2}$ inches diameter; found in Forfarshire;

Two large flat stone knives, about 9 inches long, by 5 inches in breadth, and $\frac{3}{8}$ ths of an inch in thickness; tapering to a sharp edge round the margin; found in Shetland;

Two Stone Whorles; one 1 inch in diameter, and rudely ornamented with small punctures; the other $1\frac{1}{4}$ inch in diameter, ornamented with lines;

Flint Arrow-Head with barbs, $1\frac{1}{4}$ inch in length; found in Forfarshire.

By Mr GIBB, schoolmaster, Aldbar.

Portion of a Clay Urn, ornamented with short perpendicular and transverse lines, found in 1823 on the banks of the River Almond, near Clifton Hall;

Small portion of Chain Armour, found in forming the Glasgow Road on the estate of Old Liston, eight miles west from Edinburgh.

By JOHN MAITLAND, Esq., Accountant to the Court of Session.

Marble Turkish Tombstone, 3 feet long, $4\frac{1}{2}$ inches square, with turban on top, inscription on side, and pointed below for insertion in ground; from Bicos, on the Bosphorus. By the Rev. DAVID ARNOT, D.D., one of the Ministers of the High Church, Edinburgh.

The inscription, which is in the Persian language, but in Turkish character, has been thus translated by Major Othman Nouri, of the Turkish service:—

Like a bulbul he has ascended,

To the grief of his mother:

Pray for mercy to him

The letters of whose name, Ali, tell the date of his death.

(H. 1140; A.D. 1720.)

Stone found under the pavement in Young Street, measuring 3 feet by 2 feet 4 inches, on which is sculptured, on an ornamented panel (Elizabethan style) two winged figures supporting a shield displaying armorial bearings; a bend dexter, on which is a crescent between two mullets; surmounted by the helmet of an Esquire. By THOMAS STEVENSON, Esq., C.E., F.S.A. Scot.

Sword Dollar, or Thirty-shilling Piece, of James VI. By HALL PRINGLE, Esq., Largo.

Shell of a Turtle, on which apparently a coat of arms had been painted.

Iron Cannon Ball, 2 inches in diameter, with the stone in which it had been found embedded.

Stone Celt, 2 inches across face, polished at the end.

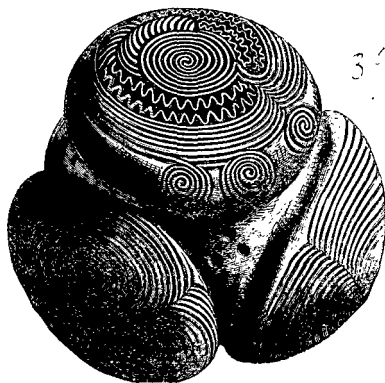
Boar's Tusk, 8 inches long, and portions of a large unornamented cinerary baked clay urn in which it was found. From Rathen, Aberdeenshire.

Marble Head, apparently the portion of a statue of Budha, 7 inches high, considerably weathered.

Gold St Andrew of James I., and the Gold Lion of James II. of Scotland. These coins formed portion of a hoard (treasure trove) found in August 1815, near the ruins of the Castle of Cadder, in the county of Lanark.

By the COUNCIL OF THE ROYAL SOCIETY OF EDINBURGH.

Stone Ball, $2\frac{1}{2}$ inches diameter, with four rounded projections, three of which are ornamented with different incised patterns; the fourth being smooth, or without any pattern (see woodcut); it was found in digging a drain several feet under ground, on the Glass Hill, or Gray Hill, parish of Towie, Aberdeenshire. By Mr JAMES KESSON, farmer, Upper Drummellachay; through the Rev. John Christie, Kildrummy.



On the Glasshill many ancient remains have been found, such as stone cups, &c. On the hill and in the neighbourhood are several large tumuli.

Burmese Manuscript Book, on palm leaves, with wooden boards. The leaves are 20 inches long by $2\frac{1}{2}$ inches broad, and are partially gilt on the edges, the boards being also ornamented with a pattern in gold.

Pair of Wooden Boards of another MS. Book, ornamented red and gold.

Three Burmese Manuscript Books on paper.

By Mrs BOYD, 16 London Street.

Various Bone Implements, consisting of pins, barbed fishing hooks, &c., from Davis Straits. By ALEXANDER BRUCE, Esq., S.S.C.

Gutta Percha Cast of an inscription on a bronze tripod vessel found near Hexham. By W. D. FAIRLESS, M.D., Montrose.

Account of the Cathedral of Throndeim. Folio; plates. The text by Professor P. A. Münch. Published by order of the Norwegian Government. Christiania, 1859.

Karlamagnus Saga ok Kappa Hans. 8vo. Christiania, 1859.

Den Norske Kirkes Historie under Katholicismen af R. Keyser, Professor ved Universitetet i Christiania. 4 vols. 8vo. Christiania, 1856-58.

Foreningen til Norske Fortidsmindesmerkers Bevaring. Royal 8vo and 8vo. Christiania, 1850-59.

Norges Historie I Kortfattel Udtog af P. A. Münch. 8vo. Christiania, 1858.

By the ROYAL UNIVERSITY, CHRISTIANIA, NORWAY.

Nordiske Oldsager i det Kongelige Museum i Kjöbenhavn ordnede og forklarede af J. J. A. Worsaae. Royal 8vo. Copenhagen, 1859. By J. J. A. WORSAAE (the author), Copenhagen.

The Sick-bed of Cuchulainn; quoted from the Yellow Book of Slane. 8vo pamphlet (pp. 60). Dublin, 1858. By EUGENE O'CURRY, Esq., M.R.I.A., Corr. Mem. S.A. Scot.

The following Communications were read:—