Annual Report of the Superintendent of Public Instruction of the State of Michigan for the year 1881; *Reports of the Geological Survey of the State of Michigan*, 1869–80, 4 vols.; *Special Report of Commissioner of Mineral Statistics*, March 1883; *Forestry Bulletins* for 1881. (C. K. A.)

MICHIGAN, LAKE. See ST LAWRENCE.

MICHIGAN CITY, a town of the United States, in Laporte county, Indiana, on the south-east shore of Lake Michigan, 40 miles east-south-east of Chicago. As a lake-port and a junction for several railroads, it is a place of considerable prosperity. It is the largest lumber-market in the State, and one of the largest in the west, and has numerous manufacturing establishments. The northern State prison (with 577 convicts at the close of 1880) is one of the principal buildings. The population increased from 3985 in 1870 to over 10,000 in 1883.

MICHMASH (מִכְמָשׂ, מִכְמָס), the scene of one of the most striking episodes in Old Testament history (1 Sam. xiv., comp. vol. xii. p. 403), was a place in Benjamin, about 9 Roman miles north of Jerusalem (*Onom.*, ed. Lag., p. 280). Though it did not rank as a city (Josh. xviii. 21 *sq.*), Michmash was recolonized after the exile (Neh. xi. 31), and, favoured by the possession of excellent wheat-land (*Mishna*, Men. viii. 1), was still a very large village (Μαχμάς) in the time of Eusebius. The modern Makhmás is quite a small place.

The historical interest of Michmash is connected with the strategical importance of the position, commanding the north side of the Pass of Michmash, which made it the headquarters of the Philistines and the centre of their forays in their attempt to quell the first rising under Saul, as it was also at a later date the headquarters of Jonathan the Hasmonæan (1 Mac. ix. 73). From Jerusalem to Mount Ephraim there are two main routes. The present caravan road keeps the high ground to the west near the watershed, and avoids the Pass of Michmash altogether. But another route, the importance of which in antiquity may be judged of from Isa. x. 28 *sq.*, led southwards from Ai over an undulating plateau to Michmash. Thus far the road is easy, but at Michmash it descends into a very steep and rough valley, which has to be crossed before reascending to Geba.[1] At the bottom of the valley is the Pass of Michmash, a noble gorge with precipitous craggy sides. On the north the crag is crowned by a sort of plateau sloping backwards into a round-topped hill. This little plateau, about a mile east of the present village of Makhmás, seems to have been the post of the Philistines, lying close to the centre of the insurrection, yet possessing unusually good communication with their establishments on Mount Ephraim by way of Ai and Bethel, and at the same time commanding the routes leading down to the Jordan from Ai and from Michmash itself.

MICKIEWICZ, ADAM (1798–1855), Polish poet, was born in 1798, near Nowogrodek, in the present government of Minsk, where his father, who belonged to the schlachta or lesser nobility, had a small property. The poet was educated at the university of Vilna; but, becoming involved in some political troubles there, he was forced to terminate his studies abruptly, and was ordered to live for a time in Russia. He had already published two small volumes of miscellaneous poetry at Vilna, which had been favourably received by the Slavonic public, and on his arrival at St Petersburg he found himself admitted to the leading literary circles, where he was a great favourite both from his agreeable manners and his extraordinary talent of improvisation. In 1825 he visited the Crimea, which inspired a collection of sonnets in which we may admire both the elegance of the rhythm and the rich Oriental colouring. The most beautiful are *The Storm*, *Bakchi-serai*, and *Grave of the Countess Potocka*.

In 1828 appeared his *Konrad Wallenrod*, a narrative poem describing the battles of knights of the Teutonic order with the heathen Lithuanians. Here, under a thin veil, Mickiewicz represented the sanguinary passages of arms and burning hatred which had characterized the long feuds of the Russians and Poles. The objects of the poem, although evident to many, escaped the Russian censors, and it was suffered to appear, although the very motto, taken from Machiavelli, was significant: "Dovete adunque sapere come sono duo generazioni da combattere . . . bisogna essere volpe e leone." After a five years' exile in Russia the poet obtained leave to travel; he had secretly made up his mind never to return to that country or Poland so long as it remained under the government of the Muscovites. Wending his way to Weimar, he there made the acquaintance of Goethe, who received him cordially, and, pursuing his journey through Germany, he entered Italy by the Splügen, visited Milan, Venice, and Florence, and finally took up his abode at Rome. There he wrote the third part of his poem *Dziady*, the subject of which is the religious commemoration of their ancestors practised among Slavonic nations, and *Pan Tadeusz*, his longest poem, by many considered his masterpiece. A graphic picture is drawn of Lithuania on the eve of Napoleon's expedition to Russia in 1812. In 1832 Mickiewicz left Rome for Paris, where his life was for some time spent in poverty and unhappiness. He had married a Polish lady, Selina Szymanowska, who became insane. In 1840 he was appointed to the newly founded chair of Slavonic languages and literature in the Collége de France, a post which he was especially qualified to fill, as he was now the chief representative of Slavonic literature, Poushkin having died in 1837. He was, however, only destined to hold it for a little more than three years, his last lecture having been given on the 28th of May 1844. His mind had become more and more disordered under the influence of religious mysticism. His lectures became a medley of religion and politics, and thus brought him under the censure of the Government. A selection of them has been published in four volumes. They contain some good sound criticism, but the philological part is very defective, for Mickiewicz was no scholar, and he is obviously only well acquainted with two of the literatures, viz., Polish and Russian, the latter only till the year 1830. A very sad picture of the declining days of Mickiewicz is given in the memoirs of Herzen. At a comparatively early period the unfortunate poet exhibited all the signs of premature old age; poverty, despair, and domestic affliction had wrought their work upon him. In 1849 he founded a French newspaper, *La Tribune des Peuples*, but it only existed a year. The restoration of the French empire seemed to kindle his hopes afresh; his last composition is said to have been a Latin ode in honour of Napoleon III. On the outbreak of the Crimean War he was sent to Constantinople to assist in raising a regiment of Poles to take service against the Russians. He died suddenly there in 1855, and his body was removed to France and buried at Montmorency.

Mickiewicz is held to have been the greatest Slavonic poet, with the exception of Poushkin. Unfortunately in other parts of Europe he is but little known; he writes in a very difficult language, and one which it is not the fashion to learn. There were both pathos and irony in the expression used by a Polish lady to a foreigner, "Nous avons notre Mickiewicz à nous." He is one of the best products of the so-called romantic school. The Poles had long groaned under the yoke of the classicists, and the country was full of legends and picturesque stories which only awaited the coming poet to put them into shape. Hence the great popularity among his countrymen of his ballads, each of them being connected with some national tradition. Besides *Konrad Wallenrod* and *Pan Tadeusz*, attention may be called to the poem *Grazyna*, which describes the adventures of a Lithuanian chieftainess against the Teutonic knights. It is said by Ostrowski to have inspired the brave Emilia Plater, who was the heroine of the rebellion of 1830, and after having fought in the ranks of the insurgents, found a grave in the forests of Lithuania. A fine vigorous Oriental piece is *Farys*. Very good too are the odes to Youth and to the historian Lelewel; the former did much to stimulate the efforts of the Poles to shake off their Russian conquerors. It is enough to say of Mickiewicz that he has obtained the proud position of the representative poet of his country; her customs, her superstitions, her history, her struggles are reflected in his works.

[1] So Isa. x. 28 describes the invader as leaving his heavy baggage at Michmash before pushing on through the pass.

MICKLE, William Julius (1734–1788), son of the minister of Langholm, Dumfriesshire, holds a respectable place among the imitative minor poets of the 18th century. He wrote a poem on *Knowledge*—carefully versified, pointing a moral on the vanity of intellectual pride—at the age of eighteen, entered into business as a brewer at his father's request and against his own inclinations, soon became bankrupt, went to London on outlook for work as a man of letters, solicited patronage in vain, earned a living hardly by writing for magazines, made some impression in 1765 by "a poem in the manner of Spenser" called the *Concubine* (afterwards *Syr Martyn*), was appointed corrector to the Clarendon Press, and finally took a place among the leading poets of that very barren time by a translation of the *Lusiad* of Camoens into heroic couplets (specimen published 1771, whole work 1775). So great was the repute of the work that when Mickle—appointed secretary to Commodore Johnstone—visited Lisbon in 1779 the king of Portugal gave him a public reception. As a translator of Camoens Mickle has been superseded, but he aimed, not at close rendering of the original, but at making a poem which should be worthy of a permanent place in English literature. This ambition he was not capable of fulfilling, though he had great fluency and vigour. It may be doubted whether the fashionable forms which he imitated were the best suited to his natural gifts. He shows delight in lively action, a sense of dramatic effect, and, in the *Concubine*, the substance of which might have been conceived by Crabbe, considerable fulness of detail in coarse realistic painting. Certainly, if the Scottish poem *There's nae luck aboot the hoose* was Mickle's, he mistook his medium. Scott read and admired Mickle's poems in his youth, and, besides founding *Kenilworth* on the ballad of *Cumnor Hall*, was a good deal influenced by him in style. Mickle's prose is lively and vigorous.

MICROMETER, an instrument generally applied to telescopes and microscopes for measuring small angular distances with the former or the dimensions of small objects with the latter.

Before the invention of the telescope the accuracy of astronomical observations was necessarily limited by the angle that could be distinguished by the naked eye. The angle between two objects, such as stars or the opposite limbs of the sun, was measured by directing an arm furnished with fine "sights" (in the sense of the "sights" of a rifle) first upon one of the objects and then upon the other, or by employing an instrument having two arms each furnished with a pair of sights, and directing one pair of sights upon one object and the second pair upon the other. The angle through which the arm was moved, or, in the latter case, the angle between the two arms, was read off upon a finely graduated arc. With such means no very high accuracy was possible. Archimedes concluded from his measurements that the sun's diameter was greater than 27′ and less than 32′; and even Tycho Brahe was so misled by his measures of the apparent diameters of the sun and moon as to conclude that a total eclipse of the sun was impossible.[1] Maestlin in 1579 determined the relative positions of eleven stars in the Pleiades (*Historia Cœlestis Lucii Baretti*, Augsburg, 1666), and Winnecke has shown (*Monthly Notices R. A. S.*, vol. xxxix. p. 146) that the probable error of these measures amounted to about ± 2′.[2]

The invention of the telescope at once extended the possibilities of accuracy in astronomical measurements. The planets were shown to have visible disks, and to be attended by satellites whose distance and position angle relative to the planet it was desirable to measure. It became, in fact, essential to invent a "micrometer" for measuring the small angles which were thus for the first time rendered sensible. There is now no doubt that William Gascoigne, a young gentleman of Yorkshire, was the first inventor of the micrometer. Crabtree, a friend of his, taking a journey to Yorkshire in 1639 to see Gascoigne, writes thus to his friend Horrocks. "The first thing Mr Gascoigne showed me was a large telescope amplified and adorned with inventions of his own, whereby he can take the diameters of the sun and moon, or any small angle in the heavens or upon the earth, most exactly through the glass, to a second." The micrometer so mentioned fell into the possession of Mr Richard Townley of Lancashire, who exhibited it at the meeting of the Royal Society held on the 25th July 1667.

The principle of Gascoigne's micrometer is that two pointers, having parallel edges at right angles to the measuring screw, are moved in opposite directions symmetrically with and at right angles to the axis of the telescope. The micrometer is at zero when the two edges are brought exactly together. The edges are then separated till they are tangent to the opposite limbs of the disk of the planet to be measured, or till they respectively bisect two stars, the angle between which is to be determined. The symmetrical separation of the edges is produced and measured by a single screw; the fractions of a revolution of the screw are obtained by an index attached to one end of the screw, reading on a dial divided into 100 equal parts. The whole arrangement is elegant and ingenious. A steel cylinder (about the thickness of a goose-quill), which forms the micrometer screw, has two threads cut upon it, one-half being cut with a thread double the pitch of the other. This screw is mounted on an oblong box which carries one of the measuring edges; the other edge is moved by the coarser part of the screw relatively to the edge attached to the box, whilst the box itself is moved relatively to the axis of the telescope by the finer screw. This produces an opening and closing of the edges symmetrically with respect to the telescope axis. Flamsteed, in the first volume of the *Historia Cœlestis*, has inserted a series of measurements made by Gascoigne extending from 1638 to 1643. These include the mutual distances of some of the stars in the Pleiades, a few observations of the apparent diameter of the sun, others of the distance of the moon from neighbouring stars, and a great number of measurements of the diameter of the moon. Dr Bevis (*Phil. Trans.*, 1773, p. 190) also gives results of measurements by Gascoigne of the diameters of the moon, Jupiter, Mars, and Venus with his micrometer.

Delambre gives[3] the following comparison between the results of Gascoigne's measurements of the sun's semi-diameter and the computed results from modern determinations:—

		Gascoigne.	*Conn. d. Temps.*
October	25 (o.s.)	16′ 11″ or 10″	16′ 10″·0
,,	31 ,,	16′ 11″	16′ 11″·4
December	2 ,,	16′ 24″	16′ 16″·8

Gascoigne, from his observations, deduces the greatest variation of the apparent diameter of the sun to be 35″; according to the *Connaissance des Temps* it amounts to 32″·3.[3] These results prove the enormous advance attained in accuracy by Gascoigne, and his indisputable title to the credit of inventing the micrometer.

Huygens, in his *Systema Saturnium* (1659), describes a micrometer with which he determined the apparent

[1] Grant, *History of Physical Astronomy*, p. 449.

[2] This is an astonishing accuracy when the difficulty of the objects is considered. Few persons can see with the naked eye—much less measure—more than six stars of the Pleiades, although all the stars measured by Maestlin have been seen with the naked eye by a few individuals of exceptional powers of eye-sight.

[3] Delambre, *Hist. Ast. Moderne*, vol. ii. p. 590.

diameters of the principal planets. He inserted a slip of metal, of variable breadth, at the focus of the telescope, and observed at what part it exactly covered the object under examination; knowing the focal length of the telescope and the width of the slip at the point observed, he thence deduced the apparent angular breadth of the object. The Marquis Malvasia in his *Ephemerides* (Bologna, 1662) describes a micrometer of his own invention. At the focus of his telescope he placed fine silver wires at right angles to each other, which, by their intersection, formed a network of small squares. The mutual distances of the intersecting wires he determined by counting, with the aid of a pendulum clock, the number of seconds required by an equatorial star to pass from web to web, while the telescope was adjusted so that the star ran parallel to the wires at right angles to those under investigation.[1] In the *Phil. Trans.*, 1667, No. 21, p. 373, Auzout gives the results of some measures of the diameter of the sun and moon made by himself, and this communication led to the letters of Mr Townley and Dr Bevis above referred to. The micrometer of Auzout and Picard was provided with silk fibres or silver wires instead of the edges of Gascoigne, but one of the silk fibres remained fixed while the other was moved by a screw. It is beyond doubt that Huygens independently discovered that an object placed in the common focus of the two lenses of a Kepler telescope appears as distinct and well-defined as the image of a distant body; and the micrometers of Malvasia, Auzout, and Picard are the natural developments of this discovery. Gascoigne was killed at the battle of Marston Moor on the 2d July 1644, in the twenty-fourth year of his age, and his untimely death was doubtless the cause that delayed the publication of a discovery which anticipated, by twenty years, the combined work of Huygens, Malvaison, Auzout, and Picard in the same direction.

As the powers of the telescope were gradually developed, it was found that the finest hairs or filaments of silk, or the thinnest silver wires that could be drawn, were much too thick for the refined purposes of the astronomer, as they entirely obliterated the image of a star in the more powerful telescopes. To obviate this difficulty Professor Felice Fontana of Florence (*Saggio del real gabinetto di fisica e di storia naturale*, 1755) first proposed the use of spider webs in micrometers,[2] but it was not till the attention of Troughton had been directed to the subject by Rittenhouse that the idea was carried into practice.[3] In 1813 Wollaston proposed fine platinum wires, prepared by surrounding a platinum wire with a cylinder of silver, and drawing out the cylinder with its platinum axis into a fine wire.[4] The surrounding silver was then dissolved by nitric acid, and a platinum wire of extreme fineness remained. But experience soon proved the superiority of the spider web; its perfection of shape, its lightness and elasticity, have led to its universal adoption.

Beyond the introduction of the spider line it is unnecessary to mention the various steps by which the Gascoigne micrometer assumed the modern forms now in use, or to describe in detail the suggestions of Hooke,[5] Wren, Smeaton, Cassini, Bradley, Maskelyne, Herschel, Arago, Pearson, Bessel, Struve, Dawes, &c., or the successive productions of the great artists Ramsden, Troughton, Fraunhofer, Ertel, Simms, Cooke, Grubb, Clarke, and Repsold. It will be sufficient to describe those forms with which the most important work has been done, or which have survived the tests of time and experience.

Before astronomical telescopes were mounted parallactically, the measurement of position angles was seldom attempted. Indeed, in those days, the difficulties attached to such measures, and to the measurement of distances with the filar micrometer, were exceedingly great, and must have taxed to the utmost the skill and patience of the observer. For, on account of the diurnal motion, the direction of the axis of the telescope when directed to a star is always changing, so that, to follow a star with an altazimuth mounting, the observer requires to move continuously the two handles which give slow motion in altitude and azimuth.

Sir William Herschel was the first astronomer who measured position angles; the instrument he employed is described in *Phil. Trans.*, 1781, vol. lxxi. p. 500. It was used by him in his earliest observations of double stars (1779–83); but, even in his matchless hands, the measurements were comparatively crude, because of the difficulties he had to encounter from the want of a parallactic mounting. In the case of close double stars he estimated the distance in terms of the disk of the components. For the measurement of wider stars he invented his lamp-micrometer, in which the components of a double star observed with the right eye were made to coincide with two lucid points placed 10 feet from the left eye. The distance of the lucid points was the tangent of the magnified angles subtended by the stars to a radius of 10 feet. This angle, therefore, divided by the magnifying power of the telescope gives the real angular distance of the centres of a double star. With a power of 460 the scale was a quarter of an inch for every second.

The Modern Filar Micrometer.

When equatorial mountings for telescopes became more general, no filar micrometer was considered complete which was not fitted with a position circle.[6] The use of the spider line or filar micrometer became universal; the methods of illumination were improved; and micrometers with screws of previously unheard-of fineness and accuracy were produced. These facilities, coupled with the wide and fascinating field of research opened up by Sir William Herschel's discovery of the binary character of double stars, gave an impulse to micrometric research which has continued unabated to the present time. A still further facility was given to the use of the filar micrometer by the introduction of clockwork, which caused the telescope automatically to follow the diurnal motion of a star, and left the observer's hands entirely at liberty.[7]

The modern filar micrometer has now assumed forms of five types. Classification of micrometers.

Type A.—Micrometers in which there are two webs, each movable by a fine screw with a divided head. This is the usual English form of filar micrometer.

Type B.—Micrometers in which one web is movable by means of a fine screw with a divided head, and the other by a screw without a divided head. The latter screw, in ordinary use, is only employed to change the coincidence-reading of the two webs, for eliminating the errors of the micrometer screw. This is the ordinary German form of micrometer as originally made by Fraunhofer and since by Merz, and employed by the Struves and other principal Continental astronomers down to the present day.

Type C.—A similar form of micrometer to B, except that the coincidence-point cannot be changed,—there being no second screw to alter the position of the fixed web.

Type D.—A micrometer somewhat similar in general construction to form B, except that, in addition to means of changing the zero point, there is a screw head by which a fine movement can be given to the whole micrometer box, in the direction of the axis of the micrometer screw. This is the modern form of micrometer as constructed by Repsold.

Type E.—Micrometers fitted with two eye-pieces for measuring angles larger than the field of view of an ordinary eye-piece.

The micrometer of type A is due to Troughton; it is represented in figs. 1, 2, 3. Fig. 1 is a horizontal section in the direction of the axis of the telescope. The eye-piece *ab* consists of two plano-convex lenses *a*, *b*, of nearly the same focal length, and with the two

[1] *Mém. Acad. des Sciences*, 1717, p. 78 *sq.*

[2] In 1782 (*Phil. Trans.*, vol. lxxii. p. 163) Sir W. Herschel writes:—"I have in vain attempted to find lines sufficiently thin to extend them across the centres of the stars, so that their thickness might be neglected." It is a matter of regret that Fontana's suggestion was unknown to him.

[3] Quekett in his *Treatise on the Microscope* ascribes to Ramsden the practical introduction of the spider web in micrometers. The evidence appears to be in favour of Troughton.

[4] *Phil. Trans.*, 1813, pp. 114–118.

[5] Dr Hooke made the important improvement on Gascoigne's micrometer of substituting parallel *hairs* for the parallel edges of its original construction (Hooke's *Posthumous Works*, p. 497).

[6] Herschel and South (*Phil. Trans.*, 1824, part iii. p. 10) claim that the micrometer by Troughton, fitted to their 5-feet equatorial telescope, is the first position micrometer constructed capable of measuring position angles to 1′ of arc.

[7] So far as we can ascertain, the first telescope of large size driven by clockwork was the 9-inch equatorial made for Struve at Dorpat by Fraunhofer; it was completed in 1825. The original idea appears to be due to Passement (*Mém. Acad.*, Paris, 1746). In 1757 he presented a telescope to the king, so accurately driven by clockwork that it would follow a star all night long.