MISCELLANEOUS.

A HISTORY OF THE ART OF PHYSICAL EXPERIMENTATION.

It is a fascinating picture for the student of civilisation that Dr. E. Gerland and Dr. F. Traumüller have unrolled in their recent *History of Physical Experimentation*.[1] We have many books that treat of the development of physical theory, but none that give a complete history of the origin and growth of the wonderful and ingenious mechanical devices by means of which our mastery of the forces of nature has been advanced to the astonishing pitch witnessed by the closing days of the nineteenth century.

It is little considered what the history of civilisation owes to the invention of the simplest machines and tools, which may be regarded as the extensions and materialisations of man's intellect, which have entirely offset the initial advantages that brute creation possessed over him in the struggle for existence, and which have multiplied his power and opportunities to a degree nothing short of superhuman. The invention of the wheel alone bears upon it the burden of as great cultural achievements as the political history of many empires; its presence is so familiar to us and its function so imbedded in the fabric of our material welfare, that the very idea of its having had an origin or of a period of civilisation that could have possibly existed without its puissant aid, appears to have altogether escaped the notice of the ordinary observer. Yet the Assyrian and Egyptian monuments plainly show that some of its simplest and crudest uses are far from having been prehistoric. Its introduction, the development and application of its varied powers, were very slow processes; and, moreover, that development was, as in most other cases, continuous, and little broken by accident; its history, from a short time after its possible chance beginning to its present stage of extreme mechanical refinement, has been a succession of interrelated and rational conquests, conditioned by the knowledge, art, technical advantages, and intellectual dispositions of the ages. The accidents in its development have never occurred save to the inventive minds who were looking for them.

This intellectual and cultural continuity in the evolution of human implements, workshops, and laboratories is finely brought out in some of the examples whose history we can follow in Dr. Gerland and Dr. Traumüller's work, and notably so in the case of the development of the steam-engine, the origin of which popular romance delights to accord to the chance contemplation of a boiling tea-kettle. It is not a derogation, but rather a noble compliment, to Watt's genius to recognise

[1] *Geschichte der physikalischen Experimentierkunst.* Leipsic: W. Engelmann. 1899. Pages, 442. 425 cuts. Price, bound, 17 marks.

that his great invention was the rational and crowning flower of the scientific and technical growth of an entire century, and that he had in his work a line of illustrious predecessors, Huygens, Somerset, Savery, Pappin, and Newcomen, one of whom at least was as clear as man could be of the desired goal. No finer picture, in fact, of the state of experimental art and mechanical ideals a century after Galileo can be found than that of the efforts of Denis Pappin (1647–1714) to construct a steam-engine to replace human labor. He invented both a low-pressure and a high-pressure steam-engine; his procedure was as logical and as cautious as could be desired; his work was guided, not by theoretical fancies, but by the requirements of the facts, as experimentally ascertained. He was fully conscious of the scope of his invention; it was designed to pump water from mines, to throw projectiles, and to propel ships and vehicles. Legend even had it that he actually built a steam-boat, urged by oars, and sailed on it in 1707 from Cassel to Münden, intending afterwards to proceed to England,—a project in which he was foiled by the Westphalian mariners, who destroyed his vessel from jealousy. Be that as it may, one cannot withhold one's admiration either for Pappin's ideas or for his practical execution of them. But the *technique* of his time failed him, and, as our authors remark, the construction of his machine was so unutterably clumsy that it can now provoke from us only a generous smile.

The foregoing is but one of the many developments in the work under consideration which will interest the unprofessional reader. The history of the experimental and mechanic arts in Egypt and Assyria, in Greece and Rome, though meager, is not without its surprises. Archimedes, Hero, Philo, Ctesbius, and Ptolemy do much to relieve the absolute barrenness of the later periods. The inquirers of antiquity and the Middle Ages mostly constructed their apparatus themselves; although Hero and Philo report that they had special mechanics of great skill. The manufacture of astronomical instruments was entrusted chiefly to goldsmiths and other workers in metal. The artistic Roman steelyards are distinctively their work. This did not change for centuries, and the trade of instrument-making proper was not constituted as an independent craft until the invention of mechanical clocks: the first professional instrument-makers came from the ranks of the clock-makers.

The Byzantine period has nothing to show; the Arabs are more interesting; there are some glimmerings in the Middle Ages (Roger Bacon); there is light in the sixteenth century with Leonardo da Vinci, Maurolycus, Della Porta, Gilbert, Copernicus, Stevinus, and Tycho Brahe (some of whose astronomical instruments were reproduced from the present work in *The Open Court* for July, 1900); but the full radiance of the experimental procedure in physics burst forth with Galileo (1564–1642), who first systematically applied the Socratic method of induction in science and rightly conjoined it with deduction, as controlled by experiment. Galileo's procedure required the constant check of conclusions by facts; and the development of experimental technics sprang from this requirement as fast as the advance of the mechanic and industrial arts in each succeeding age permitted. The leaps which it has taken in the present century are known, as to their magnitude at least, by all.

But, as was above noted, the ideas of the inquirers often ran in advance of the possibility of execution. One of the most celebrated books describing physical experiments of the seventeenth century is that of Otto Guericke, the inventor of the air-pump. The two cuts here reproduced from his *Experimenta nova (ut vocantur) Magdeburgica* (1672) show the simple apparatus with which he originally

sought to obtain a vacuum. The first is that of a common barrel filled with water which was drawn out by means of a fire-engine pump and which the air followed through the crevices as rapidly as the exhaustion was performed; the second is that of two semi-spherical copper vessels, which burst owing to their defective curvature.

GUERICKE'S FIRST CRUDE AND UNSUCCESSFUL ATTEMPTS TO OBTAIN A VACUUM.
(Facsimile reproduction from the *Experimenta Magdeburgica*, Amsterdam, 1672.)

Guericke's book has supplied our authors with a great number of very interesting illustrations. This, indeed, is a feature in which their work is very rich. The cuts, which number 425, are drawn from rare sources and in themselves form a

veritable panorama of the development under consideration. The works of Huygens, Descartes, Hooke, Newton, Faraday, and many others, far more rare, have also been exploited by the authors and publisher in lavish and commendable manner; and it is our only regret that we cannot give more space to the notice of the important phases of human thought which they represent. Certainly, to many readers this book will prove an inspiring one. T. J. McCormack.

ASPIRATION.

A SONNET.

'Tis the afterglow of sunset! and a mist
Of molten gold, at the bidding of the breeze,
Is blown athwart the sky beyond yon trees,
Wind-woven with waves of fire-fringed amethyst.
No limits bar the soul! Where'er it list,
Borne on the untrammelled wings of Joy, it flees
Through throbbing paths of light: yet naught it sees,
Nor dreams of aught, save but to be star-kissed.
On! on! it hastens; all its heart athirst
With love unspeakable, to touch with love
That lovely light which glimmers now in grey:
On! on! until in Hesper's arms, where erst
It yearned to lie, it sinks; as all above
Night's palsy stills the last faint pulse of Day. F. J. P.

AN AMERICAN ANTHOLOGY.

The task of compiling an anthology of American verse[1] could not have been entrusted to a more sympathetic critic than Mr. Edmund Clarence Stedman, the author of the admirable *Victorian Anthology*, and himself a poet of no mean merit. He has performed his work with true American breadth and in a democratic spirit that few would have had the courage to exhibit, but which has shown the development of our national versification in all its varied phases, in its highest as well as its lowest sources, demonstrating it to be a genuine utterance of the national heart, "of import in the past and to the future,"—a powerful stimulant to the nation's growth. By his wide inclusiveness of selection he has put it beyond a doubt that "if our native anthology yields to a foreign one in wealth of choice production," it is still "from an equally vital point of view the more significant of the two." Throughout the years resulting in the Civil War, literature was with us really a force; and a generous foreign critic, Mr. William Archer, has in Mr. Stedman's judgment truly said: "The whole world will one day come to hold Vicksburg and Gettysburg names of larger historic import than Waterloo or Sedan." "If this be so," Mr. Stedman continues, "the significance of a literature

[1] *An American Anthology*, 1787–1899. Selections Illustrating the Editor's Critical Review of American Poetry in the Nineteenth Century. Edited by *Edmund Clarence Stedman*. Boston and New York: Houghton, Mifflin & Co. 1900. Pages, lxvii, 878. Price, large crown 8vo, $3.00; full gilt, $3 50; half calf, $5.00.