

OBITUARY NOTICES.

MR. CHARLES EDWARDS AMOS was one of the last links connecting the old-fashioned millwright with the modern engineer. He was born at March, in Cambridgeshire, on the 27th of November, 1805, his father being Mr. Jonas Amos, who had married the daughter of a millwright and carpenter of the district. Shortly after his birth his family removed to the Wildmore Fen, in Lincolnshire, where the elder Amos became manager on the farm of a Mr. Clements, of Horncastle. This occupation was not very different from that of a colonist at the present time; for in those days, owing to the isolation of the district and the general absence of drainage and cultivation, fenland might be purchased in fee-simple for what would be but a year's rental now.

Such education as the place afforded young Amos managed to acquire, albeit the bad state of the roads, and the passage of the river Witham rendered his attendance at school in winter very desultory, while in summer the value of children's labour stopped his lessons entirely. He was, however, so quick and intelligent that, in spite of these drawbacks, he soon distanced his comrades in the acquisition of the three R's, and was allowed to amuse himself with an old folio "Life of Josephus" during the time the master instructed the rest of the class.

On the removal of his parents to Upwell, where his father became farm manager to Mr. William Bacon, young Amos went to regular farm work, and became, while literally "whistling at the plough," thoroughly conversant with agricultural implements and operations, a knowledge which years afterwards stood him in good stead. At the age of about eighteen years, he apprenticed himself to Mr. John Wilkinson, millwright and machine maker at Elm. Starting on a weekly wage of 10s. 6d., with which he had to maintain himself, he soon became so far useful to his master as "leading-hand" on out-door work as to be placed frequently in charge of such jobs, and remained about four years, during which he acquired a competent knowledge of windmills, sluice-work, threshing-machines, and other mechanism incidental to a country business. Being now twenty-two years of age and an experienced journeyman, he, accompanied by a fellow-apprentice, determined to go "on tramp," and soon found employment at the workshop of

Mr. Beaumont of Ramsey, Hunts, whose practice was almost exclusively confined to fen-work. At that time the fens were drained mainly by windmills actuating scoop-wheels, following the practice imported by the old Dutch settlers. The introduction of steam has during later years dispensed with many of these windmills, but at that period steam-power, machine-tolots, and the host of other appliances, were unavailable for the facilitating the work of the millwright, and he was compelled to rely upon his own resources from the preparation of the timber, iron, and other rough material to the erection of his finished work.

The repair and construction of windmills, and scoop-wheels sluices, &c., over a large extent of country, became at length monotonous; and Amos, notwithstanding kind offers on his master's part, decided to see some different class of work, and accordingly went into the shop of Mr. John Clark, millwright of Houghton, Huntingdonshire, where, in the practical construction of corn-mills, water-wheels, windmills, and tannery and brewery work, abundant field for experience was found. The old millwright system, where the master, his sons, and his journeymen worked side by side in the same shop, rendered the journeyman's post an honourable one; it secured good work, and gave a facility in the use of carpenters', fitters', and smiths' tools, which even in these days renders the old millwright, where he can be found, a valuable man in any factory.

About the year 1829 Amos entered the employment of Mr. Joseph Jordan, millwright of Hertingfordbury, Herts, whose practice was of a similar character to Mr. Clark's. Here he was employed in the erection of several water corn-mills then in progress. Mr. Jordan was executing some steam-engine work and other machinery for Mr. Thomas Creswick, of Hatfield Paper Mills, and Amos was sent to erect and start it. Mr. Creswick was one of the most active and enterprising paper-makers of his day, and his name and productions stood deservedly high, and wishing to introduce several new improvements and processes into his manufactory and machinery, and keeping them private for trade purposes, he was anxious to have a steady and skilful constant hand exclusively to himself. Amos, although nominally in Mr. Jordan's employment and receiving his pay, had virtually so acted for a considerable time, not going home for weeks together. At length Mr. Creswick offered him this situation, which, after consultation with Mr. Jordan, was accepted, in preference to embarking in business and taking over the goodwill and trade of Mr. Cotterill, of St. Albans (who died about that

time), which he was strongly tempted to do by several of the leading millers, brewers, &c., of that district.

In the autumn of 1835, Mr. Creswick purchased the Iron Mills, Wandsworth, Surrey, which had been a rolling-mill and foundry where, among other things, the iron columns used by Mr. Nash in the formation of the Quadrant, Regent Street, were cast. In view of the contingency of Mr. Amos embarking in business for himself, on the completion of the Wandsworth Paper-Mills, he received instructions from Mr. Creswick to place some of the work in the hands of Mr. Henry Pullen, millwright and engineer of that town, at prices sufficiently liberal to induce him hereafter to devote his energies and the resources of his establishment to the requirements of the paper-mill, when its owner could no longer command the aid of his own engineer. In consequence, designs for two water-wheels were handed to Mr. Pullen for execution, but they had barely been commenced before the sudden death of that gentleman frustrated the arrangement. In this emergency it was suggested that Mr. Amos could not do better than establish himself as a millwright and engineer at Wandsworth, in which case his aid would be available for the paper-mills, and its machinery generally could be constructed by him.

It was about that time that Mr. George Dives contemplated the erection of a new steam-engine and other gear at his corn-mills, Battersea, and made a contract with Mr. Pullen for their installation; his death at an early stage of the business, however, brought matters to a standstill, and under these circumstances Mr. Dives requested Mr. Amos to complete the affair. Although the advantages of expansion in the working of steam-engines were known, not much practical use had been made of the knowledge. With the exception of the Cornish pumping-engines, most engines, ashore and afloat also, were worked with steam at a few pounds only above atmospheric pressure, which was expanded slightly in the cylinder and then condensed, engineers generally bestowing attention more on the details of construction than on the economical effect obtainable. The general principle of the "Woolf," or compound engine, had been set forth about 1804, and its progenitor, "Hornblower's" engine, dated as far back as 1781, but very little practical use had been made of it, and its employment in presence of the then existing practice was attended with some hardihood. Nevertheless a compound beam-engine was erected at Mr. Dives', the details of which were worked out by Mr. Amos, and the economical effect of corn ground for coal consumed was, at the time, remarkable. The engine in question is (or

was up to a short while ago) still at work, and its performance bore respectable comparison with the duty of engines of the present time. Several of the constructive details, as continuous bedplate, valve-motions, mode of framing, &c., were in advance of the day, and have been generally employed since.

The success of Mr. Dives' engine attracted a good deal of attention, and among other persons, who through it came in contact with its constructor, was the late Mr. James Easton; the acquaintance resulted in a partnership, which commenced in 1836.

The compound engine, on the system tried at Mr. Dives' mill, became a speciality in the hands of Easton and Amos: but, although many such engines were built, the principle did not make general headway, and Messrs. I. and E. Hall, of Dartford, Messrs. John Wentworth and Sons, of Wandsworth, and they remained the principal constructors, so far as the South of England was concerned. The little 4-HP. engine at the Polytechnic Institution, built about this time by Mr. Edward Humphrys, M. Inst. C.E. (afterwards of Messrs. Humphrys and Tennant), was about the best known representative of this class; and it was sold by auction on the 1st of March, 1882, on the dismantling of the Polytechnic Institution, apparently in as good order as when it started.

While advocating strongly the merits of compound engines he was not insensible to the claims of single cylinder expansion, and he always stated that he believed he was the first man who successfully applied a cut-off slider working direct on the back of an ordinary slide for expansive working. It is to be regretted that the precise date when this was brought out is unknown. At the Reform Club-house such a device was used, a cut-off slide worked on the back of an ordinary slide-valve, and closed ports formed therein. Variations of the grade of expansion being obtained not only by swivelling the expansion eccentric around the shaft, so as to alter the time of cut-off, but by simultaneously varying the ravel. It is figured and described in the 'Civil Engineers' and Architects' Journal,' of February 24th, 1844, and Mr. George Spencer, who describes it, gives the date of the application at the Reform Club as probably earlier than 1840. However this may be, this is doubtless one of the earliest instances of "double slide expansion," and is probably as old, if not older, than "Meyer's System."

Soon after the establishment of the firm, the remodelling of Mr. Walker's oil-mills at Dover was placed in their hands. For driving some of the machinery a pair of side-lever marine engines from one of the old packets, the "Royal George," was employed. Mr.

Amos removed the cylinder of one, and compounded it with the other engine by putting a smaller cylinder in its place. As the cranks were at right angles the disused cylinder was placed between the engines as an equaliser.

His old experience of paper-making was also turned to account, and several of the principal mills of the country were either built, remodelled, or added to under his auspices. In 1849, in conjunction with Mr. Moses Clark, of Mr. Wm. Joynson's mills at St. Mary Cray, Kent, he took out patents for a new knotter or pulp-strainer, also for a single-sheet cutting machine, which rapidly found favour both in the English and continental paper-mills; and a further patent for an automatic regulating valve, for giving steam of constant tension, notwithstanding variations of boiler pressure, found equal favour among steam-users in the West Indies and elsewhere. Other inventions relating to the paper manufacture, notably the revolving rag-boiler for boiling direct with high pressure steam in a closed vessel, also a method of sizing and drying, and sundry incidental details, were successfully brought out.

Hydraulics, and the practice incidental thereto, were favourite matters both with Mr. Amos and his partner. The supplying of towns and water-works machinery became special objects of attention, and a large practice resulted. One of the consequences was the revival of the use of the "bucket and plunger" or "double-acting pump." This had become so far obsolete that an amusing controversy occurs in the *Civil Engineers' and Architects' Journal* for 1849, wherein one of the disputants claimed its application at the then Richmond Water Works as a new thing. The point was settled, however, by a letter from the firm in that journal, under date June 14th, 1849, showing that the device had been revived and applied by them in the machinery erected at the Government Water Works, Trafalgar Square, in 1844.

The consideration of a difficult case, in which the flow of water through a very long main was involved, led Mr. Amos to work out certain rules as to the influence of varying land-contour and main-contour upon such flow. The leading principles thus enunciated are given in "Practical Hydraulics," by Thomas Box, with a suitable acknowledgment by the author of the source from whence he derived them.

On the retirement of Mr. Josiah Parkes, M. Inst. C.E., the firm were appointed Consulting Engineers to the Royal Agricultural Society. In this capacity, Mr. Amos found congenial employment. At the Norwich Show, 1849, he established the system of engine-

trials on the "Prony" brake, which has largely contributed to the high duty and general excellence of the modern portable engine. The invention of a dynamometer, whereby the dynamic effort involved in working any winch-driven implement was recorded by automatic lever and spring-balance movements, was the means of securing special recognition and a special gold medal from the Society in 1849, a circumstance which has escaped record in the various descriptions published of the Society's testing apparatus. An apparatus for ascertaining the power consumed by horse-gear threshing-machines was brought into use at the Exeter Show in 1850, and a rotary dynamometer (whereby the power consumed by any machine driven by steam or other prime motor was recorded) was invented and brought into use at the Lincoln Show in 1854. The various modifications in the form of dynamometer used by the Society were mostly due to Mr. Amos, who ultimately, in 1864, produced one for testing the draught of steam-ploughs, cultivators, and the like, by recording the stress occurring continuously on the steel wire hauling-rope. The integrating gear required much care in manipulation, but with such care the apparatus acted well. A complete illustrated description of it, by the inventor, is given in the 'Journal of the Royal Agricultural Society of England,'¹ and the general principles embodied in it are fully explained. Some minor apparatus for testing the stress on plough anchors and various other purposes were likewise arranged by him for the use of the Society.

Mr. Amos relinquished the post of Consulting Engineer after the Oxford Show in 1870, and was on retirement presented with an illuminated address and a gold medal, in recognition of his services to the Society.

In the arrangement for the cable-laying machinery for the old Atlantic cable, in 1857, employed upon H.M.S. "Agamemnon," and the U.S. frigate "Niagara," a committee was appointed to assist the engineer, Mr. (now Sir Charles) Bright, M. Inst. C.E., comprising the late Mr. John Penn, the late Mr. Joshua Field, the late Mr. Lloyd of the Admiralty, and Chief Engineer W. E. Everett, of the United States Navy, upon the latter of whom a good deal of the oversight of the construction devolved. In consultation, Mr. Amos, in whose firm's hands the construction had been placed, suggested the placing of the paying-out drums in duplicate, so as to form a self-fleeting windlass, a device he had employed some years before with success at the Rhyl swivel

¹ Second Series, vol. i., p. 204: "A Description of the Newcastle Dynamometer."

bridges, on the Chester and Holyhead Railway. It answered the purpose, and although in after years an ordinary single drum has been commonly used, on account of greater simplicity, with an inclined plough-piece to thrust over the coil, there is doubtless more strain and punishment of a cable in this case than with the more complex arrangement of the self-fleeting or double-drum. For picking-up purposes, however, the double drum is still frequently employed.

The merit of the "Dynamometer" arrangement, which was brought out and designed for this expedition, is entirely due to Mr. Amos. The principle of the invention, in brief, lies in deflecting, by a wheel loaded with known weights, the cable as it passes away to the taffrail, the load coming equidistant between two fixed pulleys, and the angle formed by the cable (or, in other words, the amount of deflection) will, in accordance with the well-known laws of parallelogram of forces, indicate the stress upon the cable at any time, which may be read off upon a scale. The experiment was tried on a temporarily-fitted apparatus at Gravel Lane, Southwark (where the machinery was erected), and the details were very completely worked out for the two cable-vessels.

The invention of Appold's centrifugal pump, and its public exhibition, in 1851, in Hyde Park, was the means of establishing a lasting friendship between the late Mr. J. G. Appold, Assoc. Inst. C.E., and Mr. Amos. The centrifugal pump formed a favourite subject of speculation with the latter, who bestowed much time and thought on the investigation of the general laws governing the action of such pumps, and in experimenting upon them under varying conditions.

In the erection of the ship-elevator, invented by Mr. Edwin Clark, M. Inst. C.E., at the Thames Graving-Dock, Victoria Dock, wherein the hydraulic arrangements were placed in the hands of his firm, Mr. Amos introduced a three-cylinder compound-engine and a system of working the hydraulic pumps in groups, throwing off in succession as the lift proceeded and the stress increased; there were also some specialities in the arrangement of the valve-gear in the valve-house for operating the hydraulic cylinders.

In conjunction with Mr. John Francis, Mr. Amos patented a machine for dressing slates, which was successfully tried at Penrhyn Quarries, and came largely into use in slate quarries generally afterwards. A number of other inventions might be described, but enough has been stated to show the versatility of his mechanical ideas. One instance will suffice to show that little

matters did not escape attention. In lead-pipe machinery, the practice had been to place the lead-pressing cylinder above the hydraulic cylinder, and so draw out the pipe upwards; much care had to be taken in adjusting the "triplet" truly concentric with the "die," so that the pipe should be of equal thickness, and frequent breakages were the result of any lack of attention in this respect. In conjunction with Mr. Hanson of Huddersfield, Mr. Amos reversed the order of things, forming the column of the press hollow, the pipe being drawn downwards: the "triplet" was further hung pendulous and left free instead of being rigidly confined; the result was that as the viscid, partially fluid metal, had no particular reason for flowing down one side of the triplet more than another, the triplet itself hung naturally concentric with the die, and an equal thickness of pipe ensued without undue strain or risk of breakage. The press, which was peculiar in this respect, was worked for many years in this way, and apart from its regular business, was frequently used for experimental purposes; for instance, in pressing trial composition for "Hale's rockets," about the date of the Crimean war, by the Woolwich authorities; and in pressing lead rod on trial, preparatory to the invention of the Minié rifle-bullet machinery, by Mr. (now Sir John) Anderson, M. Inst. C.E., the machinery superintendent at Woolwich Arsenal.

In 1866 Mr. Amos retired from business, but he did not by any means become an idle man. The chairmanship of the Sutton Gasworks, a directorship of the Grays Chalk Quarries Company, and other industrial pursuits occupied a large part of his time. He also found leisure, at the request of the Society of Arts, to devise and construct a dynamometer for testing the tractive force required on various pavements in London with a given load. He was a good witness in cases of disputed patent-right, and in other matters involving vexed questions in mechanics.

A severe attack of illness in the winter of 1881 effectually undermined his naturally strong constitution. Recovery was very slow, and though in the following spring it was hoped that he had overcome the enemy, his apparent restoration proved to be but the flickering of an expiring flame. On the 12th of August 1882 his spirit passed away without pain or pang of any sort, when in the seventy-seventh year of his age.

Mr. Amos was elected a Member of the Institution of Civil Engineers on the 22nd of May 1855, and was also connected with most of the associations devoted to the furtherance of practical science. He was a juror at the Paris Universal Exhibition of 1855

and International Exhibition, London, 1862, and, among several other distinctions, received a gold medal and diploma from the Agricultural Exhibition of Sweden and Norway in 1871, and was shortly after presented by Carl XV. with the Cross of the Order of Vasa.

Mr. Amos was a typical Englishman of a high class. In him the intuitive sense of mechanical principles, perhaps inherited, but in any case amounting almost to genius, with clear-headedness, enterprise, energy and determination more than compensated for deficiencies of early education, and combined to land him at a goal in advance of that reached by many men who start with far greater advantages. When to these qualities are added sterling uprightness and moral worth, the value of such a man passes the limited bounds of his individual sphere, and he becomes a pillar of the commonwealth and an honour to his country.

Mr. ROBERT BRIGGS was born in Boston, U.S.A., on the 18th of June, 1822, and was educated in the public schools of that city, attaining special proficiency in mathematics. At the age of seventeen he entered the office of Captain Alex. Parris, a civil engineer and architect of Boston and Charlestown, N.Y., and presumably for three or four years was under training as a pupil, although he most likely received a salary, the English system of premium-pupilage not obtaining in the United States. In any case, this first experience of engineering work must be considered as instructional, for it preceded a practical education which his death alone terminated, and which ranged over all, and more than all, branches that in this country are considered as constituting the profession of an engineer, from the conduct of hydrographic surveys to the making of sugar-mill machinery; from the draughtsman's board to the editor's table. This varied career, during which the longest engagement in one department seems to have been nine years, the others being much shorter, began in 1847, under Mr. Charles Hastings, C.E., who secured Mr. Briggs' services for a few months to assist him in laying out railways in Massachusetts; but Briggs soon left surveying to become "Constructing Engineer" to the Glendon Rolling-mill, a notable establishment then being built at East Boston. On the completion of that undertaking he opened an office in Boston, which he retained for two or three years while in practice for himself. In 1850 he went to Newton, New Jersey, as superintendent engineer of the works of Messrs. Bird and Wild,