the best of these undertook to make, in Mr. Redding's presence, a stone arrow head, using only such tools and implements for this purpose as were in use by the Indians before their contact with the white man. Promptly at the time appointed the old man, Consolulu, appeared, grey-haired, and though between sixty-eight and seventy-two he was still erect and vigorous. He brought, tied upon a deer's skin, a piece of obsidian weighing about a pound, a fragment of a deer's horn, split from a prong lengthwise, about four inches in length and half an inch in diameter and ground off squarely at the ends; this left each end a semicircle, besides two deer prongs with the points ground down into the shape of a square sharp pointed file, one of these being much smaller than the other. He had also with him some pieces of iron wire tied to wooden handles and ground into the same shapes. These, he said, he used nowadays in preference to the deer prongs, simply because they did not require such constant sharpening. Holding the piece of obsidian in the hollow of his left hand, he placed between the first and second fingers of the same hand the split piece of deer's horn first described, the straight edge of the split horn resting against one-fourth of an inch of the edge of the obsidian, this being about the thickness of the flake he desired to split off, then with a small round water-worn stone which he had picked up, and which weighed perhaps a pound, he with his right hand struck the other end of the split deer's horn a sharp blow. The first attempt resulted in failure; a flake was split off, but it was at the same time shattered to fragments. The next blow was successful, a perfect flake was obtained, and a third was equally so. Now squatting on the ground, sitting on his left foot, his right leg extended in tailor-like fashion, he placed in the palm of his left hand a piece of thick, well tanned buck-skin; it was thick but soft and pliable; on this he laid the obsidian flake, holding it firmly in its place by the first three fingers of the same hand; the elbow was steadied on the left knee. In his right hand he took the larger of the two deer prongs and commenced to reduce one edge of the circular form of the flake to a straight line with the thumb of the right hand resting on the edge of the left hand as a fulcrum. The point of the deer prong would be made to rest on about an eighth of an inch or less of the edge of the flake, then with a firm pressure of the point a conchoidal fragment would be broken out, almost always of the size desired. This operation was repeated until in a few moments the flake was reduced to a straight line on one edge; by rubbing this on the side of the deer horn the sharp edge was worn down. Next, the flake was turned end for end and the chipping renewed; when completed care was taken that the cutting edge was left in the centre. It was now plain that the straight edge thus made was to be one side of the long isosceles triangle, the form of the arrowheads which is used by the tribe. The other side was formed in the same manner and next the base. The chipping but of the slot by which the arrow head is firmly bound by deer tendon to the shaft was the simplest and most rapid portion of the work. It had taken forty minutes to split the two flakes from the obsidian mass and to form one of them into the arrow head. The detailed account of this most interesting process will be found, with illustrations, in the November number of the *American Naturalist*.

REV. JAMES CLIFTON WARD, F.G.S.

OUR geological readers will learn with sincere regret that one of the most earnest of the band of "workers" in this country passed away on April 15, aged 37. Early adducing a taste for science, Mr. Ward was sent to the Royal School of Mines in 1861, studying in the Geological Division, and obtaining the Associateship in 1864. In the following year he joined the staff of the Government Geological Survey, and was sent down to the Yorkshire coalfield, in the survey of which he took an active part. Under the superintendence of Prof. Green he contributed to the elucidation of the geology of seven ordnance quarter sheets, including at least twenty-three maps of Yorkshire, on the scale of 6 inches to the mile, to many Horizontal and Vertical Sections explaining the structure of the coal-field, and furnished information included in the Survey *Memoirs* on the Dewsbury and Huddersfield district, 88, N.E., in 1871, the Burnly Coalfields in 1875, and the "Geology of the Yorkshire Coalfield" in 1878, and was called before the Royal Coal Commission to give to them the results of his labours in that coalfield. In 1869 Mr. Ward was transferred to the Survey of the English Lake District, then commencing under the superintendence of Mr. Aveline, and we henceforth see Mr. Ward in a new light. Hitherto conscientious work and indefatigable industry had alone characterised him; but so soon as he was surrounded by the scenery of the Lakes, and breathed its exhilarating atmosphere, he developed, in addition to these qualities, a rare appreciation of its beauties, alike present in sunshine and in storm, not far removed from that "being one with nature" that is so marked a characteristic of the little band of poets which, in the time that has just gone by, have rendered this district, classic ground for the student of English literature. Keenly enjoying the impressions received from moor and mountain, the search after their origin, the elucidation of their past, and the restoration of their physical geology were ever present in his mind, pursued with a zest and an industry that only can be realised by those who have witnessed it. To pick up a line or clear up a doubtful point he would retrace his steps up the roughest and steepest ground, after a long day's tramp, at a speed that proved the curiosity and interest that he felt in its solution, and after the longest and hardest day in the field we have seen him working at his microscope into the small hours of the night, whilst early the next morning he was ever ready for fresh expeditions, in which no fatigue could check his interest and no discomfort try his good nature. The results of his labours in the Lake District are embodied in the "Keswick Quarter-Sheet" of the Geological Survey and the accompanying memoir on "The Geology of the Northern Part of the English Lake District," published in 1876, and in various official maps and sections, as well as in papers in the *Journal* of the Geological Society, the *Geological Magazine*, *Popular Science Review*, *Science Gossip*, and NATURE. To more fully understand the history of the volcanic rocks of his favourite Borrowdale, he undertook a journey to Italy to study Vesuvius and other volcanoes in that region. He spared neither time, cost, nor labour in microscopic sections of rocks and their chemical analyses, to aid his results in the field, and though some German petrographers have questioned some of his results worked out in the laboratory, we doubt whether any future observer will be able to suggest any improvement or change in the elaborate network of boundary lines covering the maps of the northern Lake District.

In his papers on the Lake District he pointed out the *radiate* arrangement of the ice from the higher grounds during the Glacial Epoch, and the fact that though the rock-basins were scooped out by ice, the amount denuded is an exceedingly small proportion of the entire valley, which was the product of a long period of denudation, and that the district afforded no evidence of a universal ice-cap moving across it in one direction. In his petrographical papers he deduces from "the liquid cavities in quartz-bearing rocks" that the granitoid rocks of the Lake District were consolidated at a depth not greater than 30,000 feet. Comparing the modern volcanic rocks of Vesuvius and Naples with the old lavas of the Lake District and North Wales, he refers the latter to the felstone group, and those of Cumberland to a group midway between the felstone and the basaltic; in both

Wales and Cumberland felspathic ashes being metamorphosed into felstone-like rocks.

Mr. Ward had always a strong bent towards educational work, and lectures of his first given to a school audience, and afterwards before the Keswick Literary Society, were expanded and published as text-books ("Elementary Natural Philosophy" and "Elementary Geology," 1872). Like the late Canon Kingsley with the Chester Society of Natural Science, Mr. Ward exerted an immense influence in attracting people to the pursuit of natural science, and in breaking down those trammels which prevent people of different ranks meeting for a common useful object; and not only increased the number of members of the Keswick Society and put its museum in scientific order, enriching it with his own collections, but united the society with the other societies of the county, and formed them into the Cumberland Association —a society publishing a useful journal. In 1878 he left the Geological Survey and entered the Church, holding successively two cures under the Bishop of Carlisle: the first, a curacy at Keswick; the second, the vicarage of Rydal. Thus in the shadow of Wordsworth's home, surrounded by the mountains he loved so well, he closed his useful, respected, and sadly too short life, C. E. R.

THE INSTITUTION OF MECHANICAL ENGINEERS

AT the recent meeting of the Institution of Mechanical Engineers four papers were read on subjects of practical interest to engineers and men of science, viz., on Electric Lighting, by Dr. John Hopkinson, F.R.S. Remarks on Chernoff's papers on Steel, by Mr. W. Anderson of Erith. On Permanent Way for Street Tramways, with special reference to Steam Traction, by Mr. J. D. Larsen; and on Water Pressure Engines for mining purposes, by Mr. H. Davey of Leeds.

Dr. Hopkinson's paper is divided into three principal parts. The first is a continuation of a paper read by the author in April, 1879, in which he exhibited by means of a curve the interconnection between the current passing through a dynamo-electric machine, the speed of revolution, and the electromotive force. Since the date of the authors earlier paper other electricians have made experiments in the same direction; notably Auerbach and Meyer in Germany, and Dr. Siemens, F.R.S., in this country. The results arrived at by these experiments are now given in a similar form to that adopted by the author for illustrating his own experiences.

The second part of the paper deals with the brightness of the electric arc. It is common to speak of the brightness of an electric light in terms of so many candles. The colour of the electric light is however different to that of a candle. Hence "the statement without qualification, that a certain electric lamp and machine give a light of a certain number of candles" "is wanting in definite meaning." "Captain Abney (*Proceedings* of the Royal Society, March 1878) has given the results of the measurements of the red, blue, and actinic light of electric arcs in terms of the red, blue, and actinic light of a standard candle." It has also been ascertained that the electric light under certain circumstances gives very different intensities of brightness in different directions. These two facts, together with certain practical difficulties, have rendered the measurement of the light emitted by the electric arc somewhat difficult. In the second part of his paper Dr. Hopkinson describes the methods which he has adopted for overcoming these difficulties.

In the third section the author considers the efficiency of the electric arc, and concludes by giving a rule for the "measurement of the efficiency of any system of electric lighting in which the electric arc is used, the arc being neither exceptionally long nor exceptionally short."

Mr. Anderson's remarks on Chernoff's papers on Steel are chiefly interesting as tending to direct attention to an almost unknown series of papers by a distinguished Russian metallurgist. Few men have had better opportunities for becoming acquainted with the nature of steel than M. Chernoff. He has been for some years assistant manager of the celebrated Abouchoff Steel Works, close to St. Petersburg. At these works five different processes of manufacturing steel, *viz.*, the old crucible, the Siemens crucible, the Bessemer, the Siemens-Martin, and the Whitworth fluid compressed steel systems, may all be seen in operation. Visitors to the Vienna Exhibition in 1873 will remember the splendid specimens of artillery, including a breech-loading forty ton gun, which were turned out by this factory. The establishment is provided with an admirable laboratory, with one of Kirkaldy's testing machines, and with every appliance necessary for investigating the nature and properties of the metal. Under these circumstances any contribution to our knowledge of steel coming from the pen of M. Chernoff would probably well deserve the attention of English metallurgists. The first of the papers referred to was published in 1868, but was not translated into English till 1876. It deals with the chemical composition of steel, the effects of introducing extraneous subjects into its composition, and the effect upon its properties and molecular structure of heating the metal up to various temperatrues as high as the melting point, and then cooling it again from the melting point.

In 1876 M. Chernoff published a paper on the Bessemer Process, "which gives a number of interesting analyses made at the Abouchoff works and elsewhere, and institutes a comparison as to the dimensions of apparatus, quantity of air required, and other details, in different countries and for various qualities of iron."

In 1878 he produced a paper on the Structure of Cast-Steel Ingots, which deals with the nature and origin of the defects to be met with in ingots, and the proper method of obviating them. This paper also goes into the very important question of whether steel-castings do or do not require subsequent treatment under the hammer, and the author gives tables of experiments to show that by proper annealing steel-castings can be rendered "fully as tough, tenacious, and ductile as the forged metal."

Mr. Anderson has done good service by translating these papers for the benefit of English readers. He notices at the beginning of his own paper that the Russian language is so little understood that it is only by accident that the labours of many very distinguished Russians became known in Western Europe. We commend this remark to the attention of the editorial committee of the Institution of Civil Engineers The *Transactions* of the Institution beenfit some time been remarkable for the admirble series of abstracts of papers Institution foreign periodicals. No English committee of the mplain that the scientific publications of other countries are inaccessible to him, therefore it seems the greater pity that any little difficulty about the language should cause the labours of Russian savants to have been overlooked.

The latter portion of Mr. Anderson's paper has mosting to do with M. Chernoff. It deals principally with the effect which occluded gases seem to play in the hardening and tempering of steel, and also considers the molecular changes, and the variations in the specific gravity of steel brought about by tempering. On this point we should like to draw the author's attention to a most interesting series of experiments by Dr. Schott, a German, on the effect of tempering glass in oil; a *résumé* of which is to be found in the foreign abstracts of the last volume of "Transactions of the Institution of Civil Engineers."