Hughes' induction balance was made evident, the source of current being three Leclanché cells, and the interrupter being of the scraping contact type actuated by clockwork.

Among other experiments was shown one to prove that in certain cases the parts into which a rapidly alternating electric current is divided may be greater than the whole (see *Phil. Mag.*, vol. xxii. p. 496, 1886). The divided circuit was formed from the three wires with which, side by side, a large flat coil is wound. One branch is formed by two of these wires connected in series, the other (in parallel with the first), by the third wire. Steady currents would traverse all three wires in the same direction. But the rapidly periodic currents from the interrupter distribute themselves so as to make the self-induction, and consequently the magnetic field, a minimum ; and this is effected by the assumption of opposite values in the two branches, the ratio of currents being as 2 : − 1. On the same scale the total or main current is + 1. It was shown by means of the telephone and flame that the current in one branch was about the same (arithmetically) as in the main, and that the current in the other branch was much greater.

THE STOCKHOLM MEETING OF THE IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute, held at Stockholm on August 26 and 27, under the presidency of Mr. E. P. Martin, of Dowlais, was a most successful one. An influential reception committee, including the Governor General of Stockholm and all the leading men in the iron industry, entertained the members with lavish hospitality. The King of Sweden invited the members to supper at his Palace, and attended the meeting in person.

The meetings were held at the House of Lords, a fine building erected in 1648, and were largely attended. Addresses of welcome were given, and the President announced that Prof. W. C. Roberts-Austen, C.B., F.R.S., had been unanimously chosen to succeed him as President.

No less than eleven papers were on the programme. The first paper read was by Mr. R. Åkerman, Director General of the Board of Trade, on the development of the Swedish iron industry. He traced the history of the industry from the earliest times, and showed the influence exerted by the chemists Scheele and Berzelius on metallurgy. The Swedish production last year comprised 538,197 tons of pig iron, 189,632 tons of wrought iron, 107,679 tons of Bessemer ingots, and 165,836 tons of open-hearth ingots.

Prof. G. Nordenström read a paper describing the characteristic features of Swedish iron ore mining. He began with an account of the geology of the country, and then discussed the geographical distribution of the iron ores, their mode of occurrence, composition, mining and production. The total production last year was 2,086,119 tons. Much of the paper was devoted to the use of magnetic instruments in exploring for iron ore, a subject previously treated by Mr. B. H. Brough in a paper read before the Institute in 1887.

Mr. C. P. Sandberg's paper on the danger of using too hard rails, contained the results of experience on the Swedish railways. He considered that it is preferable to adopt a heavier weight of rail of moderate hardness, rather than to try to remedy the deficiency in weight of rails originally used by now resorting to a dangerous hardness of rail of the same section.

Mr. A. Greiner, director of Cockerill's works at Seraing, communicated, as a supplement to the paper he read in May, the results of experiments by Mr. A. Witz with a simplex motor, using blast furnace gas. The results were highly satisfactory, showing that the working of the 200 horse-power engine is very economical and as regular as that of a steam engine. The dust in the gas is in no way injurious to its continuous operation.

Mr. H. Lundbohm, of the Geological Survey of Sweden, described the iron ore deposits of Kiirunavaara and Luossavaara, the largest deposits in Swedish Lapland. The ore occurs in bed-like masses in porphyry. It is very rich, and the author estimates that there is above the level of the lake at Kiirunavaara 215,000,000 tons, and at Luossavaara 18,000,000. The situation of the beds within the Arctic circle at 67° 50′ north lat. renders them inaccessible. A railway, now in course of construction, from the Gulf of Bothnia to Ofoten, will give access to these deposits and furnish a most important source of iron ore supply.

Mr. J. E. Stead supplemented the important paper on the crystalline structure of iron by presenting further facts bearing upon the brittleness produced in soft steel by annealing. The most important point established is that phosphorus must not exceed 0·08 per cent.

The paper on the micro-chemistry of cementation, read by Prof. J. O. Arnold, was of special interest as giving a detailed description of the effect of cementation on the brands of iron sent by Sweden to England.

Mr. G. R. Johnson, of Embreville, Tennessee, contributed a paper on the action of metalloids on cast iron. He insisted that foundrymen in buying iron should require analysis as well as fracture, for it is impossible to judge of the composition of an iron merely by looking at it.

Prof. W. C. Roberts-Austen discussed the action of the projectile and of the explosives on the tubes of steel guns, showing the interesting results obtained by an examination of the bores of corroded guns by the aid of micro-photography. An interesting discussion followed the reading of the paper, a noteworthy contribution being supplied by Mr. Nordenfeldt.

The two other papers on the list were taken as read. Baron H. Jüptner applied the data as to the thermal relations of iron carbon alloys contained in Prof. Roberts-Austen's fourth Report to the Alloys Research Committee of the Institution of Mechanical Engineers, to correcting the conclusions expressed in his paper on the solution theory of iron and steel read last May. And Prof. E. D. Campbell, of the University of Michigan, described some further experiments made by him on the diffusion of sulphides through steel.

The usual votes of thanks were given, and the meeting terminated.

An elaborate programme of excursions was arranged. Various works in Stockholm were visited. Before the meeting a limited number of members visited the remarkable iron mines of the Arctic Circle, and after the meeting there were two excursions occupying several days : one to the ironworks of Domnarfvel, Hofors, Sandviken, and the mines of Grängesberg, Falun, and Dannemora ; and the other to the ironworks of Laxå, Degerfors, Bofors, Uddeholm and Storfors, and to the Persberg iron mine. All the arrangements were most satisfactory, and great credit is due to the Hon. Secretary of the Reception Committee, Mr. J. C. Kjellberg, and to Mr. Brough, the Secretary of the Institute.

THE OLD BEDS OF THE AMU-DARIA.

THE Russian Geographical Society has just issued a new volume which contains an important contribution to the much debated question as to the old beds of the Amu-daria. It is written by the mining engineer, A. M. Konshin, and contains a geological map showing the extension of the Pliocene and modern Caspian deposits, as well as of the Loess and the fluviatile deposits in the Transcaspian region, and a number of drawings of dunes and *barkhans* (of aeolic origin), and small plans of the Uzboi and the Ungus (supposed old beds of the Amu).[1]

When the Transcaspian region was first opened to scientific exploration it was generally believed that the ravine which runs from Lake Aral to the Caspian Sea, the Uzboi, as well as the Ungus and the Kelif Uzboi, represent old beds of the Amu, which, continually shifting its bed towards the right, ran successively at the foot of the Kopet dagh, then across the Karakum desert, and finally, after having taken to its present bed, sent a branch towards the Caspian Sea along what is now known as the Uzboi. This hypothesis has still a fervent adherent in Baron Kaulbars. A further exploration of this region, which was made in 1883, proved, however, that the Uzboi has not the characters of an old river bed, and that in Post-Pliocene times the Caspian Sea sent a broad gulf eastwards, into what is now the Karakum desert. The Ungus, which crosses this desert, is also not an old bed but an escarpment by which the Pliocene clays of the Karakum Plateau fall towards the lower-lying Post-Pliocene Karakum Sands. Consequently, two hypotheses are now in presence. One of them, supported by M. Konshin, is that a gulf of the Caspian stretched as far eastwards as the longitude of Merv, sending in its western part a branch northwards, along the Uzboi, as far as the

[1] "Contribution to the Question relative to the Old Course of the Amu-daria." 256 pp. with several maps and drawings. St. Petersburg, 1897. (*Memoirs of the Russian Geographical Society*, General Geography, vol. xxiii. part 1). Russian.

Sarykamysh lakes. When this gulf began to desiccate, the Amu began to flow northwards, in its present bed. The other hypothesis, developed with great skill by M. Obrucheff ("The Transcaspian Lowlands," 1890), is that the Karakum gulf existed and received the Amu with its tributaries, the Murghab and the Tejen; when the gulf began to desiccate the Amu continued to flow that way and entered the Caspian, and only later began to flow northwards, sending a branch along the Uzboi.

In his new volume M. Konshin discusses this hypothesis in detail, and gives his arguments in favour of his own views. His chief arguments are, first, that the Caspian shells, belonging to species now living in that sea (*Dreissena*, *Hydrobia*, *Neretina*, and *Lithogliphus*), are found in the southern parts of the Uzboi, uncovered by deposits of fluviatile origin, as also at the western entrance of the Karakum Gulf, where they are found at elevations of from 140 feet to (at least) 175 feet, and occasionally 280 feet, above the present level of the Caspian; and next, that the Karakum Sands bear no traces of fluviatile deposits or of the levelling action of water which would be apparent in case the Karakum Gulf had harboured a river after its desiccation. The hillocks, 150 feet to 250 feet high, which cover these sands, are marine dunes, and the elongated depressions filled with salt water (*shors*), which are considered as indicative of old river beds, have nowhere the regularity which old river beds would be possessed of. They are traces of a retreated sea.

It is evident that further exploration is wanted; but it must be acknowledged that the absence of river deposits in the Karakum Sands militates in favour of M. Konshin's views. P. K.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PROF. R. B. OWENS, of the Nebraska University, has been appointed to the McDonald chair of Electrical Engineering in the McGill University, Montreal.

THE following appointments have been made in the School of Agriculture, Ghizeh, Egypt:—Senior Professor of Agriculture, Mr. H. J. Mohson, lecturer on agriculture and horticulture at the Yorkshire College, Leeds; Junior Professor of Agriculture, Mr. Andrew Linton, B.Sc. (Hons.), Durham University.

THE 1898-99 programme of technological examinations conducted by the City and Guilds of London Institute has just been published by Messrs. Whittaker and Co. The contents comprise syllabuses of the seventy subjects in which examinations are held, and copies of the papers set at this year's examinations. At the end of the syllabus of each subject is a list of works of reference, which must prove of great service to both teachers and students.

THE doctorates conferred by universities in the United States in 1897 are classified in *Science*, with the view to comparing the tendency of the work of the students. It is pointed out that the American university is definitely a place for research, where both teachers and students are engaged in research or in learning the methods of research. The results of the work of the students is, therefore, in large measure summarised by the theses for the doctorate, and it is interesting to know what is the outcome of the past year's research. It appears from the classified list referred to that eighteen leading universities conferred the Ph.D. degree on 234 candidates. Of this total number, no less than 105 degrees were conferred for scientific theses. The Humanities came next with 91 degrees, while History and Economics numbered only 38 degrees.

THE reports of inspectors on schools and classes under the Department of Science and Art, contained in the forty-fifth annual report of the Department, show that the teaching of science in the Government schools is undergoing distinct improvement. In the schools of science inspection has entirely taken the place of examination, at any rate in the elementary course, and this, by relieving the teacher of the strain entailed by preparation for examination at a prescribed date, has tended to sounder and more satisfactory work. It is being gradually realised that a school of science should be characterised more by a systematic course of study than by the mere possession of laboratories and apparatus. In classes in physics and chemistry a decided improvement in the methods of teaching is reported. Apparatus is more freely used than formerly, the teaching is less mechanical, and increased attention is being given to practical work. There can be no doubt that the practical instruction in these and other science subjects adds enormously to the value of the theoretical lessons, and it is to be hoped that the number of schools arranging for such work will increase year by year.

THE coordination of the work of the class-room and laboratory was the subject of a paper read by Prof. Gaetono Lanza, Professor of Applied Mechanics, Massachusetts Institute of Technology, at the recent annual meeting of the American Society for the Promotion of Engineering Educatio n. Prof. Lanza insisted that pure science and literature should not be neglected in an engineering education, and he pointed out that to impart to the student a thorough mastery of scientific principles far outweighs in importance anything else that can be done for him, and this is the chief function of an engineering course. The class-room work forms the basis of the course; and the laboratory work, to serve its purpose, must be based upon the class-room work which has preceded it, must be thoroughly coordinated with it, and must be made to depend upon it, to use it, and to serve as an aid to illustrate the principles involved. The functions of the engineering laboratory are partly to emphasise and illustrate the work of the class-room, partly to drill the students in performing carefully and accurately such experimental work as they are liable to be called upon to perform in the practice of their professions, and partly to teach them to carry on experimental investigation. In order to fulfil these purposes there should be an intimate relation between the class-room and the laboratory work, and the student should be made to work up the results of the tests in the light of what he has learned in the class-room. Prof. Lanza concluded by expressing the view that any organisation which does not tend to preserve the most intimate relation between the two, is not for the best interests of the student and should not exist.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, vol. iv. No. 10, July.—The structure of the hypoabelian groups, by Dr. L. E. Dickson, gives a marked simplification both in the general conceptions and in the detailed developments of the theory of the two hypoabelian groups of Jordan and of the author's generalisation ("the first hypoabelian group generalised," *Q. J. of Mathematics*, 1898), to the Galois field of order 2^n of the first group. It is important, for the generalisation, to give these groups an abstract definition independent of the theory of "exposants d'échange," by means of which Jordan derived them. The crucial point in the simplified treatment lies in the discovery of the explicit relations

$$\sum_{i,j}^{1\ldots m} a^{(i)}_{j}\,\delta^{(i)}_{j} = m,\ \sum_{i,j}^{1\ldots m} a^{(i)}_{j}\,\delta^{(i)}_{j} + \alpha'_1 + \beta'_1 + \gamma'_1 + \delta'_1 = m,$$

satisfied by the substitutions of the simple sub-groups J and J_1, respectively, but ruling out the remaining substitutions of the total hypoabelian groups G and G_1. The paper was read in abstract at the Chicago meeting, April 9.—The following five papers were read at the meeting of the Society held on April 30 (for an account of five other papers read at the same meeting, see vol. lviii. No. 1500, p. 310).—On the Hamilton groups, by Dr. G. A. Miller. Dedekind's definition of such a group is that it is a non-Abelian group, all of whose sub-groups are self-conjugate. If the order of such a group is $p_1^{a_1} p_2^{a_2} p_3^{a_3} \ldots$ ($p_1, p_2, p_3 \ldots$ being prime numbers) it must be the direct product of its sub-groups of orders $p_1^{a_1}, p_2^{a_2}, p_3^{a_3}, \ldots$ since each of these sub-groups is self-conjugate, and no two of them can have any common operator except identity (*Math. Annal.*, vol. xxii. p. 97). Each of these sub-groups is either Abelian or Hamiltonian. Dr. Miller proceeds to show that one of the given prime numbers must be 2, and that every sub-group whose order is a power of any other prime number must be Abelian. The results are conveniently summarised at the end of the short paper.—Note on the infinitesimal projective transformation, by Prof. E. O. Lovett. The writer proposes to find the form of the most general infinitesimal projective transformation of ordinary space directly from its simplest characteristic geometric property. Geometrically, these transformations are those infinitesimal point transformations which transform a plane into a plane, *i.e.* which leave invariant the family of ∞^3 planes of ordinary space.—Prof. Lovett contributes a further note on infinitesimal transformations of concentric conics. He defines a family of curves to be invariant under the transformations of a continuous group of transformations when the family is invariant under the