explosive effects; such ignitions, though occasionally observed in small mills, being caused either by the striking of fire by the stones, or by the incautious application of a light near the millstones, or the meal-spout attached thereto, have not in these instances been attended by any serious results. But in an extensive mill, where many pairs of stones may be at work at one time, each pair has a conduit attached to it, which leads to a common receptacle called an exhaust-box; into this the mixture of air and very fine flour-dust which surrounds the millstones is drawn by means of an exhaust-fan, sometimes aided by a system of air-blowers. The fine flour is allowed to deposit partially in this chamber or exhaust-box, and the air then passes into a second chamber called a stive room, where a further quantity of dust is deposited. It follows that when the mill is at work these chambers and the channels or spouts connecting them with the atmosphere immediately surrounding each millstone, are all filled with an inflammable mixture of the finest flour-dust and air, and that consequently the application of a light to any one of those channels, or the striking of fire by any one of the millstones, by igniting some portion of the inflammable mixture, will result in the exceedingly rapid spread of flame throughout the confined spaces which are charged with it, and will thus develop an explosion. The violence of such explosions depends much upon details of construction of the exhaust-boxes and stive rooms, and upon the dimensions of the channels of communication; it must obviously be regulated by the volume of inflammable mixture through which fire rapidly spreads and upon the extent of its confinement.

The subject of flour-mill explosions, though it has attracted little if any attention in this country previous to the Tradeston explosion, is discussed in continental treatises on flour-mills, and the results of Professors Rankine and Macadam's inquiries have demonstrated that accidents of this kind are actually of ordinary occurrence in mills, especially since the introduction of the exhaust arrangements. Those gentlemen point out that it appears scarcely possible to guard against such accidents altogether, although the frequency of their occurrence may probably be much reduced by adopting efficient precautions to prevent, as far as possible, a stoppage of the "feed" to the millstone, or the accidental introduction of nails between them together with the grain, and by prohibiting the employment of naked lights in the vicinity of the mills and the dust passages. In order to reduce as far as possible the damage and risk of sacrifice of life resulting from such explosions, it is important that all receptacles into which the dust-laden air is drawn from the mills should be fixed outside the buildings, and constructed so as to offer as little resistance as possible to the sudden expansion resulting from the ignition of the inflammable mixture. The conduits leading from the mills to the exhaust chambers should, moreover, be of small dimensions, and there should be no other communication between the interior of the building and the dust receptacles, which must not be opened while the mill is at work. By adopting precautions of this kind the mill-owner may succeed, at any rate, in reducing the mischief resulting from an accidental ignition of flour-dust at the millstones to such limits that the mill itself and the lives of those engaged in it will not be endangered.

The production of explosions by mixtures of air with marsh gas, coal gas, petroleum vapours, or a finely divided inflammable solid such as flour, has been shown to be due to the application of sufficient heat to some portion of the mixture to cause the atmospheric oxygen to combine with the combustible constituents of the gas, vapour or solid, the results being the development of chemical action, the formation of gaseous products, and their expansion by the heat developed. It need scarcely be said that the same explanation applies to the producton of explosions by that class of so-called explosive agents which is prepared by intimately mixing combustible or inflammable solids with a solid oxidising agent (*i.e.*, an oxygen compound which readily yields up a part or the whole of that gas under the influence of heat, and with the co-operation of chemical force, to carbon, hydrogen, or other readily oxidisable elements). Distinct from these explosive mixtures as regards their nature, but quite analogous to them in their behaviour and the effects they produce when subjected to heat or other disturbing influences, are explosive *compounds*. The majority of these contain carbon, hydrogen, and oxygen as the most important components; they are more or less susceptible of sudden or extremely rapid transformation into gases or vapours, attended by development of great heat, in consequence either of their resolution into their elementary constituents, or generally of the rearrangement of these into comparatively simple forms of combination. Some of these explosive compounds are of such unstable character that they are liable to undergo change from very slight inciting causes, such as the existence in them of minute quantities of foreign substances of active chemical character; or they may even be prone to absolutely spontaneous charge. In such substances decomposition may be in the first instance established only to a very minute extent, but this decomposition, by the products to which it gives rise, and by the attendant development of heat, however small, may speedily promote further and more rapid change in the mass of the substance, so that eventually decomposition of violent nature may be established, and the principal portion of the compound may suddenly undergo the same transformation into gases or vapours, attended by the same development of heat, as though any one of the agencies (*i.e.*, fire, friction, or percussion) ordinarily employed to determine the explosion of these bodies had been applied. Cases of so-called spontaneous explosion thus brought about are more familiar to scientific and manufacturing chemists than to the general public, but accidental explosions of very alarming, and, in a few instances, of very calamitous character, are on record which, though not actually of spontaneous nature, in the strict application of the term, have been brought about without any apparent application of external inciting agencies, and have hence, from a practical point of view, not been incorrectly classed as spontaneous explosions.

(*To be continued.*)

SOCIETIES AND ACADEMIES

London

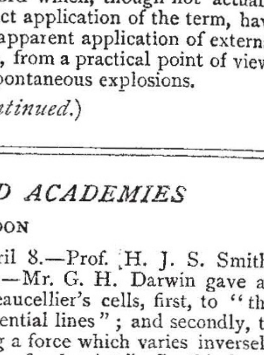
Mathematical Society, April 8.—Prof. H. J. S. Smith, F.R.S., president, in the chair.—Mr. G. H. Darwin gave an account of two applications of Peaucellier's cells, first, to "the mechanical description of equipotential lines"; and secondly, to "a mechanical method of making a force which varies inversely as the square of the distance from a fixed point." In this latter case, let o be the fixed pivot of a cell, and suppose the cell to be in equilibrium under the action of two faces, P and P', acting at D and B. Then by the principle of virtual velocities—

$$P' . \delta . oD + P . \delta . oB = o. \quad \text{Now, } oD . oB = oA^2 - AD^2$$

$$\therefore \frac{\delta . oD}{oD} = - \frac{\delta . oB}{oB} \quad \therefore P' . oD = P . oB$$

whence
$$P = \frac{P'(oA^2 - AD^2)}{oB^2}$$

If then P' is a constant force acting away from o, P is an attractive force varying as oB^{-2}. Mr. Darwin stated that the idea was the joint production of his brother Horace and himself, and that he entertained the hope that it would be possible to construct a toy to give an ocular proof of elliptic motion. A rough model was exhibited. Sir W. Thomson, F.R.S., expressed his pleasure at having heard the communication, as he had himself failed in trying to get a mechanical means of making such a force.—Sir W. Thomson then made two communications to the Society: one on the integration of the equations for the motions of a system acted on by forces expressed by linear functions of the displacements and velocities; the other on the vibrations of a stretched string of gyrostats (dynamical theory of Faraday's magnetic rotation of the plane of polarisation).—Prof. Cayley, F.R.S., made a few remarks on some integrals connected with the theory of attractions.—Mr. Tucker, hon. sec., then read a portion of a paper by Prof. Wolstenholme. The problem discussed in this paper is thus enunciated:—A tube of fine uniform bore is bent into the form of a regular polygon of n sides, and filled with equal volumes of n different fluids which do not mix; it is then closed, and held in any position in a vertical plane. The sides of the polygon formed by joining the common surfaces of the different fluids will always have constant directions; but if two conditions be satisfied, every position will be one of equilibrium. He applies his results to a few simple cases; thus, if $n = 3$, and the densities be in arithmetical progression, the straight line joining the ends of the fluid of



mean density will always be vertical. Again, if $n = 4$, and $\rho_1 + \rho_4 = \rho_2 + \rho_3$ ($\rho_1\rho_2\rho_3\rho_4$ being the densities of the fluids), then the diagonals of the square formed by the surfaces of the fluids will be vertical and horizontal. This instrument, Prof. Wolstenholme suggests, might possibly be used as a level and plumb-line; perhaps, also, some interesting toys might be made by other polygons.—A paper by Prof. J. Clerk-Maxwell, F.R.S., on the application of Hamilton's characteristic function to optical instruments symmetrical about an axis, and the value of the function for a spherical surface, was taken as read.

Geological Society, March 24.—Mr. John Evans, V.P.R.S., president, in the chair.—The President announced that the late Sir Charles Lyell had bequeathed to the Society the sum of 2,000*l.* for the purposes stated recently in our Notes, p. 434.—Prof. Prestwich proposed and Mr. W. W. Smyth seconded the following resolution:—"That this meeting, having heard the announcement of the bequest made to the Geological Society by the late Sir Charles Lyell, desire to record their deep sense of the loss the Society has sustained by his death, and their grateful appreciation of the liberal bequest for the advancement of geological knowledge placed at their disposal by their late distinguished Fellow."—The following communications were read:—On the occurrence of phosphates in the Cambrian Rocks, by Henry Hicks, F.G.S. In this paper the author showed from experiments that the Cambrian strata in Wales contain a far greater amount of phosphate and carbonate of lime than had hitherto been supposed. The results published by Dr. Daubeny some years ago, and which have since received the support of some eminent geologists, were proved therefore to be entirely fallacious when taken to represent the whole Cambrian series; for though some portions show only a trace of these ingredients, there are other beds both interstratified with and underlying these series, which contain them in unusually large proportions. The author, therefore, objects to look upon Dr. Daubeny's experiments as tending in any way to prove that the seas in which these deposits had accumulated contained but little animal life, and that we had here approached the borders of the lower limit of organic existence. He contended that the presence of so much phosphate of lime, and also of carbonate of lime, as was now proved by analyses made by Mr. Hudleston, F.C.S., Mr. Hughes, F.C.S., and himself, to be present in series of considerable thickness in the Longmynd group, Menevian group, and Tremadoc group, proved that animal life did exist in abundance in these early seas, and that even here it must be considered that we were far from the beginning of organic existence. The amount of phosphate of lime in some of the beds was in the proportion of nearly ten per cent., and of carbonate of lime over forty per cent. The proportion of phosphate of lime, therefore, is greater than is found in most of what have been considered the richest of recent formations. The amount of P_2O_5 was also found to increase in proportion to the richness of the deposit in organic remains. It was found that all animal and vegetable life had contained it from the very earliest time; but it was apparent that the Crustacea were the chief producers of it in the early seas; and of the Crustacea, the trilobites more particularly. It was always found where they were present, and the shell of some of the larger trilobites, as now preserved, contained as much as from forty to fifty per cent. of phosphate of lime. The analyses made by Mr. Hudleston and the author, of recent Crustacea, proved that they also contain P_2O_5 in very considerable proportions. In the second part of the paper the author showed that where intrusive dykes had passed through or between the beds containing the phosphate of lime, the beds for some distance on each side of the dykes had undergone a considerable change. Scarcely a trace of the P_2O_5 or of the lime was now to be found in them, though it was evident that before the intrusions into them had taken place, they, like the other portions of the beds, had evidently contained both ingredients in considerable proportions. It was well known that heat alone could not separate P_2O_5 from lime; therefore he found it difficult to account for this change in the character of the beds, unless it could be produced by gases or watery vapour passing into them at the time the intrusions took place. He thought it even probable that the dykes, which in some parts are found to contain a considerable amount of lime and also of P_2O_5, might have derived these, or at least some portions of these, from the beds through which they had been forced, and which must have been broken up and melted as they passed through them. There are no contemporaneous tuffs known in Wales of earlier date than the Llandeilo beds; and he thought these dykes belonged to that period, and that they were injected into the Lower Cambrian beds after from 8,000 to 10,000 feet of deposit had been superimposed. In an agricultural point of view the author considered that the presence of so much phosphate of lime in some of the series of beds must be a matter of great importance; and on examining the districts where these series occurred, he invariably found the land exceedingly rich. Mr. Hudleston gave the results of the analyses made by him at the request of Mr. Hicks. He found in a portion of dark gray flaggy rock taken from close to a fossil 1·62 in a portion of black slaty rock containing trilobites, but in contact with trap 0·11, in a portion of the shell of a trilobite 17·05, and in the trap above-mentioned 0·323 per cent. of phosphoric anhydride. A lobster-shell dried at 100° C. gave 3·26, an entire boiled lobster (undried) 0·76, and a boiled lobster without shell 0·332 per cent. of P_2O_5. If the analysis of an entire lobster be correct, he estimated that a ton of boiled lobsters would contain about 17 lbs. of phosphoric anhydride. In the analysis of a shell of a trilobite there appears to be a great excess of phosphoric acid, which Mr. Hudleston thought must be due to substitution.—Note on the structure of the phosphatic nodules from the top of the Bala Limestone in North Wales, by Mr. Hawkins Johnson, F.G.S. In this paper the author described the appearances presented by thin sections made from some of the phosphatic nodules and shales described by Mr. D. C. Davies, F.G.S., in his recent paper. In both nodule and shale he finds structure which he is inclined to identify with sponge-structure; but the mass also contains innumerable foreign bodies, chiefly fragments of the shells of Mollusca and Crustacea, with many irregularly ovate bodies that remind him of *Coscinopora*, and some that may be sponge-spicules. The author enumerated fourteen nodular formations from various localities and of various composition, in which he has detected organic structure, and to which he therefore assigns an organic origin; and he protested against the application of the term "concretionary" to such bodies.—On the maxillary bone of a new Dinosaur, *Priodontognathus Phillipsii* contained in the Woodwardian Museum of the University of Cambridge, by Mr. Harry Govier Seeley, F.L.S., Professor of Physical Geography in Bedford College, London. The bone described in this paper was indicated by the author in his "Index to the Aves, Ornithosauria, and Reptilia in the Woodwardian Museum," under the name of *Iguanodon Phillipsii*. Further examination and the detection of successional teeth resembling those of *Scelidosaurus*, and those referred by Prof. Huxley to *Acanthopholis*, induced him to regard the species as representing a new genus, most nearly related to *Hylæosaurus*. The specimen consists principally of the external and alveolar portion of the left maxillary bone, which is $4\frac{7}{8}$ inches long, the alveolar part being $4\frac{1}{2}$ inches, and the remainder made up by a posterior spur for connection with the malar. From the middle of the upper margin springs an ascending nasal process, separating the orbit from the nasal aperture. The presence of the posterior spur, or jugal process, seems to indicate an affinity to the Iguanodontidæ, notwithstanding the resemblance of the teeth to those of *Scelidosaurus*. The teeth, which are seen in their sockets, have their crowns resembling those referred to *Echinodon*, *Scelidosaurus*, and *Acanthopholis*, especially the last, differing chiefly by being relatively narrower, by having only 5–7 denticles on each side, by wanting the thickening at the base, and by terminating in a sharp point. The author described in detail the characters presented by the fossil, and indicated their bearing upon its systematic position. It was imbedded in a small slab of yellow sandstone, which also contained a specimen of *Pecten vagans*, and is probably of Great Oolite age.—Description of a new species of the genus *Hemipatagus*, Desor, from the Tertiary Rocks of Victoria, Australia, with notes on some previously described species from South Australia, by Mr. R. Etheridge, jun., F.G.S. In this paper the author described a new species of the genus *Hemipatagus*, under the name of *H. Woodsii*, and appended to this description some remarks on the characters of *Psammechinus Woodsii*, Laube, *Micraster brevistella*, Laube, and *Monostychia australis*, Laube; and also a synoptical list of the Australian Tertiary Echinodermata hitherto described.

Physical Society, April 10.—Prof. G. C. Foster, vice-president, in the chair.—Prof. H. M'Leod communicated to the Society some observations on the defects of the human eye as regards achromatism. The eye has been considered to be achromatic because it practically is so; but it is easy to offer abundant evidence of the defects of the organ in this respect. For instance, to short-sighted persons the moon appears to have a blue fringe. In using the spectroscope, the red and blue ends of the spectrum cannot be seen with equal distinctness without adjusting the focussing glass. A black patch of paper on a blue ground appears to have a fringed edge if viewed from even a short distance, while a black patch on a red ground, when observed under similar conditions, has a perfectly distinct margin. Prof. M'Leod then explained that the overlapping of images in the eye produced the mental impression that there is no want of achromatism. It is interesting to note that Wollaston considered that the coloured bands of the spectrum were really divided by the black (Fraunhofer) lines, and his statement that the red end of the spectrum does not appear to have a boundary line, "because the eye is not competent to converge the red rays properly," shows that he had very nearly, if not quite, discovered the achromatic defects of the eye. Dr. Young ascribes to Wollaston the merit of having observed that when a luminous point is viewed through a prism the blue end appears to be wider than the red, the eye being incapable of recognising that the spectrum has the same width throughout its entire length. An excellent experiment was then exhibited to show the relative distinctness of a dark line on grounds of various colours. A string or wire was so arranged that its shadow traversed the entire length of a spectrum which was thrown on a screen by an electric lamp. When viewed from a short distance the edges of the shadow appeared to be sharp at the red end, but gradually became less distinct, until at the blue end nothing but a blurred line remained. Dr. W. H. Stone considered that the paper was specially valuable as suggesting a possible mode of investigating the relation between the defects in the eye and the personal co-efficient of error in observation.—Prof. Guthrie showed a kaleidoscope, devised by Mr. R. Cowper, in which the usual geometrical effects were produced by fragments of mica illuminated by polarised light.—Mr. Wilson, Demonstrator in the Physical Laboratory, South Kensington, exhibited a modification of Thomson's galvanometer, which might be readily constructed at a small expense. He used two discs of glass and replaced the usual brass quadrants by tinfoil; the connection between the binding screws and the quadrants was effected by fusible solder and platinum wires.—The Vice-President then alluded to the lamented death of Mr. C. Becker, of the firm of Messrs. Elliott, whose loss will be severely felt in every laboratory in this country.

Royal Microscopical Society, April 7.—H. C. Sorby, F.R.S., president, in the chair.—A paper by the Rev. W. H. Dallinger and Dr. Drysdale was taken as read; it was entitled, "Some further Researches upon the Life History of the Monads," and described the results of a number of careful observations made in continuance of the series communicated upon former occasions.—The President read a paper on some contrivances for the study of spectra and for applying the mode of spectrum analysis to the microscope. Having exhibited and explained the improved form of spectrum microscope, the adaptation of the spectroscope to the binocular arrangement, and a new form of diaphragm, the author proceeded to show the meaning of the absorption bands and the various methods of measurement and determination, pointing out the advantages of his new wave-length system over his former plan of comparison with the quartz interference scale. The effects of acid or alkaline additions to solutions were also shown by means of diagrams.

Institution of Civil Engineers, April 6.—Mr. Thos. E. Harrison, president, in the chair.—The first paper read was on the manufacture of steel, by Mr. Wm. Hackney, B.Sc.—The second paper was on Bessemer steel rails, by Mr. Josiah Timmis Smith. The object of this paper was to endeavour, briefly, to show that, with care in manipulation and in selection of materials, Bessemer steel might be produced constant in quality, and that certain inexpensive tests might be applied which would absolutely determine the quality of the material, in most if not all of its characters, so far as was required for railway and structural purposes.

PARIS

Academy of Sciences, April 5.—M. Frémy in the chair.—The following papers were read:—On a singular case of magnetisation, by M. J. Jamin.—On the theory of aspiration, with remarks on the new note of M. Peslin, by M. Faye.—On the limits of combining carbon with iron, by M. Boussingault.—On some documents relating to the history of diabetes, by M. Andral.—M. van Beneden then presented to the Academy a work on parasites in the animal kingdom.—The Academy then nominated a number of gentlemen to superintend the competition for various prizes during 1875.—On a scientific balloon ascent of long duration, by MM. Sivel, Crocé-Spinelli, A. and G. Tissandier, and Jobert. This is a detailed account, with several diagrams, of the ascent made by these gentlemen in the balloon *Le Zenith* on March 23rd last. The balloon was 18 metres in diameter, and held 3,000 cubic metres of gas; the scientific observations were made with barometers, thermometers, hygrometers, compasses, telescopes, and spectroscopes. Moreover, they had a fine electroscope, with a long copper wire of 200 metres, and an apparatus to measure the absorption of carbonic acid. The observers saw a fine lunar halo and six shooting stars, one of which with a long intensely blue trail. Four carrier pigeons were despatched, none of which returned to Paris.—A note by M. Sirodot, on the Mammoth of Mont-Dol (Ille-et-Vilaine).—On the relation between the *m* cyclic periods of the exponent of an algebraic curve of the *m* degree, by M. Max Marie.—Researches on co-variables, by M. C. Jordan.—A memoir by M. H. Durrande, on the applications of the general theories of dynamics to the motions of a body of varying form.—A note by M. Bouty, on the quantities of magnetism and the situation of the magnetic poles in thin needles.—On the physical properties of thin layers of collodion, by M. E. Gripon.—On the formation of iodic acid in flames in which iodine is volatilised, by M. G. Salet.—A note by M. R. Engel, on the substitution of hydrogen by mercury in creatine.—A note by by M. Lecoq de Boisbaudran, on the inequality of action of different isomorphous bodies on the same supersaturated solution; account of experiments made principally with potassic chrome alum and ammonia alum.—On a new process of extracting salt from soils, applied in the South of France, by M. A. Joannon. This process renders large tracts of land, which are now lying bare and unfertile, fit for purposes of agriculture.—A note by M. A. F. Marion, on the anatomy of a remarkable species of the group of Nemertida, *Drepanophorus spectabilis*.—A note by M. E. Prillieux, on tumours produced on the wood of apple-trees by the *Puceron lanigère* (a parasitic insect).—A note by M. Dezautière, on the sounds produced by the heart.—MM. Schnetzler, Pelletrau, Chase, Nodey, Chaperon, and Delfau, then made some communications with regard to Phylloxera.—M. Petrequin then addressed to the Academy several papers on the application of galvano-puncture in the treatment of aneurisms.—A memoir by M. Jacquet, on the use of the tables of Pythagoras for any number.—A note by M. Tridon, on the means of making telescopic observations and obtaining photographic proofs in the inside of an aërostatic diving-bell.—A note by M. Gruey, on the zodiacal light observed at Toulouse in February and March 1875, giving detailed tables of the observations of this interesting phenomenon.—On a method of calculating the absolute perturbations of comets, by M. Hugo Gyldén.—On manganesiferous iron from carbonates, by MM. L. Troost and P. Hautefeuille.—Researches on the carbon of white cast-iron, by M. P. Schützenberger and A. Bourgeois.—On the theory of storms, a reply to M. Faye, by M. H. Peslin.—A note by M. Hildebrand Hildebrandsson, on the superior currents of the atmosphere in their relation to the isobarometrical lines.—On a new formula for the calculation of the refractive power (or the number) of convex lenses, by M. Monoyer.—Gen. Morin then presented to the Academy a new part of the *Revue d'Artillerie*, published by order of the War Minister.

CONTENTS