drive pumping and ice-making machinery and an air-propeller fixed in the roof for ventilating ; on the farm the motors are used for elevating hay and corn sheaves to the top of the stacks, for thrashing, for cutting rough grass with a chaff-cutting machine for ensilage, in fields extending to a distance of two miles, for grinding corn, &c., to make fodder, and for other purposes. The motors have also been used for pile-driving, for making cofferdams where necessary in the river, and also for dredging the river and clearing it of weeds, and for pumping the town sewage into a tank at the height of thirty feet for irrigation. The conductors are carried overhead on poles about the farm and underground in wooden troughs to the house. The practical methods employed for electric locomotion—being those of a third insulated rail, an overhead conductor, an underground insulated conductor, and storage batteries—are described, and examples of the application of all are given. To the first belong the Portrush Railway, and Besbrook and Newry Tramway ; to the next the electric railway at Moedling, near Vienna, and the Frankfort-Offenbach railway. This plan has been most largely adopted in America, where there are probably not far short of one hundred electric railways at work and projected. Of the underground conductor, the most important example is the electric tramway at Blackpool, while storage batteries are being employed on the North Metropolitan Tramway in London. The ordinary rails have been used as conductors in the short electric railway at Brighton, where the expenses amount to twopence per car-mile.

The plan of transporting material in skips on overhead wire-ropes by means of electricity, introduced under the name of telpherage by Prof. Fleeming Jenkin, has been employed with success for two years past at Glynde, near Lewes, for transporting clay to the railway over a distance of 1600 yards, and is applicable for use in places where material has to be conveyed across hilly districts. In the author's opinion a modification of this plan might be advantageously applied to alleviate the heavy street traffic in our larger cities.

The author considers the question of electric lighting under the three aspects of comfort, convenience, and economy. As regards the first two, electric lighting has the advantage over other systems ; whilst as regards cost, although electric lighting, and especially incandescent electric lighting, is still heavy, yet for lighting main streets and railway stations, or other places where concentrated light is required, the arc light is cheaper than gas. As its use extends, the cost of working becomes reduced. Thus in the Waverley Station, Edinburgh, on the North British Railway, thirty-three arc lamps, with 41,884 lamp hours, cost 2·77 pence per lamp hour from July to December 1884 ; whilst in 1886, thirty-nine arc lamps, having 55,068 lamp hours, cost 1·79 penny per lamp hour.

The cost of incandescent lighting is especially variable, and affected by the local conditions of the installation. The chief of these are the average number of hours of lighting each lamp, and the average distance of the lamps from the generating station. Where conditions are favourable, incandescent lighting can already compete with gas. Messrs. George Jager and Sons' yearly cost of lighting their sugar refinery at Leith is given as an example, it having been £347 with gas and £204 with incandescent lamps. The author draws special attention to the circumstance of the much larger application of electricity to lighting in the United States as compared with this country. In the United States there is hardly a city or town of 20,000 inhabitants which has not a central station for arc or incandescent lamps ; and many towns of 3000 to 4000 inhabitants are also supporting them.

The efficiency of dynamo machines being as high as 95 per cent., and there not being much likelihood of material improvement in steam engines, the author draws attention to the importance of improving the lamps by making them with a higher resistance and greater efficiency, the voltage having a great effect on the cost of working distant lamps. Transformers, by means of which high tension currents of electricity, sent from a distant generating station along a small conductor with comparatively small percentage of loss, can then be converted into low tension currents for the supply of ordinary incandescent lamps, are receiving a large amount of attention, the loss by conversion being as low sometimes as 5 per cent. Efforts are also being made to introduce the system of secondary batteries, charged in series by a high tension current, and discharged in parallel circuit, and if it can once be demonstrated to be economical, there would be a large field of application. At Leamington an extensive central station is now at work, the cost of the undertaking being £30,000 ; while the Bradford Corporation have recently voted a sum of £15,000 for erecting a central station in their town. Both these are instances of direct supply without transformers or secondary batteries. Electric metallurgy is a branch of electric engineering to which attention was first drawn by the late Sir William Siemens, whose death occurred before he had perfected his invention. The electrochemical separation of ores on a commercial scale by the electric furnace has been recently put to the test, chiefly in obtaining aluminium from conundrum. The furnace designed by Prof. Mabery is built of fire-brick and lined with powdered charcoal ; electricity is conducted to the ore by carbon rods, meeting near the centre. The ore mixed with charcoal and granulated copper surrounds and covers the carbons ; the furnace is closed with a layer of charcoal and a lid lined with fire-brick. A current of 50 volts electromotive force is supplied and melts the metal around the electrodes, which are moved apart gradually until the whole is melted. The conundrum becomes gradually deoxidized, the aluminium combining with the copper, while the oxygen with the carbon escapes as carbonic oxide, about five hours sufficing to complete the reduction. Aluminium, being only one-third the weight of iron, and possessing great strength, its production at a cheap rate would probably cause a revolution in engineering construction.

The meeting was presided over by Mr. E. H. Carbutt, the President, who was re-elected to the chair, whilst Sir Douglas Galton, K.C.B., was the new member elected on the Council. The meeting was as usual of a very successful character.

THE NATIONAL SMOKE ABATEMENT INSTITUTION.[1]

IN presenting the Report to the members for the year 1887, the Council consider it desirable to reprint from the Memorandum of Association the objects for which the Institution was established. These are the following :—

To promote the abatement of coal smoke and other noxious products of combustion in cities and other places, in order to render the atmosphere as pure and as pervious to sunlight as practicable. To check the present serious waste of coal, and the direct and indirect loss and damage accompanying the overproduction of smoke and noxious products of combustion. To continue, organize, and extend the public movement inaugurated and hitherto carried on by the Smoke Abatement Committees (otherwise known as the Joint Committees for Abatement of Smoke, appointed by the National Health Society and Kyrle Society of London, and the Smoke Abatement Committee of Manchester), and to take up and proceed with any work undertaken or commenced by such Committees. To advance the aforesaid objects by promoting and encouraging the better and more economical use of coal and coal products, and the selection of suitable fuel, as well as general improvement in the various modes of obtaining, applying, and using heat and light for domestic and industrial purposes. And in connection with such objects to obtain and provide such buildings, appliances, and assistance as may be deemed expedient. And without prejudice to the advancement of the objects aforesaid by other means to advance the same by the following means more particularly :—

(*a*) By calling public attention to the serious pecuniary loss and injury, to the health and comfort, which arise from coal smoke, and from defective heating, ventilating, and lighting arrangements.

(*b*) By stimulating, assisting, and encouraging inventors, manufacturers, traders, and others to bring forward, develop, and perfect new or improved fuels, substances, methods, and appliances for the generation or application of heat or light, and for consuming or lessening the production of smoke and noxious products of combustion.

(*c*) By conducting practical trials of fuels, apparatus, and systems connected with the generation or application of heat or light, and causing reports to be made thereon for the guidance, assistance, or information of inventors, traders, intending users, and the public generally.

(*d*) By granting awards, certificates, medals, or prizes in connection with approved fuels, methods, or apparatus.

(*e*) By establishing, or assisting in establishing, public exhibitions, either periodical or otherwise, of appliances pertaining to heating, ventilating, or lighting.

[1] Report of the Council for the year 1887.

(*f*) By collecting and recording statistics and information, and making, assisting, or encouraging experiments or researches as to the effects upon the atmosphere, and upon life, health, and property of the use of coal and other fuels and means employed or to be employed in connection with heating or lighting; and by printing, publishing, and circulating any such statistics or information, including the intended report of the Committees aforesaid, or any similar composition or literary work.

(*g*) By imparting information, instruction, and assistance to local authorities, manufacturers, workmen, householders, servants, and the public generally whether by means of lectures, demonstrations, pamphlets, written articles, or otherwise in relation to the subject of smoke prevention or abatement.

(*h*) By joining or concurring with any other institution, society, or persons, in doing or causing, or procuring to be done, any of the things aforesaid.

To promote the abatement of noxious vapours arising from manufactures or manufacturing processes, and to resort to and use for that purpose powers and means analogous to those hereinbefore contemplated with reference to Smoke Abatement and any other reasonable means. For all or any of the purposes aforesaid, either alone or in conjunction with others, to promote legislation and parochial and other regulations, and to assist in the enforcement thereof, and of any existing or future legislative, parochial, or other regulations.

In reporting upon the business transacted by the Institution during the past year, it is essential that the members should be reminded of the urgency for further legislation on the subject of smoke prevention.

The Institution has been in communication with the medical officers of health and chief constables throughout the country, and the most valuable information obtained with reference to the working of existing by-laws is given as supplements Nos. 1, 2, 3, 4, 5, and 6, to a paper on Smoke Abatement, read at the Bolton Congress of the Sanitary Institute. These supplements are published in the Transactions of the Sanitary Institute of Great Britain, and by reference to them it will be seen that the municipal authorities of Liverpool are much more alive to the necessity of prosecuting offenders against the Smoke Abatement Acts than the authorities in any of the other places from which reports have been obtained.

By comparison with the Report issued by the Commissioner of Police for the Metropolis of 1886, it will be seen that the number of cases in which fines were imposed in Liverpool was 545, whereas the number of convictions in the metropolis amounted only to 82. It might further be noted, however, in respect to the penalties imposed, that the average of all the fines in Liverpool was 19*s.* 11¼*d.* The average in London was £1 17*s.* 5*d.* The inadequacy of the fines imposed is a serious obstacle in dealing with police prosecutions, and the fines have little effect, if any, in the prevention of smoke, in consequence of the amount of the penalty being so disproportionate to the financial positions of the persons on whom they are imposed.

During the year attention was prominently called by Lord Stratheden and Campbell to the provisions in the Bill introduced by him to the House of Lords "To amend the Acts for abating the nuisance arising from the smoke of furnaces and fire-places within the Metropolis," and resulted in a Select Committee being appointed to consider the terms of the Bill, and to report to the House of Lords. The minutes of evidence were laid before the House of Lords on the 15th of July, 1887, and the published Report contains much valuable information with respect to the working of the Smoke Abatement Acts:—The nuisance created by steamers on the Thames; the necessity for extension of the metropolitan area to be within the Acts; the necessity for controlling the emission of smoke from club-houses, hotels, private residences, and other buildings not within the scope of the existing Acts; the usual course followed by the police in instituting prosecutions; a return showing the number of police employed in carrying out the Smoke Nuisance Abatement Acts; the effect of the increase of smoke on the health of the people, and the advantages from a sanitary point of view to be derived by the prevention of smoke; also particulars regarding the commercial advantages to be derived by the consumption of smoke; particulars of the methods which might be adopted for the complete combustion of fuel in domestic grates; and generally, a great mass of information dealing with the subject laid before the House of Lords by the following gentlemen: Mr. W. R. E. Coles, the engineer appointed by the Home Secretary to examine furnaces in the metropolis; Mr. James Edward Davis, of the Home Office, legal adviser to the Commissioners; Mr. Charles Cutbush, Superintendent of Police; and Mr. Ernest Hart, Chairman of Council of the National Smoke Abatement Institution.

By reference to the Police Orders and Regulations reprinted at the end of this Report, it will be observed in paragraph 36 that hotel-keepers in the metropolis not using steam-engines can only be proceeded against under Section 19, Sub-Section 3, of 29 and 30 Vict., cap. 90, and be guilty of an offence under that Section. In consequence of this Act of Parliament, Section 19, Sub-Section 3, stipulates that any chimney (not being the chimney of a private dwelling-house) sending forth black smoke in such quantity as to be a nuisance is exempt from the working of the Act and it is left to the justices to dismiss the complaint if they are satisfied such fire-place or furnace is constructed in a manner to consume, *as far as practicable*, all smoke arising therefrom, but it does not state any standard smoke shade or any degree to be fixed upon as the limit, and therefore the justices may or may not convict at their option.

The purpose of Lord Stratheden and Campbell's Bill is to prohibit or regulate the emission of smoke from any building, no immunity being granted to hotels, club-houses, or domestic fire-places now exempted from the existing Acts. The effect of the general evidence brought before the Select Committee of the House of Lords was a resolution to await the results of the further operation of the existing Acts, the purpose and intention of which should, it was held, be more fully carried into effect.

The Council invite the careful consideration of members to the necessity for legislation, and on an early date will arrange for a series of meetings to be held, at which it is expected the sanitary inspectors from the leading provincial towns will assemble, in order to compare and suggest revisions for the existing municipal by-laws, as well as for the purpose of drafting propositions to submit to the authorities on the subject of improved legislation in the metropolis.

The Council having considered the desirability of taking the first opportunity for conducting simultaneous tests of the furnaces of a large number of steam-boilers under equal conditions, thought that such an opportunity might be offered at the forthcoming Exhibition to be held in Glasgow. They accordingly directed the Secretary to write to the Lord Provost of Glasgow, laying the outlines of their scheme before him, and suggesting its adoption by the Exhibition authorities. Briefly stated, the proposal was: That the whole range of boilers to be used for working the machinery of the Exhibition should be erected in such a manner that each boiler should have its setting and chimney independent of the other boilers, so that the several systems of stoking and arrangement of furnaces could be fully tested under identical conditions of fuel, atmosphere, and time; while the results as regards smoke would be evident to the public.

It is to be regretted that the authorities in charge of the Glasgow Exhibition have not been able to see their way to co-operating with the Smoke Abatement Institution as proposed. Simultaneous tests on such a large scale have never previously been made. Many tests of great value have been made on furnaces, but these have been at separate times, and under different atmospheric conditions, and the results, however favourable in themselves, have been incapable of classification for comparison. The proposal of the Council, if adopted, would have supplied what is wanting by making these tests of several boilers at the same time, and under the supervision of an impartial body.

With reference to this subject, a correspondence has taken place with Mr. Fletcher, Chief Inspector under the Alkali Acts, as he has in preparation a report upon the injurious effect of the impurities of the air and water on the Clyde. Mr. Fletcher was asked to furnish a copy of the report, but replied that it was in the hands of the Secretary for Scotland. Application has been made to the Secretary for Scotland, and attention drawn to the importance of the series of tests which the Council proposed. The Secretary for Scotland in his reply stated that Mr. Fletcher's report has not yet been brought before Parliament, and with respect to the testing of the boilers, said that he would inform the Committee of the Glasgow Exhibition that he considers the suggestion of the Institution to be deserving of consideration and adoption.

At a meeting of the Institute of Engineers and Shipbuilders in Scotland, on the 8th of December, a very comprehensive paper

was read by Mr. George C. Thomson on "Smoke," and in the discussions which followed, Mr. W. R. W. Smith, Chairman of the Health Committee of the Glasgow Corporation, urged upon the members present the desirability of doing all in their power to secure that at the forthcoming International Exhibition in Glasgow each of the boilers be supplied with a separate chimney, so that a series of exhaustive trials may be made with mechanical stokers, &c., and other means for the purpose of showing what might be done in the way of smoke prevention.

With reference to the subject of testing, the Committee are of opinion that arrangements should be made as soon as possible for obtaining the use of three testing-rooms for testing stoves, grates, and ranges, the rooms being conveniently accessible for such articles, and having gas connections under command. The tests made in these rooms, under the same conditions of chimney and cubic capacity, would then become of greater comparative value than tests made in independent rooms.

Arrangements will be made as soon as practicable for procuring such accommodation for testing, and also for providing the necessary instruments used for testing; and as the system develops, attention will be given to the establishment of a chemical laboratory, the analysis of gases, and testing-rooms for testing-apparatus incidental to the work of the Institution.

SCIENTIFIC SERIALS.

American Journal of Science, December 1887.—On the destruction of the passivity of iron in nitric acid by magnetization, by Edward L. Nichols and W. S. Franklin. From the experiments described in this paper, which was originally read before the Kansas Academy of Science, November 1885, it appears that the action of the magnet tends to lower the temperature of transition to the active state, and that the intensity of the magnetic field necessary to convert passive into active iron at a given temperature increases rapidly with the concentration of the acid. An account is promised of further researches offering a satisfactory explanation of the manner in which the chemical behaviour of iron is modified, and its passivity destroyed in the magnetic field.—On a method of making the wave-length of sodium light the actual and practical standard of length, by Albert A. Michelson and Edward W. Morley. The preliminary experiments recently carried out according to the method here proposed seem to confirm the anticipation that it would furnish results more accurate than any of those hitherto suggested. The apparatus for observing the interference phenomena is the same as that used in the experiments on the relative motion of the earth and the luminiferous ether.—The work of the International Congress of Geologists, by G. K. Gilbert. This is a reprint of an address delivered before the Section of Geology and Geography of the American Association for the Advancement of Science at the New York meeting, August 10, 1887. It deals largely with a revised system of geological terminology, the substance of which has already been published. The question of geological coloured maps is also considered, and practical suggestions made for their greater efficiency and economy.—On the existence of certain elements together with the discovery of platinum in the sun: contributions from the physical laboratory of Harvard University, by C. C. Hutchins and E. L. Holden. These investigations, carried on with Prof. Rowland's magnificent diffraction grating, deal with cadmium, lead, tin, silver, potassium, and several other elements, including platinum, the presence of which in the solar atmosphere is here for the first time determined. Between 4250 and 4950 were found sixty-four lines of platinum, sixteen of which agree with the solar lines.—The flora of the coast islands of California in relation to recent changes of physical geography, by Joseph Le Conte. A careful study of these insular groups, at present from 20 to 30 miles distant from the coast, shows that they at one time formed part of the mainland, from which they were undoubtedly separated during the Quaternary period. That they still formed part of the continent during later Pliocene times is shown by the remains of the mammoth found on Santa Rosa, one of the largest and furthest off of the whole group.—A new instrument for the measurement of radiation, by C. C. Hutchins. The instrument here described and illustrated presents great advantages over the thermopile as an accurate measurer of radiations. It is much more sensitive and requires no longer time to return to zero than for the galvanometer needle to come to rest. A lighted match at 6 feet drives the needle round to its stop.—Mineralogical notes, by George F. Kunz. Descriptions with analyses are given of a rhodochrosite from Colorado, of crystals of hollow quartz from Arizona, of hydrophane from Colorado, and of a remarkable silver nugget weighing 606 ounces from the Greenwood mines of Michoacan, Mexico.

January.—The speed of propagation of the Charleston earthquake, by Prof. Simon Newcomb and Captain C. E. Dutton. A careful comparative study of the reports from all parts of the disturbed area shows a general average speed of $3{\cdot}214 \pm 0{\cdot}072$ miles, or 5171 ± 116 metres per second.—History of the changes in the Mount Loa craters, Hawaii; Part I, Kilauea, by James D. Dana. The first paper embraces the whole period from 1823 to 1886, during which there appear to have been at least eight discharges from Kilauea. The general dynamical conclusions are that the cycle of movement is simply (1) a rising in level of the liquid lavas, and of the bottom of the crater; (2) a discharge of the accumulated lavas down to some level in the conduit determined by the outbreak; (3) a down-plunge of more or less of the floor of the region undermined by the discharge. It is further shown that Kilauea is a true basalt volcano in its normal state, the rock material being dolerite or basalt, and the heat sufficing for the perfect mobility of the lavas.—The analysis and composition of tourmaline, by R. B. Riggs. The methods of analysis are described, with results for various specimens from different parts of North America and Brazil. The general inference is that there are three types, lithia, iron, and magnesia tourmaline, with an indefinite number of intermediate varieties, iron appearing to be the connecting link between the whole series. The special formulas of the three distinct types are:—

(1) Lithia: $12SiO_2, 3B_2O_2, 4H_2O, 8Al_2O_2, 2(NaLi)_2O$.
(2) Iron: $12SiO_2, 3B_2O_3, 4H_2O, 7Al_2O_3, 4FeO, Na_2O$.
(3) Magnesia: $12SiO_2, 3B_2O_3, 4H_2O, 5Al_2O_3, \frac{2}{3}MgO, \frac{2}{3}Na_2O$.

—On the different types of the Devonian system in North America, by Henry S. Williams. It is shown that in North America the Devonian system offers at least four distinct types in four corresponding areas, blending somewhat at their borders, but in their central parts presenting marked peculiarities. The four areas are: (1) Eastern Border, mainly in Northern New England; (2) Eastern Continental, including New York, thence southwards to West Virginia and north-westwards to Canada West and Michigan; (3) Interior Continental, chiefly Iowa and Missouri, extending northwards probably to the Mackenzie basin; (4) Western Continental, in Nevada and conterminous States.—On the law of double refraction in Iceland spar, by Charles S. Hastings. The general inference from these researches is that Huyghens' law of double refraction in uniaxial crystals is probably true to less than 1 part in 500,000, and consequently that there is no known method by which any error in it can be detected by observation alone.—In the Appendix, Mr. O. C. Marsh describes a new genus of Sauropoda and other new Dinosaurs from the Potomac formation; also a new fossil Sirenian from California.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 19.—"Notes on the Spectrum of the Aurora." By J. Norman Lockyer, F.R.S.

I exhibited to the Society on November 17, 1887, a tabular statement showing the bright lines seen in the spectra of various celestial bodies, and I also gave those recorded in the spectrum of the aurora, showing many remarkable coincidences.

I now find that the connection is closest between the auroral spectrum and that of stars III.*a*, and, in anticipation of a subsequent communication of details, I send on the accompanying table, showing the origin of Dunér's bands, so far as I have at present made them out, and their connection with the spectrum in question.

The individual observations which I have used in the table are those collected by Mr. Capron and Mr. Backhouse (NATURE, vol. vii. pp. 182 and 463).