coke; while as the temperature rises above 750° C., the pitch residue decomposes, yielding hydrogen, carbon monoxide, and methane as gases, while the carbon residue from the pitch binds the residual mass into coke. It is this residual pitch that Burgess and Wheeler have mistaken for a primary constituent of coal.

It is clear, however, that (putting detail on one side until our knowledge has been broadened by experience) the answer to the question as to what is the composition of coal—whether the answer is derived from a consideration of the actions taking place during its formation and of the substances from which it was derived, or is obtained from analytical data, as was done by Anderson and Roberts, or from the products of distillation, as has been done by Burgess and Wheeler—must be that coal is a conglomerate of humus and its degradation products with the resinic bodies and their derivatives.

(In the second lecture of the series, Prof. Lewes traced the alterations in the methods of carbonisation from Murdoch's pot stills to the latest forms of gas-making retorts, showing the reasons that led to the horizontal iron retort, its gradual replacement by fire-clay retorts, the introduction of the inclined retort, and the improvements in gas settings.)

Since 1893, when the advent of the incandescent mantle as a practical method of developing light began to do away with the necessity for gas of high illuminating value, so general became the adoption of the mantle that in 1900 applications began to be made in Parliament in various Gas Bills to reduce the standard of light for those companies whose previous average had been about 16 candles, it being felt that a 14-candle gas was better fitted for yielding light with the incandescent mantle, power in the gas engine, and for heating in gas stoves than higher qualities; and it also gave the possibility of economies in manufacture, which it was hoped might lead to lowering of the price of gas to a point at which it would better compete with fuel gas for power purposes.

During the last ten years there has been an amount of activity in attempts to alter the process of gas manufacture which has exceeded any that has taken place since the first few years of its inception, and this new era may be considered to have started with the inauguration of the vertical retort, in which, by utilising a large oval fire-clay retort set on end with a slight taper from bottom to top, much larger charges could be used than had been possible with the horizontal or inclined retorts, and in which also gravity was utilised to the full for charging and discharging.

The vertical retort dates back to 1828, when it was first introduced by John Brunton, who, finding that the gas could not escape freely from the lower portions of the charge, and so created considerable pressure, put a perforated pipe in the centre of the charge to afford an easy way of escape. Nothing more was heard of the process, so it probably failed; but at later dates attempts of the same kind were made by Lowe and Kirkham and also by Scott.

After these early experiments nothing seems to have been done for sixty years until the summer of 1903, when Settle and Padfield put up a vertical retort at Exeter and Dr. Bueb started experimenting on the subject in Germany.

Vertical retorts during the last few years have met with great success on the Continent, and their use has spread with the greatest rapidity.

In England it has been felt that, good as are the results obtained with the vertical retort working intermittently, *i.e.*, by putting in a full charge of coal, carbonising and drawing, and then recharging in the same way as with the old form of retorts, great improvements could be effected by making the process continuous, as was first attempted by Settle, so approaching more nearly to uniform conditions of carbonisation. Vertical retorts on this principle have been devised by Messrs. Duckham and Woodall, and by Messrs. Glover and West, and they certainly show results which will lead to continuous carbonisation being one of the most important factors in the future of gas manufacture.

The economies to be derived from carbonisation in bulk have on the Continent led to still further advances in the size of the charge, and little more than three years ago chamber carbonisation was introduced at Munich, in which charges of 3 to 8 tons of coal can be dealt with at a time, and this method also has met with a large amount of success, a number of installations having been erected on the principles laid down by Ries, Koppers, and others.

Many observers felt that the old horizontal retort could be made to yield better results than had hitherto been obtained, and Mr. C. Carpenter, at the South Metropolitan Gas Company's works, found that great advantages may be obtained by packing the old horizontal retorts full of coal, as had been suggested by Kunath in 1885, instead of only partly filling them, this doing away with the large space that had always been left above the charge of carbonising coal, and so eliminating to a great extent the baking of the gases and contact with the heated crown of the retort, this giving a distinct advance in make and quality not only in the gas, but in the tar.

Whilst these changes in form have been taking place, improvements in the settings, gas fuel, and regenerative firing have made such strides that the temperatures employed are limited only by the nature of the refractory materials used, and the result of these higher temperatures with light charges is to largely increase the volume of the gas obtainable per ton of coal, but at the same time its illuminating value is reduced, and the tar is deteriorated, and it also gives rise to stoppage of ascension pipes and an increase in naphthalene troubles in the service.

When iron retorts were used, the temperatures that could be employed were limited by the softening point of the iron, and rarely rose above 800° C., and although only 9000 cubic feet of gas were made per ton of coal, the gas was rich in heating and lighting value, and the tar excellent in quality. The advent of the fire-clay retort, as has been seen, enabled temperatures to be increased, and 10,000 cubic feet of gas was the general yield. With the introduction of regenerative firing, the volume of gas obtained rose to 11,000 cubic feet, whilst the more modern developments approach a yield of 13,000.

In all these changes the gas manager has been actuated by the desire to get the greatest volume of gas possible per ton of coal, and at the same time to do it with the greatest economy, and but little attention has been paid to the quality of the tar and coke, which have been looked upon as by-products. In point of fact, the tar, when temperatures were pressed to their highest in lightly charged horizontal retorts, became so poor and choked with naphthalene and free carbon as to be almost valueless.

The introduction of large masses of coal in carbonisation, for reasons which will be discussed fully later, has led to distinct improvements in this respect, and although there is no modern tar which approaches in value the product of the old iron retort, the improvement in many places of late has been very marked.

(The gradual growth of the coke-making industry was then dealt with from the Meiler heap to the modern coke recovery ovens.)

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The following are among the courses that will be held in the Faculty of Science at University College during the present term:—"General and Geological Aspects of Palæobotany," by Dr. Marie Stopes, on Tuesdays at 4 p.m., beginning on January 16; "Instruments and Maps," by Mr. M. T. Ormsby, on Tuesdays at 4 p.m., beginning on January 23; "Vertebrate Palæontology," by Prof. J. P. Hill, on Tuesdays at 5 p.m., beginning on January 23. In connection with the Francis Galton Laboratory for National Eugenics, Prof. Karl Pearson will deliver two lectures on "Sir Francis Galton," on Tuesdays, January 30 and February 6, at 8.30 p.m., to be followed on subsequent Tuesdays by a course of six lectures on "Some Problems of Eugenics."

WE learn from the *Revue Scientifique* that M. Georges Leygues has just given 25,000 francs to the University of

Paris in aid of the new Institute of Chemistry, and that M. David Weill has made a third donation of 30,000 francs to the University.

BUILDINGS costing nearly 200,000*l.* are, says *Science*, either being constructed or will be started at the University of Wisconsin before the next academic year opens. Nine new structures will be completed within the next twelve months on various parts of the University grounds. The new buildings and their cost will be as follows:—Biology hall, 40,000*l.*; wing to library, 33,000*l.*; home economics building, 23,000*l.*; model high school, 30,000*l.*; women's dormitory, 30,000*l.*; agricultural chemistry, 18,000*l.*; chemistry building wing, 15,300*l.*; horticultural building, 11,400*l.*; gymnasium annexe, 3000*l.*

A COURSE of ten lectures on illuminating engineering will be given on Tuesday evenings at the Northampton Polytechnic Institute, St. John Street, London, E.C., commencing January 16. The lectures are intended for a technical audience, and each lecture will be given by a specialist in the particular subject. The subjects of the lectures are:—"The Nature of Light and of Radiation"; "Photometry and the Measurement of Light"; "The Production of Electric Light and its Distribution"; "The Chemistry of Gas Manufacture and Lighting"; "The Use of Shades and Reflectors"; "Physiological Factors in Illumination"; "The Practical Use of Arc Lamps"; "The Practical Use of Metallic Filament Glow Lamps"; "The Practical Use of Gas Lamps."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Microscopical Society, December 20, 1911.—Mr. H. G. Plimmer, F.R.S., president, in the chair.—F. Shillington **Scales**: The photomicrography of the electrical reactions of the heart. The lecturer described the principle and construction of the Einthoven string galvanometer, with especial reference to the optical arrangements and the methods of photographing the movements of the wire, resulting from the differences in potential set up by the heart-beat. Photomicrographs of the movements of the hearts of various animals under the influence of drugs were shown.—Rev. Hilderic **Friend**: British Tubificidæ. The author first gave a brief historical sketch, alluding to the work of Lankester, Beddard, and Benham, and the various Continental and other authorities who have in past years written on the family. After showing the difficulties attending definition, and the value of the setæ for the purposes of classification, the author proceeded to arrange the British species in two classes:—(1) those genera which are destitute of capilliform setæ; and (2) those which possess them. These two groups are again subdivided, and no fewer than thirty species, besides some subspecies and varieties, are placed on record, of which ten are described for the first time, and sixteen have been added by the author during the year. Specially interesting is the discovery of a new genus, named Rhyacodrilus, containing two species, of which one (*R. bichaetus*, Friend) is new to science. These two species are as yet known only in Derbyshire. Hyodrilus is now definitely recorded as British, with no fewer than five species.

Linnean Society, December 21, 1911.—Dr. D. H. Scott, F.R.S., president, in the chair.—Rev. Hilderic **Friend**: Some annelids of the Thames Valley.

DUBLIN.

Royal Irish Academy, December 11, 1911.—Rev. Dr. Mahaffy, president, in the chair.—W. F. de V. **Kane**: Clare Island Survey Reports.—Butterflies and moths. The lepidopterous fauna of Clare Island is relatively poor, and shows a marked preponderance of northern species. The island affords a second Irish habitat for *Dasydia obfuscaria*, a remarkably melanic variety. The coast sandhills of Achill and of isolated points on the adjoining mainland are noteworthy for the occurrence of *Nyssia zonaria*, and the discontinuous range of this species, with its wingless female and sluggish herb-eating larva, presents an interesting and difficult problem to the student.—F. Balfour **Browne**: Water-beetles. Ninety species of water-beetles are now known to occur in the Clare Island district. Amongst these are some uncommon species, notably *Deronectes griseo-striatus* and *Agabus congener*; the latter insect had not been previously found in Ireland. The local *Octhebius legolissii* occurred on Clare Island. In addition to the full lists of species, a careful analysis is given of the West Mayo water-beetle fauna. The author recognises the occurrence of a distinct west-ranging Irish group of species—of both northern and southern European origin—a fact which has also been noticed in other sections of the fauna of the west of Ireland.—Miss Jane **Stephens**: Freshwater sponges. Five species of fresh-water sponges were found, namely, *Spongilla fragilis*, *S. lacustris*, *Ephydatia mülleri*, *E. fluviatilis*, and *Heteromeyenia ryderi*. The first-named is new to Ireland. Of the remaining species, *H. ryderi*, a sponge common to North America and the west of Ireland, is very widely distributed throughout the district examined. Different forms of this species are described for the first time from Ireland. The differences between the sponges growing in lakes lying on limestone and those in lakes on non-calcareous rocks are noted.

BOOKS RECEIVED.

Die Chemie der Cellulose unter besonderer Berücksichtigung der Textil- und Zellstoffindustrien. By Prof. C. G. Schwalbe. Zweite Hälfte (Schluss des Werkes). Pp. 273–666+xii. (Berlin: Gebrüder Borntraeger.) 14.80 marks.

Handbuch der bautechnischen Gesteinsprüfung. By Prof. J. Hirschwald. Erster Band. Pp. xi+387. (Berlin: Gebrüder Borntraeger.)

Annuaire Astronomique et Météorologique pour 1912. By C. Flammarion. Pp. 360. (Paris: E. Flammarion.) 1.50 francs.

Mineralogy. By Dr. F. H. Hatch. Fourth edition. Pp. ix+253. (London: Whittaker and Co.) 4*s.* net.

Increasing Human Efficiency in Business. By Prof. W. D. Scott. Pp. v+339. (London: Macmillan and Co., Ltd.) 5*s.* 6*d.* net.

The Rational Arithmetic for Rural Schools. By G. Ricks. Scholar's Book. Third Year's Course. Pp. 48. Fourth Year's Course. Pp. 48. (London: Macmillan and Co., Ltd.) 3*d.* each.

Black's Literary Readers. By J. Finnemore. Book vi. Pp. 268. (London: A. and C. Black.) 1*s.* 9*d.*

Twenty-seventh Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1905–6. Pp. 672. (Washington: Government Printing Office.)

Supplement to the Fourth Report of the Wellcome Tropical Research Laboratories at the Gordon Memorial College, Khartoum. By Dr. A. Balfour, Captain R. G. Archibald, and others. Pp. 448. (London: Baillière, Tindall and Cox.) 15*s.* net.

Handbuch der vergleichenden Physiologie. Edited by H. Winterstein. 18 Lieferung, Band ii., Erste Hälfte. Pp. 1145–1563+x. 19 Lieferung, Band iii., Erste Hälfte. Pp. 160. (Jena: G. Fischer.) 5 marks each.

Complete Yield Tables for British Woodlands and the Finance of British Forestry. By P. T. Maw. Pp. xii+108. (London: Crosby Lockwood and Son.) 7*s.* 6*d.* net.

Shackleton in the Antarctic: being the Story of the British Antarctic Expedition, 1907–9. By Sir E. Shackleton, C.V.O. Pp. 255. (London: W. Heinemann.) 1*s.* 6*d.*

Flashes from the Orient, or a Thousand and One Mornings with Poesy. By J. Hazelhurst. Book four—Winter. Pp. xi+284. (London: Hazell, Watson and Viney, Ltd.) 1*s.* 6*d.* net.

An Intermediate Course of Practical Physics. By Rajanikanta De. Pp. xii+284. (Calcutta: International Publishing Company.)

Willing's Press Guide, 1912. Pp. xiv+489. (London: J. Willing, jun., Ltd.) 1*s.*

Biological Aspects of Human Problems. By Dr. C. A. Herter. Pp. xvi+344. (London: Macmillan and Co., Ltd.) 6*s.* 6*d.* net.

A Geography of the World. By B. C. Wallis. Pp. xvi+372. (London: Macmillan and Co., Ltd.) 3*s.* 6*d.*

The Chemistry of Bread-making. By J. Grant. Pp. vi+224. (London: E. Arnold.) 5*s.* net.

Memories of a School Inspector: Thirty-five Years in