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CONTRIBUTIONS TO THE HISTORY OF CAST IRON, AND THE NATURE OF ANCIENT IRON SLAGS, ESPECIALLY IN HOLLAND.

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Some inquiries I have made relative to the ancient slags found in the highest district of our country, in Guelderland forest, and covered by the roots of trees, may be prefaced by a historical review of the invention of melting iron.

It is doubtful whether cast iron was known to the Greeks; the only author who mentions it is Aristotle (*Meteorologica*, IV., 6). Karsten (*Eisenhüttenkunde*, 3rd ed. I., p. 12) gives an interpretation of this ambiguous passage. The expressions used by Pliny (*Hist. Nat.*, xxxiv., 39-43) are quite applicable to the process of direct calcining or reducing the ore to spongy iron after the tapping off of the slags. By taking a proper punctuation, different from what is found in our printed editions, his description is quite right. "Mirumque," he says, "cum excoquatur vena, aquae modo liquari, ferrum postea in spongias frangi." That such a method was practised by the Romans, is positively stated by the Austrian geologist, Von Morlot, when describing the remains of Roman iron works at Worhein, near Vitnach, in the Oberkrain; the "fabrica," as it was called by the Romans, lies 4,000 feet above the level of the sea. A large quantity of slags with Roman antiquities have been found there, fibulae, needles of bronze, onyx, coins from the time of Augustus, 27 B.C., to that of Constantine, 333-35. (*Jahrbuch der K. K. Reichs Anstalt zu Wien*, 1850, I., s. 199.) The place belongs to the Roman province of Noricum, known by its excellent iron, as mentioned by Ovid—"Durior et ferro, quod Noricus excoquit ignis."

In the history of Siderurgie, scarcely any mention is made of the Chinese. I found in the Dutch translation of the voyage of the Portuguese, Fernando Perez d'Andrade, ed. 1517, that he saw domestic utensils cast of iron, like those which, in his age, were made at Neurenberg from brass; the Chinese utensils, he said, being very fragile, so that by falling they broke to pieces like glass.

In Western Germany and Eastern France the art of casting iron was known before it was introduced in England. In the 15th century such progress was made that a gun could be cast in one piece; until that period they were composed of three parts, and generally there were added twelve or more *culasses* (chambers) as change pieces. This is proved by some of our marine accounts, as preserved in the archives of Leyden. The last gives 1477 by mistake, as the oldest gun of cast iron in Europe was known as that of s'Hertogenbosch, named the "Diabliesse" et "Couleuvrine de Bolduc" (Bois le Duc, the French translation of the Dutch name). Its range was extraordinary. It is preserved in that town to the present time. There was engraved on it the date of the year when it was made. Firstly it was said that the year 1411 was inscribed, and this is quoted in several historical introductions to the books on iron metallurgy. From a more accurate examination, however, it appears that it was made in 1511; and that it was forged from malleable iron. The account of the blacksmith who forged it in that year has lately been discovered.

John Owen, in England, who cast guns from gun-metal, is said to have employed cast iron for the same purpose in 1535, and he was followed by Ralph Page, in 1540.

Some mention a Frenchman, Thomas Baudé, as the first who made use of cast iron in England. Notwith-

standing this, it appears that the "Blast-furnace" (Hoch-Ofen) for pig iron, was quite unknown in England before 1558.

Agricola, who finished his well-known work "De re Metallurgica," in 1550, has not made any mention of pig-iron or cast iron. He speaks only of the "Stück-ofen" as a means for calcination of such iron ores as are too refractory for a direct reduction on the "Rennherd" (ed. 1657, p. 339); he illustrates how the slags are tapped off, and the spongy iron remains in the furnace to be taken out after cooling.

In 1562, there already existed at Rostock (Mecklenburg), an "Ofengiesser." The contract of an "Eisen schmelzer" (iron-founder), Hanz Maltzsch, in 1570, is preserved, and printed, with all its details, in the "Jahrbucher und Jahresbericht des Vereins für Mecklenburgischen Geschichte und Alterthumskunde VII." p. 52 (1842). In this contract, the "first" (as yet known) mention is made of blast-furnaces to cast guns, balls, grenades, furnace pots, ironworks for mills, &c. In the same contract an arrangement was made for recovering the iron from the slags by stamping and washing. Guns were cast from iron in Saxony, in the year 1594. In the Hartz, castings from iron were earlier known. Häckens describes the iron-foundry at the Schulenberg (1572), and speaks of the blast-furnaces, and of iron pots cast by twice molten iron, "Eisenpötte und zwey geschmolzen eisen" (*Acta Historico-Chronologico-Mechanica circa Metallurgiam in Hereynia Superiori, auctore Henning Calvör*, 1763, II., p. 212).

The casting of iron was introduced into Sweden by a gentleman of Liège, Debesche, who was driven from thence by the religious prosecution of the Huguenots. In connection with this gentleman, our renowned Lodewyk de Geer laid the grand foundation of the Swedish modern iron industry. He (de Geer) developed the trade in weapons to such an extent in Amsterdam that one thousand guns were frequently exported at one time. A large number of men were employed in this industry.

The Dutch likewise introduced the iron industry into Russia. The names of the Dutchmen who, at Kaloega, constructed the first blast furnace (1613), are not forgotten; it was in the time of the Czar Michel Feodorowitz. At Toela, under their direction, were cast the balustrade for the Palace at Moscow, and the plates for the pavement of the Metropolitan Church, before there was a single iron foundry erected in Eastern Germany.

Pig iron from bog iron ore was first made in our country (Holland), in 1689, at Rekhem, in the province of Guelderland, by Josiah Olmius. These iron works were afterwards removed to the present site at Keppel, near Doesborgh. There are now seven or eight blast-furnaces, working bog iron ore in that district, as noted in my chart by blue marks.

It is a remarkable fact that large heaps of slags (noted by red Δ marks) have been found underground, covered by peat moss and overgrown by trees of large size, without any historical notice nor any relic of melting works, of furnaces, or of the habitation of man.

Several opinions have been promulgated relative to the origin of these heaps, and it was, in the first place, necessary to demonstrate by chemical analysis, as was easily done, that:—

1. The slags are not remains from volcanic action in the Rhine district—nor similar to the rare mineral from the volcanic island Fayal (The Azores)—called *Fayalit*—nor the *vulcanische eisen-glass* of Klaproth, being a refinery slag, as stated by Prof. Rammelsberg, at Berlin, where the fragment is preserved—nor Thomson's *anhydrous silicate of iron* from the Slavcarragh, in the Morne mountains of Ireland.

2. They are not fragments of a meteorite, although a few years ago a large quantity was forwarded to the Museum at Leyden, with the inscription, "Meteorite fragments." There exists, indeed, an astonishing quantity of meteorites on a large area, the Wolfsmühle, near

Thorn (Prussia), known by the description of Professor Karsten, in 1853 (Berliner Monats-berichte I., p. 30). The chemical constitution of our slags was, however, quite different. The fragments of the Wolfsmühle contained 54.75 per cent. pure iron, without any trace of carbon.

3. They are not from pig iron works or blast-furnaces. The chemical constitution was, as shown by the analysis of the fragments from a heap in the forest, called Onzalige-Bosch, near Arnheim, 80 mètres above the level of the sea :—

Silicic Acid	20.56
Oxide of Iron Fe O	56.33
Oxide of Iron Fe ₂ O ₃	10.30
Alumina Al ₂ O ₃	3.45
Oxide of Calcium Ca O	0.49
Oxide of Magnesium Mg O	0.33
Kali	0.67
Oxide of Manganese	0.10
Sulphur and Soda	traces.
Phosphoric Acid	nihil.

The comparison of the analysis from the different heaps, together clearly demonstrates that they are silicates of iron-oxide under the form of 3 Fe O, Si O₂, with a variable quantity of iron-oxide Fe₂O₃ from the decomposition and the incomplete process of reduction of the ores. The variation of the constituents is as follows:—

Silicic Acid, maximum	31.80	minimum	23.63
Oxide of Iron, Fe ₂ O ₃ "	62.10	"	46.62
Oxide of Iron, Fe ₂ O ₃ "	26.00	"	9.30
Oxide of Manganese "	1.00	"	0.01
Alumina, "	3.45	"	0.10
Oxide of Calcium, "	2.00	"	0.00

The slags contain a small quantity of alumina and the constituents of wood-ash. It is clearly demonstrated that they are not from a process where limestone is employed. They contain not a vestige of iron as regulus; a few particles of the powder are attracted by the magnet; the mass shows an attractive power on the magnetic-needle. The specif. gr. = 3.4. They resemble the slags dropping from the reverberatory furnaces for converting old or scrap-iron into forgings (*fer ramassé*), covered by the vermiculated traces of the drops, so that the farmers supposed the stones were petrified worms or snails. There are several distinct layers of the vermiculated traces in the fragments. The slags are molten easily in the reverberatory furnace as mentioned above. Their fusibility does not differ from these slags. The slags of these furnaces show the same composition:—

Slags of the reverberatory furnace for forgings—			
		at Leyden. at Delft.	
Silicic Acid... ..	25.09	...	29.50
Iron-oxide, Fe ₂ O ₃ ...	58.50	...	54.90
Iron-oxide, Fe ₂ O ₃ ...	16.50	...	15.25
Calcium-oxide	0.22	...	"
Magnesia	0.06	...	"

In several places heaps of charcoal were discovered. Under them I found a small piece of roasted bog-iron ore, with an external crust of slag. Its composition was hydrated iron-oxide 89.85, and 7.42 of silicate. At other places the charcoal was quite decayed to a black powder, and is employed by the farmers as a black dye (*noir de fumée*). In some places this black earth and charcoal powder are famed as fertilizers.*

A good deal was said of ashes to be found in the vicinity of the heaps, under and between the fragments

* At one place the ground covering the slags contained nearly 64.25 per cent. peat substances. It is a remarkable phenomenon, as was already noticed by Wallerius, relative to Sweden and Norway, that the slag-heaps were overgrown by the largest trees. He supposed that iron was a compound of an argillaceous substance, so that the slags, by their decomposition, produced a fertile ground.—(*Systema Mineralogicum*, II., p. 268).

of slags. Such a phenomenon was quite inconsistent with any process of iron manufacture. Indeed, the analysis of all that was called ashes, showed that the name only originated from the appearance; really they are diluvial sands of quartz mixed with some humus from decomposed heath and mosses. The maximum of humic substances and water was 6.70; and the minimum of insoluble sand 86.20. It was, therefore, by mistake that this grey coloured sand was called ashes.

A few small fragments of the supposed furnaces were found between the slags. These were made from diluvial sand mixed with loam. The loam was burnt to a red colour, the sand only agglutinated.

One piece of forged iron only up to this time has been found, and it is now preserved in the Archæological Museum at Leyden; antiquarians suppose that it belongs to an arch. My drawing shows it in the natural size.

Coins have not been found amidst the slags. Fragments of hand millstones from the basalt-lava of Andernach; fragments of very rude earthenware (supposed by our antiquarians to be of the Carlovingian age) and bones of calves and pigs have been collected from a heap of slags, called the Iron Mountain (Yzeren Berg). There are heaps containing several hundred loads.

The phenomenon of slag-heaps is not an exceptional one to this country. Finland, and Sweden, and Norway, as described by Ole Evenstad; the Roman and Danish cinders of the Forest of Dean (Scrivenor, "History of the Iron Trade," p. 29); the iron scoræ of Loch Goil, described by John T. T. Kyle (British Association, at Dublin, 1857); slags in the vicinity of Rouen, Dieppe, St. Amand, and elsewhere in France, examined by Berthier; the schlacken-halde of Silesia, overgrown by trees of six centuries old; "Le Champ parsémé de Scories," near Bofor, in Luxemburg, &c., &c., altogether of the same nature and chemical constitution, being silicates of iron oxides, prove clearly that the iron manufacture, direct from the ores was once generally practised in Europe, where wood and easily reducible iron ores were found. In our country, the bog iron ore was found in the vicinity of the forests, and at no great distances from the localities where the heaps of slags have been detected. Our present bog iron ores contains iron regulus 41.14 to 52.81, under the form of yellow hydrated iron-oxide mixed with diluvial quartz sand and humus.

For illustrating the simple method of the ancient process of reducing iron direct from its ores, I have in another place given a description of that now employed by the natives of Borneo, Blitong producing the steel-iron, called "pamor," of their excellent arms and guns, not different in quality from Indian "wootz." Pure oxides or hydrated oxides of iron, without lime, easily fusible at a low temperature, and charcoal or wood as fuel, are the conditions under which this process succeeds perfectly. The influence of lime on the fusibility of the slags was proved by the process of making forgings in the reverberatory furnaces at Leyden and Delft. The operation has not succeeded when using sand from the coast of Scheveningen, where the sand of the downs contains nearly 3.20 carbonate of lime, from small particles of shells—but very well when employing the pure sand of the Helder, being 99.574 per cent. pure quartz.

There can be no doubt, that for manufacturing cheap malleable iron from all sorts of iron ores, the intermediate process for pig iron is wanted; however, it cannot be denied that quantity and cheap production are gained at the expense of quality. Hence we see, that during the last years, many trials have been undertaken to modernise the method for reducing malleable iron from its ores direct. I may mention for example:—Heath's process for the Madras iron (1849); Winkler, in Silesia (1842), and Thoma, in Moravia (*Berg-und Hütten Münische Zeitung*, 1843, p. 241, 577; 1845, p. 161; 1848, 58); the trials by the order of the Oberste Bergwernbehörde, at Vienna, undertaken by Von Gersdorff and Hampe, at Neuberg; the late Ad.

Chenot, who received a medal of honour at the Paris exhibition for, "Cette perfection exceptionnelle due à la science et au travail," called by the celebrated Professor Leplay*, the greatest siderurgical progress of our age; and last of all, James Renton's patent, carried into operation in the new world, at Cincinnati, by the firm Davis and Co., by the Harvey Steel and Iron Company, at Motthaven, near New York, as mentioned by Professor Wilson, in his admirable report on the New York Exhibition. The new process, called by the German siderurgists "Erzpuddeln" (ore-puddling) by gas, as described by Mr. Thoma Gashüttenman, at Suhl, in Thuringia (Berg-und Hüttermänn Zeitung, 1856, No. 22), is perhaps the commencement of a new era to restore the primeval and semi-civilised method of manufacturing pure iron direct from its ores,

All the slags, refinery, puddling, tap-cinders, mill-furnace, from the forges, catalans, &c., of the typical constitution, 3 Fe O , Si O_3 , or silicate of protoxide of iron, are properly rich iron ores, containing 69.53 iron oxides, or 53.97 iron regulus. A question has been mooted whether our ancient slags are of any value. To answer this, I give a concise history of the propositions made for the utilisation of slags. Berthier was the first (*Journal des Mines*, tom. xxiii. p. 177, et xxvii. p. 193; *Annales des Mines*, ser. 1e, tom. vii. p. 377).—"Les scories des anciens," he says, "pourraient aussi être traitées au haut-fourneau avec beaucoup de profit, puisque leur produit moyen serait d'à-peu-près 45 pour cent de fonte. Leur abondance est telle dans les lieux où elles se trouvent, qu'elles dispenseraient pendant longtems d'employer du minerai, &c." A. N. S. Arndtz published, in 1829, a notice, to show how the slags and scoriæ could be employed for the production of iron (Kunst und Gewerbeblatt für Bayern, 1829, p. 265). In Sweden the slags are generally utilised for iron in a special furnace, called a "stücköfen," as advised by Sefström, in 1821, and described by Durocher, who visited the iron districts of Sweden and Norway in 1855-56 (*Annales des Mines*, 1856, xi., p. 497.)

What is recommended in the works on iron by Flachet, Barruel, and Petier (i. p. 28), saying, relative to these slags:—"Comme des minerais artificiels sont riches, susceptibles de rendre 40 à 60 de fonte, leur exploitations étant d'autant plus avantageuses qu'elles sont plus pures," has been practised in several iron-works on the Continent. At Liège (Seraing) commonly 28 to 30 per cent. slags and scoriæ are mixed with the poorer clay and zinc-iron ores, producing by the high-blast furnace 43 pig-iron. In 1855, all the refinery slags from the Alvensleben-hütten, in Silesia, have been melted in the high-blast furnaces of the Königshütte, by mixing them with 35 per cent. limestone, and 14 per cent. schieferthon (argillaceous schist); this succeeded likewise in 1856. In Austria the slags have been mixed with iron ores, &c. (*Oesterreichische Zeitschrift für Berg und Huttenweser*, 1855, Nos. 89 et 50).

The ancient slags of the Forest of Dean were melted for iron in the first iron-works, as mentioned by Henry Powle, in the "Philosophical Transactions," 1678, No. 137, p. 931. They were likewise transported to Bristol, for the manufacture of well-known black bottles, as recently stated by Mr. Watson, in the "Geologist." In 1846, Dr. John Percy, in his admirable report on the crystalline slags ("British Association Transactions," p. 351), observed:—"An immense quantity of iron slag, far richer than many iron ores, is annually thrown away, and it may be that the presence of phosphorus in sensible quantity is one of the causes which prevents the re-melting of this slag with advantage. This fact has not yet sufficiently attracted the attention of those engaged in the manufacture of iron. The discovery of a method of extracting economically good iron

from these rich slags would be of great advantage to the country, and could not fail amply to reward its author." Hence, we may conclude that the methods, as described in the patents of Anthony Hill (1814), David Mushet (1815 and 1822), T. T. Dawes (1833) were not tried, or were not successful. In 1854, Professor F. Crace Calvert took out a patent for the treatment of iron slags or cinders, by calcining and mixing them with 50 per cent. slacked lime (Specification printed No., 1815) and, in 1855, another patent for the same subject, the proportions being changed to 15 to 20 per cent. quick lime, or 20 to 30 slacked lime, or 25 to 50 limestone. (Specification printed, No. 1975.) To conclude, that the slags as mentioned can be remelted into iron is sufficiently proved by the success at several iron works on the continent. In England also, as kindly communicated to me by Dr. Percy, the refinery slags, cinders, and mill furnace slags, have all been worked up in the blast furnaces during the last few years.

Their special application for providing a material for puddling furnace bottoms (the patent of Bradley, Burrows, and Hall, 1838) and their employment on account of their solvent action for the reduction of copper seyds, require no explanation. Our ancient slags have been employed in copper works, and for making roads.

METROPOLITAN BOARD OF WORKS.

The annual report of the Metropolitan Board of Works has just been published as a parliamentary paper, and contains an elaborate account of their proceedings during the past year. In detailing the steps they have taken with reference to one of the most important subjects which have engaged their attention, namely, the main drainage of the metropolis, they revert to the transactions which occurred in connexion with this question shortly before the close of the period comprised in their last report, in which, however, it is hardly necessary to follow them. The powers conferred upon the board by the bill for amending the Metropolitan Local Management Act, which became law on the 2nd August, 1858, are referred to. It empowers the board to raise a sum not exceeding £3,000,000 for the purposes of the main drainage, and enable them to raise in each year, during forty years from its passing, a sum equivalent to a rate of 3d. in the pound on the annual value of the property rateable, estimated according to the basis for the county rate. The day after the passing of this act the board met for the consideration of the important works to which it was mainly directed; and referred the plans which had been submitted to the First Commissioner of her Majesty's Works to a committee who brought up a report on the 11th of the same month, and the board came to resolutions affirming the principles of drainage recommended. The following is a summary of these works. They consist of a system of intercepting sewers on each side of the Thames, making a total length of 72 miles, comprising, on the north of the river, a high level, middle level, low level, and outfall sewer, with sewers for draining the low lying area included in the extreme western portion of the metropolis. The works on the south of the river consist of a high level, low level, and outfall sewer. There will be reservoirs at the outlets, and at certain points pumping engines and machinery for lifting the sewage of the low-lying districts. The high-level sewer north of the Thames extends from the river Lea, near Old Ford, passing thence in a general westerly direction under Duckett's canal, and the North London Railway, to Stoke Newington, where it is carried under the Great Northern Railway, proceeding thence to the existing line of the Fleet Sewer, in Mansfield-road, Gospel-oak-fields, near the foot of Hampstead-hill; the size of the sewer at the Lea will be 9 feet 6 inches in height by 12 feet in width, and at the upper end it will consist of a 4-foot barrel; its length being $7\frac{1}{2}$ miles. The middle-level sewer, on the north of the Thames, will be $9\frac{1}{2}$ miles in length, and

* This process is improved by P. d'Agimont, in Belgium, and now practised by a Company at Charleroi.

it forms a junction with the high-level sewer at Old Ford, passing under the Regent's canal, and proceeding through Bethnal-green-road, Clerkenwell, and other places towards the west, till it reaches the Counter's-creek sewer, near the Great Western Railway, at Kensal-green. Its dimensions at the lower end will be 9 feet 6 inches in height by 12 feet in width, and at the upper end 4 feet 6 inches in height by 3 feet in width. In its course it will receive the Coppice-row and Piccadilly branches. The above sewers will discharge by gravitation. The low-level sewer will extend from the lift at the outfall sewer at Abbey Mills, in the Essex Marshes, where its contents will be raised by steam power into the outfall sewer, and where it is proposed to construct a pumping station. From this point it will pass in a westerly direction under the river Lea, and under the Dock Railway, the Regent's canal, and Blackwall Railway, to Tower-hill, and thence to a point near Blackfriars-bridge. Its further course from this point until its junction with the Ranelagh Sewer at Chelsea will depend on the arrangements which may be made for constructing a Thames embankment, by which it will be determined whether the sewer must be carried along some of the main thoroughfares of the metropolis, or whether it can be constructed in conjunction with an embankment in close proximity to the river. The position of the board with respect to the embankment of the Thames is clearly described in their proceedings on the 29th June in last year, where, after premising that the engineers, Messrs. Bidder, Hawksley, and Bazalgette, had recommended that the low-level sewer on the north of the river should be carried in an embankment between Westminster and London bridges, in order to avoid damage to property in the leading thoroughfares, and other injurious consequences, the board declared themselves willing to pay for a part of the Thames embankment, in such proportion as the drainage might be fairly debited with, or undertake the construction of the embankment of that part of the river for drainage and other purposes upon a contribution by the government. At the lower end the low-level sewer will be a 9-foot barrel, and at its upper extremity 4 feet in height by 2 feet 8 inches in width. It will in its course receive three branches, namely, the Hackney Brook, the Isle of Dogs, and Penitentiary branches. The high and middle level sewers near Old Ford are provided with a weir or overflow chamber, and two parallel lines of culverts at a low level for the discharge of storm waters. The outfall sewer will extend from a point near the south of the River Roding, in the county of Essex, across the marshes, through East Ham, and other places, to the River Lea, over which it is carried, and then effects a junction with the high and middle level sewers. Between this junction and the pumping station at Abbey Mills, it will consist of two parallel culverts, each 9 feet in height and 9 feet in width, and eastward from the pumping station, it will consist of three parallel culverts, each 9 feet in height by 9 feet in width; it will be $5\frac{1}{2}$ miles in length, and throughout a considerable portion of its course will be constructed in an embankment. The sewer for the western area of the metropolis will drain to a pumping station near Fulham Fields, where the sewage is intended to be deodorised. The main line will extend from Sandsend-lane to the outlet of the Stamford Brook, near Hammersmith Creek. It will vary from a 4-foot barrel to a sewer 3 feet 9 inches by 2 feet 6 inches, and will be $2\frac{3}{4}$ miles long. In its course it will receive a branch from Fulham, the Cheyne-walk branch, the existing Counter's Creek sewer, and the Acton line of sewer. In December last the board contracted with Mr. William Moxon, of Dover, for the execution of the necessary works, at the sum of £152,430. The works were begun on Hackney-common, on the 31st of January, and their progress was at first considerably retarded by the difficulty of obtaining possession of certain land belonging to private parties. On the 4th of March the line of cutting had been opened for

a length of 1,100 feet, 10,000 cubic yards of earthwork removed, 200 feet of sewer, 10 feet 9 inches by 10 feet, had been completed, another 160 feet of invert and side walls built, and a further length of 120 feet of invert laid in. The board, on the 22nd of July, accepted the tender of Messrs. Helling and Co. for the construction of the high level sewer, south of the Thames, for the sum of £217,000, and at the date of the report it was hoped the works would shortly be commenced. A tender had also been accepted for a further portion of the works known as the Acton Branch of the Western Sewers. The plans and specification of the middle level sewer were in a forward state, and it was expected that the whole of the works will have been commenced in the early part of the ensuing year. The works which have been executed, and were in course of construction in connexion with the Northern High Level Sewer, on the 30th of July, extend from the River Lee at Old Ford, Bow, to the Darnley-road, Paradise-place, and Albion-road, in the parish of Hackney.

The board next refer to the efforts made to provide funds for the execution of the works, which resulted in an arrangement with the Bank of England for the advance to the board of £3,000,000 between the date of the agreement and the 31st December, 1864; that repayment should be made by annual instalments, being the produce of the main drainage rate of 3d. in the pound on the metropolis, assessed on the county-rate basis, after providing for the interest on bonds, the Bank accepting as security for their advances bonds issued by the board, guaranteed by the Lords Commissioners of the Treasury, bearing interest at the rate of $3\frac{1}{2}$ per cent.

The works executed by the board during the year ending March 25, comprise various lengths of new sewers, making a total of 6,981 feet, 34 side entrances, 60 ventilating shafts, and a number of junctions, flaps, and gullies. The total cost of these, with that of the cleansing of 166 miles of main sewers, repairs, and the deodorisation of the sewage in main lines, with other incidental works, make the total expenditure on sewerage works £46,302 9s. 8 $\frac{1}{2}$ d. This expenditure is exclusive of the sums paid for salaries and wages for attending the flaps and outlets of the main sewers. Plans for the construction of 34 miles 4,271 feet of sewers had been submitted to the board by various vestries and district boards. These plans had been examined and approved. Some of the proposed works had been modified, in accordance with the directions of the board, and care had been taken to ascertain that the whole of them were of such a character as to render them constituent portions of a comprehensive system of general metropolitan drainage.

Under the 183rd section of the Metropolitan Local Management Act five applications have been made to the board by vestries and district boards for permission to borrow, on the security of rates leviable within their respective jurisdiction, various sums amounting in the whole to £34,600. The board, after preliminary inquiry into the necessity for and the efficiency and cost of the works, granted their sanction for loans of specified amounts.

The board, in June last year, having had their attention drawn to the importance of measures for abating, as far as practicable, the nuisance arising from the offensive condition of the Thames, caused the contents of the principal sewers to be deodorised at their outlets. The cost of these operations, which were attended with perceptible benefit, was about £3,430. For the purpose of determining upon the best means of deodorising or otherwise dealing with the sewage at the outlets of the western area, and at other points, the board have given instructions for an inquiry into and examination of the various schemes proposed for the deodorisation and disposal of sewage matter, and for neutralising the noxious properties of sewage. This investigation they have confided to the eminent chemists, Dr. Hofmann and Dr. Frankland, who at the date of the last report were engaged in testing

the merits of the schemes brought to the notice of the board.

At the date of the last report the board had taken steps for obtaining the funds requisite to enable them to proceed with the purchase of the property required for the formation of the new streets in Southwark, and near Covent-garden. A committee of the whole board had, up to the 25th March last, dealt with claims amounting to £117,093 5s. 1d. on freehold and leasehold interests, goodwills, losses on removals, &c., in regard to the Covent-garden approach, which had been settled for the sum of £80,178 14s. 8d. In the same manner the board have adjusted and settled 109 claims regarding property and interests required in opening up the Southwark and Westminster communication. These claims amounted to £143,161 11s. 10d., and were settled for the sum of £111,855 14s. 8d., when the amount of the claim and the settlement have nearly coincided.

Notices have also been served, and other steps taken, for carrying into effect the powers obtained for opening up a direct line of thoroughfare extending from the junction of the East and West India Dock roads to Victoria-park, so as to render that place available to a much larger section of the inhabitants of the eastern portion of the metropolis than is now the case. The board, on the 19th November, 1858, contracted with the Clergy Mutual Assurance Society for a loan of £42,000 for effecting the improvement.

The vast importance of opening these and other new thoroughfares, to relieve the overcrowded streets of the metropolis, has been for a long period under the anxious consideration of this board, who have had a comprehensive scheme prepared of the various improvements that appear most needed at the present time, accompanied with a map of London, showing such improvements, together with a report and approximate estimate of the cost of effecting them. One of the more prominent of these improvements is the amelioration of the gradients of Holborn-hill and Skinner-street; and the board have examined into several of the plans that have been proposed for attaining this object.

One of the most remarkable of these plans is that devised by the architect of the board, by which it is proposed to set back the frontages of the houses on the north side of Holborn-hill and Skinner-street about sixty feet from the present line of buildings, so as to obtain sufficient space for the construction of a high-level road, extending from Hatton-garden to St. Sepulchre's church, with a viaduct of one arch, spanning Victoria-street. Some alteration in the present level of Victoria-street would be effected, by means of which the traffic of that street would be connected with the east and west traffic, passing along the viaduct or high-level road. Victoria-street being at present, for the most part, unbuilt upon, these alterations of level can be effected without difficulty, and are included in the present scheme.

In many parts of the metropolis the local authorities have directed their attention to the promotion of improvements in their parishes, by widening streets and roads, and preserving open spaces, and in various cases contributions to the extent of one-third have been made by the board towards these objects.

The applications for the approval by the board of the laying out of ground in the formation of new streets under the bye-law of the board, have amounted to 61 during the year; of these, 53 were granted, five were refused, and three are pending.

The rules of the Building Act for the construction of buildings are enforced by the supervision of 56 district surveyors, subject to the appointment and control of this board. These surveyors make monthly returns of all notices and complaints, works supervised, and fees charged and received within their respective districts. These returns are required by the statute to be examined and audited in the office of the superintending architect; and from the annual abstract and report, it appears that during

the years ending 31st December, 1858, fees to the amount of £21,732 were received by district surveyors in respect of 15,500 works supervised; and that the expenses of their offices, which they are required to keep, were £4,632. The works and fees included in the returns of 1858 exceed 50,000 entries. From these returns it also appears that the probable number of new buildings erected within the metropolis during the last three years exceeds 20,000, exclusive of additions to buildings.

Between the 25th March, 1858, and the 25th March, 1859, the receipts of the board amounted to £159,886 4s. 7d., and their payments to £185,290 16s. 11d. The monies owing to the board on the 25th March, 1859, in respect of assessments by precepts on vestries and district boards, outstanding amount of improvement rates, contributions to sewerage works, &c., was £98,784 14s. 2d. Besides this, they had a general cash balance in hand of £28,998 12s. 6d., and also the sum of £15,881 16s., invested in New Three per Cents., for the repayment of mortgage debts. Their debts and liabilities at the same date, including the amount of the mortgage debts and other special liabilities of the former Metropolitan Commissions of Sewers, amounted to £458,048 7s. 1d. The above is exclusive of the monies received and expended in respect of the Covent-garden approach, Southwark, and Westminster communication, and Victoria-park approach improvements.

The board, finding their present premises in Greek-street insufficient for the transaction of their business, found it necessary to seek another situation for the erection of offices, which they had found in the site of Berkeley-house, Spring-gardens. They purchased the existing lease for the sum of £500, entered into an agreement with the Commissioners of her Majesty's Woods and Forests, for the grant of a new lease for 99 years, at a rent of £500 a year until the 10th October, 1871, and of £350 during the remainder of the term, and had accepted a tender of Mr. George Myers for the execution of the requisite works for the sum of £14,829, and the building is now in course of erection. The execution of these works will be attended with the advantage of effecting a great public improvement, by throwing an additional width of 13 feet into the existing narrow entrance into St. James's Park, by which means the width of the passage will be increased from 8 feet 6 inches to 21 feet 6 inches.

The board, in the course of the year's proceedings which formed the subject of their last report, instructed a committee of their body to prepare a draft bill, embodying such alterations in the existing law as they should consider requisite and proper for facilitating the proceedings of the board, as well as of vestries and district boards, in the execution of the Metropolis Local Management Act, and a draft bill was prepared in accordance with that instruction. The amendments proposed involved so many grave questions affecting the pecuniary obligations of the various parishes of the metropolis, and other important matters, that the board are compelled to postpone the introduction of a comprehensive measure to a future period. During the past year, they have continued to experience considerable difficulty in the conduct of their proceedings, in consequence of the dissatisfaction felt by many of the local boards at the apportionment of the former debts of the Metropolitan Sewers Commissions, effected by the act of 1855; and for the purpose, if possible, of putting an end to these embarrassing questions, the board decided on preparing such an adjustment of their debts as they might deem equitable and just, and embodying them in a bill to be presented to parliament for its sanction in the present session. Accordingly, on the 11th December last, they decided on seeking statutory powers to re-apportion the debt in respect of the £200,000 borrowed from the Rock Life-office, according to the degree of benefit accruing to each parish from the works executed. The settlement of questions so closely affecting the financial position of

the great bulk of the metropolitan parishes, as was necessarily to be anticipated, was a work of labour and time, and proved the subject of much diversity of opinion. A bill directed to the objects stated at the time of the issuing of the report had been prepared by the committee, and approved by the board, but it was extremely doubtful whether it would be practicable to introduce it into the House of Commons during the last session.

BRITISH ASSOCIATION, ABERDEEN, 1859.

CONDENSED ABSTRACT OF A FIRST SET OF EXPERIMENTS, BY MESSRS. ROBERT NAPIER AND SONS, ON THE STRENGTH OF WROUGHT IRON AND STEEL.

COMMUNICATED BY W. J. MACQUORN RANKINE, C.E., LL.D., F.R.S.S., L. & E.

The following paper was read before the Mechanical Section:—

The experiments to which this abstract relates form the first set of a long series now in progress by Messrs. Robert Napier and Sons, the details being conducted by their assistant, Mr. Kirkealdy. The whole results are now in the course of being printed *in extenso*, for publication in the "Transactions of the Institution of Engineers in Scotland," but some time must elapse before they can appear, owing to the great volume of the tables, and the number of particulars which they give.

The present abstract is all that it has been found practicable to prepare in time for the meeting of the British Association, and, notwithstanding its brevity and extreme condensation, it is believed that the results which it shows will be found of interest and importance. It gives the tenacity, and the ultimate extension when, on the point of being torn asunder, of the *strongest* and the *weakest* kinds of iron and steel from each of the districts mentioned. Each result is the mean of four experiments at least, and sometimes of many more.

The detailed tables, now being printed, will show many more particulars, and especially the contraction of the bars in transverse area along their length generally, owing to "drawing out," and the still greater contraction at the point of fracture. The experiments now complete were all made with loads applied gradually. Experiments on the effect of suddenly applied loads are in progress.

TABLE A.—IRON BARS.

	Tenacity in lbs. per sq. inch.	Ultimate extension in decimals of length.
YORKSHIRE: strongest	62886 ...	0.256
" weakest	60075 ...	0.205
" (forged)	66892 ...	0.202
STAFFORDSHIRE: strongest	62231 ...	0.222
" weakest	56715 ...	0.225
WEST OF SCOTLAND: strongest... ..	64795 ...	0.173
" weakest	56655 ...	0.191
SWEDEN: strongest	48232 ...	0.264
" weakest	47855 ...	0.278
RUSSIA: strongest	56805 ...	0.153
" weakest	49564 ...	0.133

TABLE B.—IRON PLATES.

	Tenacity in lbs. per sq. inch.	Ultimate extension in decimals of length.
YORKSHIRE; strongest lengthwise	56005 ...	0.141
" weakest lengthwise	52000 ...	0.131
" strongest crosswise	50515 ...	0.093
" weakest crosswise	46221 ...	0.076

NOTE.—The strongest lengthwise is the weakest crosswise and *vice versa*.

TABLE C.—STEEL BARS.

	Tenacity in lbs. per sq. inch.	Ultimate extension in decimals of length.
Steel for tools, rivets, &c.: strongest	132909 ...	0.064
" weakest	101151 ...	0.108
Steel for other purposes: strongest	92015 ...	0.153
" weakest	71486	

TABLE D.—STEEL PLATES.

	Tenacity in lbs. per sq. inch.	Ultimate extension in decimals of length.
Strongest lengthwise	94289 ...	0.0571
Weakest lengthwise	95594 ...	0.1986
Strongest crosswise	96308 ...	0.0964
Weakest crosswise	69016 ...	0.1964

NOTE.—The strongest and weakest lengthwise are also respectively the strongest and weakest crosswise.

LECTURES ON SOCIAL SCIENCE.

A course of six lectures on this important subject, embracing all the relations between Labour and Capital, is about to be delivered by Mr. William Ellis, under the authority of the Committee on Education, at the South Kensington Museum. These lectures are particularly addressed to school teachers, but the general public will be admitted as far as there may be room in the theatre. The first will be given on Tuesday, 11th October, and they will be continued on each succeeding Tuesday.

THE DISCOVERY OF COAL IN KENT.

In accordance with the arrangement made at the last meeting of the East Kent Natural History Society, the Rev. B. S. Malden and Mr. A. B. Andrews visited Lydden yesterday for the purpose of ascertaining the facts with reference to the alleged discovery of coal. It appears that the substance found is in reality coal, though its occurrence in the position in which it lay is difficult to explain. The workmen engaged in executing Lydden tunnel found embedded in the chalk, at a depth of 180 feet, a mass of coal weighing about 4 cwt. With the exception of this lump no other coal has been seen. In their walk through the tunnel the visitors saw great numbers of flints in the chalk, and also veins of clay and apparent faults in the formation, but where the coal was found there was nothing of the kind. The chalk here was solid, without fault or fissure. The coal is bituminous, containing veins of ferruginous clay. Mr. Malden having applied a lens, it took fire in a short time. The visitors brought away a specimen, weighing about 3 lbs., which Mr. Walker, the sub-contractor, courteously caused to be sawn off, and which the East Kent Natural History Society will present to the Canterbury Museum. The discovery of coal under the circumstances described is, we believe, extremely unusual.—*Kentish Gazette*.

Home Correspondence.

KEW GARDENS.

SIR,—I read with much interest, in the last *Journal*, the report of Sir William Hooker on Kew Gardens. It is satisfactory to observe how steady has been their development, and how increasingly useful they are likely to become. There are, however, two or three lines in the report which call attention to the fact that the gardens are not open before one o'clock in the day, and an attempt is made to justify the exclusion of the public till that hour. Having experienced the inconvenience, and suffered loss of time from this arrangement, I should be glad to know if the museum, which for commercial

purposes is of great value, is closed up to one o'clock during the short days of the winter months, as well as during the summer.

I can see good reason for closing the plant-houses in the gardens during the winter; but I cannot understand why the museum should be closed at any period of the year, nor why persons in business, and having little time at their disposal, should be excluded from the possibility of using the collection for reference, unless they can give up time in the middle of the day.

I had occasion to visit the museum about a fortnight ago, and believing that it, like most other Government museums, was opened at ten o'clock, I took an early train to Kew, intending to return to business by mid-day. Much to my annoyance, I was obliged to remain till one o'clock before I could even get into the grounds. It may have been a judicious arrangement formerly, when Kew Gardens were half-a-day's journey from London, but now that two or three railways run their trains regularly from an early hour in the morning, and steam-boats ply constantly from London-bridge to Kew, it cannot be urged that the public could not take advantage of an earlier hour of opening. In the interest of commercial men, by whom the museum may be largely used, I trust that arrangements will be made by which the museum, if not the grounds generally, will in future be opened at ten o'clock in the morning, at latest, and thus increase its usefulness, and at the same time economise the time of men in business.

If this cannot be accomplished so long as the museum is retained at Kew, I would suggest that the Society would do good service if it could get up a discussion, and urge upon Government the desirability of combining, for commercial purposes, under one roof, the Animal collection at Brompton, the Vegetable collection at Kew, and the Mineral museum in Jermyn-street. It would be a far more natural arrangement to have the specimens illustrative of the uses to which the products of the three kingdoms of nature are applied exhibited under one roof, and the economy in so collecting, arranging, and exhibiting the specimens would be great, as many duplicates could be dispensed with, and a smaller number of attendants would be required. If this suggestion could be carried out, and the advantages of an evening exhibition (as is at present the case only at Brompton) could be effected, great public good would result in an educational point of view.

I am, &c.,

H. G. HAWARD.

Bow.

Sir,—Notwithstanding the correct statements which you have been so good as to give in your columns from time to time in reference to the closing of the pleasure-ground portion of the Royal Gardens for the winter season, and though notices are duly posted in the gardens, where they can be read by the immense concourse of visitors who resort thither (more than 400,000 annually), all announcing the closing of the pleasure-grounds on the last day of September, these statements have often been construed into a closing of the entire establishment, which has never been contemplated.

The Botanic Garden constitutes one portion of the Royal grounds of Kew. It comprises seventy-five acres; includes all the plant-houses, and is separated by a light wire fence from the pleasure-grounds. It is accessible to the public every day (Good Friday alone excepted), from one o'clock (two o'clock on Sundays) till sunset, throughout the year.

The pleasure-ground is an adjacent part of the demesne—a richly-wooded park, bordered on one side by the Thames, consisting of nearly 250 acres, and now, by recent planting, constituting a noble *arboretum* of all trees and shrubs that will bear our favoured climate, and intersected with extensive and well-kept walks. A lake of five acres, with islands, is forming, and a new conservatory, or winter garden, of unprecedented size,

for tender trees and shrubs (rhododendrons, camellias, &c.), is sanctioned and provided for by the Crown. This building will be erected by Mr. Decimus Burton, the architect of the palm-house, and is to be commenced forthwith. This fine piece of ground, possessing no particular attraction in winter, nor much shelter in bad weather, has not hitherto warranted the cost of gate-keepers, &c., necessary for the admission of visitors at that season. The expressed wish of the public has, however, been considered by the First Commissioner of Works, and I am instructed by that gentleman to keep open the pleasure-grounds during the present month of October.—I am, &c.,

WILLIAM J. HOOKER, Director.

Royal Gardens, Kew, W., Oct. 1.

P.S.—There are three entrances to the pleasure-grounds from the public road; first, by the Brentford-gate; second and third, by the Lion and Unicorn Gates, on the Richmond-road. The entrance to the Botanic Garden is open daily; and during the period when the public have access to the pleasure-grounds there are communications by four gates between these grounds and the Botanic Garden.

TO THE EDITOR OF THE TIMES.

Sir,—Observing in *The Times* of to-day a letter from the director of the Gardens at Kew, which, to those unacquainted with the hours of admission and closing, is calculated to lead to disappointment, I beg space to make a few observations thereon.

The letter correctly states that the hours for admission to the Botanic Garden are, 1 o'clock on week-days, 2 o'clock on Sundays; but states no time at which the pleasure-ground is open, thus leaving a stranger to infer, as he naturally would, that the pleasure-ground is open for the entire day, which certainly might and ought to be the case if the public advantage were consulted. Why should not these public gardens, as are those on the Continent, be open at all reasonable hours.

The impression in this neighbourhood is that it is in order to keep these Gardens for the exclusive use of some of the favoured residents at Kew that they are kept closed to the public during the forenoon of the day.

These Gardens are maintained at the public expense, and the public, I venture to think, are entitled to all the benefit they are calculated to afford; and should not be, as at present, excluded during the best part of the day—viz., the whole of the forenoon.

May I be allowed to suggest further, that when the hour for closing arrives, the public be apprised thereof by a bell placed in a central situation in the Gardens, and not, as at present, have their ears rudely assailed by being bawled at by "All out," in the most vulgar and unceremonious manner conceivable.

Begging that you will be good enough to give this letter insertion,

I am, &c.,

PATERFAMILIAS.

Brentford, Oct. 4.

THE WESTMINSTER BELL.

Sir,—The great bell of the Clock Tower has again been broken. This has resulted from the use of a much larger hammer, for the weight of the bell, than the usual proportion, and the employment of so great a quantity of tin in the composition as to render it unusually brittle. For this disaster, as well as for the former one, Mr. Denison is entirely responsible.

After the confirmation of the views concerning the enormously disproportionate force of the first hammer which I published some months before the first bell was broken, others have shared the opinion that the second bell would meet the same fate as the first.

I may particularly mention Mr. Quarm, as having expressed his conviction to that effect; and Mr. James, as having proved the extreme brittleness of the metal, by

breaking three small bells, made from the same composition, with very light blows, in Mr. Denison's presence, at Messrs. Mears's foundry. Surely Mr. Denison's career as bell founder and clockmaker, under the sanction of government will now come to an end, for it has resulted in more failures and brought greater discredit on the arts of bell foundry and clock making than we otherwise find recorded in this country during the last century.

I am, &c., E. T. LOSEBY.

Oct. 1.

Srs.—Since the above letter was written, an account has been published, in which the cause of the fracture is ascribed to the bell having been tightly screwed up to the frame, without the possibility of motion when it was struck. This is erroneous, as I noticed the bell whilst sounding the hour on Wednesday last, and observed it to recede at least three-quarters of an inch from one of the blows; and it must moreover be remembered that where clock hammers are used on swinging bells, they are placed at a right angle to the plane in which the bell swings, and that they cannot therefore recede from the blow beyond the small quantity which the beam and other parts bend, and which altogether does not generally amount to one-quarter the space through which the present bell receded. At the same time there is no doubt but that the larger the bell the greater distance it should be allowed to play; not only to guard against fracture, but to permit the hammer to follow it up and remain in contact long enough to overcome the inertia of the mass, and set the entire bell in sonorous vibration.

In order to carry out these views, Mr. Quarm proposed that the bell should be suspended from a ball-and-socket joint, to allow it to yield and gradually absorb the force of the blow, but the plan was not adopted. My own plan for the same purpose is as follows:—The bell to be suspended so that it can oscillate freely in the plane of the blow, but not in any other, and it will then become a pendulum, swinging in tolerably uniform intervals; then let the time of its oscillation be ascertained, and the interval between the blows of the hammer be so regulated that the bell shall be making one of its return vibrations as the hammer descends to meet it. Each blow would then be made to neutralise the motion caused by the last one, and all accumulating or uncertain motion be prevented; and the advantages would be secured of the bell hanging perfectly free to accommodate itself to the force of the blow, without the recoil-spring having to keep the hammer at a great distance from the bell. The strain on the mountings and frame would also be considerably reduced.

I am, &c.,
E. T. LOSEBY.

4th October, 1859.

Proceedings of Institutions.

BIRMINGHAM AND MIDLAND INSTITUTE.—In the report for last year, the Council announce the first portion of the new building has been completed, and is now occupied for the purposes of the Institute. The Council have endeavoured to render the news-room as attractive as possible. The room intended for a library on the first floor has been comfortably furnished; it is supplied with the principal London and provincial newspapers, and it is believed that it meets with the approval of the members. The larger room, which will eventually be the news-room, is intended to be used as a temporary museum, for which several donations have been received. The interest of the museum will be greatly increased by an arrangement concluded with the Birmingham gun trade. The Committee of Trade are about to make a collection of military and other fire arms, which will form a historical record of the progress of the manufacture, and illustrate recent inventions and improvements. The col-

lection is to be deposited in the Institute Museum, subject to the condition that it shall not be removed, except to some other suitable place of exhibition. The public continue to avail themselves of the "Patent Specification" library. It was consulted by two-hundred and forty persons last year. Thirty-one public lectures and Monday evening readings were given, of which 16 were kindly delivered free of charge, and 5 of these were by members of the Institute. The number of members is now 561—of students qualified by the amount of their fees to avail themselves of the privileges of the general department, 27—total 588, being an increase of 104 since last year. The following is a list of the entries in the various classes, for the three terms:—

Subject.	Winter Term.	Spring Term.	Autumn Term.
*Geometry.....	6	5	8
*Algebra.....	9	9	13
*Advanced Arithmetic.....	21	16	16
Elementary Arithmetic } Penny Lessons, Average Attendance	13	18	35
Experimental Physics.....	14	19	15
Elementary Chemistry ...	34	30	39
Practical Chemistry	6	5	7
Female Class	6	7	discont.
Junior Class.....	18	9	13
Penny Lectures, average } attendance	238	175	204
*Botany	9	6	discont.
French	141	117	136
*History	20	sus- pended.	11
*English Literature	36	40	16
*Logic	11	susp.	

* The Classes marked with an asterisk are conducted by honorary teachers.

The female class and the botany class have been discontinued, on account of the small number of pupils, and the Council regret that the illness of the teacher has caused the suspension of the logic class. A class for English Grammar and Composition has been commenced. A new regulation has been established with regard to Certificates and Examinations. Each teacher has been requested to examine his class at the end of the spring term, and Teachers' Certificates are awarded to those students who have made satisfactory progress in the work of the year. Gentlemen appointed by the Council examine the classes at the commencement of the autumn term, and Council Certificates are awarded to those who, after a two years' study, have acquired a satisfactory knowledge of the subject of examination. The Council call the especial attention of the members of the Industrial Department to the Examination of the Society of Arts, an appeal which was well responded to, as is shown by the results of the last Examinations. The Council regret that the financial condition of the Institute is not in such a satisfactory condition as could be desired—the expenditure, both in the general and industrial departments, exceeds the receipts during the past year. This result is in some degree attributable to the occupation of the new buildings, where additional expenses had to be incurred, to supply the conveniences required for the carrying on the operations of the Institute. As these will not occur in subsequent years, it is hoped that, with rigid economy in the ordinary expenditure, the balance in future will appear to the credit of the Institute. The report of the classes for experimental physics, elementary chemistry and practical chemistry, and on the junior class and penny lectures, for last year, show that the average number of students, and the average attendance in the physics, elementary chemistry, practical chemistry, and junior class, and the average attendance at the penny

lectures, during the year, have been as follows:—Penny Lectures, average attendance 206; Physics, names entered 16, average attendance 8; Chemistry, names entered 34, average attendance 21; Junior Class, names entered 16, average attendance 17, including members of general department; Practical Chemistry, names entered 6, average attendance 6. In the physics class the subjects treated were, mechanics during the winter and spring terms, and hydrostatics and pneumatics during the autumn term. Those who have attended have studied diligently, and have acquitted themselves very satisfactorily at the Class Examinations. Nearly all the pupils now attending are real students. When the chemistry class commenced in 1854, the greater proportion of those attending it were merely passive listeners to the lectures, and gazers on the experiments, and they dropped away rapidly when the heavier portion of the subject was entered upon. The attendance at the Class Examinations was then very small whenever the examination was announced, and very few took part in these examinations, under any circumstances. In this respect a great improvement has taken place, the course of study has been made more severe, without apparently damaging the attendance, and the pupils have themselves requested that the examinations shall be held more frequently, as they find they learn more from these oral examinations than from the lectures. The teacher proposes, now that he can secure the active co-operation of the students in these examinations, to make them much more frequent than hitherto, to go completely over the whole of the subject matter of the lectures, and to enlarge upon them where the students are found to fail in their answers. He expresses his conviction that the Council Examinations and Certificates, and the Examinations of the Society of Arts, have largely contributed to this improvement. In the practical chemistry class the students are working diligently, and making very good progress. The students who first entered are now able to make qualitative analyses for the acids and bases of complex compounds. Some rather difficult exercises have been given to them, and in almost every case their analyses have been correct. The junior class has fallen off considerably. From the commencement of this class to the present time there have been very few accessions of pupils, so that the places of those who have outgrown the class have not been supplied. The subject of the penny lectures during the winter and spring terms was "The Raw Materials used in the Birmingham Manufactures." The subject during the autumn term has been "Physiology, and the Laws of Health." The interest and attention of the audience, referred to in the last report, has been fully maintained, though the class of people attending has, to a slight extent, altered. The proportion of working men among the audience appears to be rather smaller than formerly. A large proportion, probably two-thirds, attend regularly.

BRISTOL.—The distribution of prizes and certificates awarded by the Society of Arts to the students examined at the Bristol Athenæum in May last, took place in the lecture-hall of that Institution, on Saturday evening. The chair was taken by the Rev. Canon Girdlestone, President of the Local Board of Examiners, and among the company present were the Bevs. C. Evanson, M.A., and J. Burder, M.A.; Messrs. Hazeldine, B.A.; Coen, A.B.; D. Mackie, F.R.S.; I. A. Cooke, treasurer of the Athenæum, and several other members of the Board of Examiners, &c. The chairman addressed the meeting, eulogising the course taken by the Society of Arts in initiating the system of examination which had subsequently been adopted by the Universities, and commenting on the various forms of encouragement for different classes of society now offered to educational efforts. He also noticed the fact that the examination of the Society of Arts afforded the first and only opportunity for ladies to compete for these public rewards of intellectual achievements, and anticipated great good as resulting there-

from. He likewise drew attention to the extraordinary position attained by the Bristol Athenæum examinees in the present year's competition, G. Hale (a pupil of the Bristol Grammar School) having carried off the largest number of prizes (all of the first-class) awarded to any one student, while the only four ladies who have succeeded in winning certificates throughout the kingdom were pupils of the Athenæum, and were now present. On the last occasion four out of the only five successful candidates were also Athenæum pupils. To the whole number of 766 papers worked, only 16 first-class prizes were awarded, and of these six (3-8ths) were awarded to the Athenæum examinees, the proportion of first-class prizes to papers worked being in Bristol upwards of 20 per cent., and in all the other places only 1/3rd per cent., the proportion being as 15 to 1. The proportion of first-class certificates obtained was also in Bristol three times as great as in the rest of the kingdom. The following prizes and certificates were then handed to the several candidates present, who were hailed with enthusiastic acclamations as they, one after the other, ascended the dais to receive from the hands of the chairman their honourable distinctions:—

- ALGEBRA.—1st prize and 1st class certificate, George Hale. Certificates, H. S. V. De Candole, C. P. Evanson, R. C. F. A. Thomas, and D. C. Tovey.
 TRIGONOMETRY.—1st prize and 1st class certificate, G. Hale. Certificate, E. Clift.
 CONIC SECTIONS.—1st prize and 1st class certificate, Geo. Hale.
 STATICS, &c.—1st prize and 1st class certificate, George Hale.
 ENGLISH LITERATURE.—1st prize and 1st class certificate, H. S. V. De Candole; 2nd prize and 1st class certificate, D. C. Tovey.
 LATIN AND ROMAN HISTORY.—1st prize and 1st class certificate, D. C. Tovey. Certificates, H. S. V. De Candole, C. P. Evanson.
 ARITHMETIC.—Certificates, D. C. Tovey, R. C. F. A. Thomas.
 GEOMETRY AND MENSURATION.—Certificate, E. Clift.
 ENGLISH HISTORY.—Certificate, H. S. V. De Candole.
 FRENCH.—Certificates, Miss M. S. Lovell, Miss H. Nash, Miss M. M. Ratcliffe, M. H. Hale, and W. W. Hale.
 GERMAN.—Certificate, Miss C. E. Shapland.
 MUSIC.—Certificate, C. P. Evanson.

M. H. J. V. De Candole, on behalf of his son, moved a vote of thanks to the examiners, which was seconded by Mr. Gardner. The Rev. J. Burder moved a vote of thanks to the directors of the Athenæum, for the liberal manner in which they had placed that institution at the disposal of the Examiners for the purposes of the Society of Arts examination, which was seconded by Mr. D. Mackie, and acknowledged by Mr. I. A. Cooke, the treasurer of the Athenæum. The chairman acknowledged the vote of thanks to the examiners, and the meeting was concluded by Mr. Cooke moving a special tribute to the chairman personally, for his services that evening.

PATENT LAW AMENDMENT ACT.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[From Gazette, September 30th, 1859.]

- Dated 20th June, 1859.
 1478. L. D. Dewey, 4, Southampton-buildings, Chancery-lane—Imp. in spring seats for chairs, sofas, couches, carriages, and other similar articles. (A com.)
 Dated 4th July, 1859.
 1589. H. C. Howells, 120, Duane-street, New York, and J. C. Howells, Madison, U.S.—Imp. in the mode of registering the number of persons entering or leaving public conveyances or places of public resort, and of determining the value of the entry or fare.
 Dated 27th August, 1859.
 1957. J. Philp, Camden-town, Middlesex—Imp. in the manufacture of soap. (A com.)
 Dated 29th August, 1859.
 1959. J. Whitworth, Manchester—Imp. in ordnance, fire-arms, and ammunition.
 1964. J. Edwards, 77, Aldermanbury, London—Imp. in the manufacture of buttons.
 Dated 31st August, 1859.
 1989. R. A. Brooman, 166, Fleet-street—Imp. in treating auriferous and argentiferous ores and substances.
 Dated 3rd September, 1859.
 2014. W. Suffield, Birmingham—Imp. in the manufacture of artificial teeth, and in machinery to be employed in the said manufacture.

2016. G. Davies, 1, Serle-street, Lincoln's-inn—Imp. in printing and in apparatus connected therewith. (A com.)
Dated 17th September, 1859.
2038. E. R. Dann and E. Goldschmidt, Nottingham—Imp. in the manufacture of bonnet fronts or lapets.
2040. H. Jones Birmingham—Imp. in breech-loading fire-arms.
2042. J. L. Jullion and G. Pirie, Aberdeen—The manufacture of gelatine, and apparatus to be employed therein.
2044. A. V. Newton, 66, Chancery-lane—An improved manufacture of metallic strips, or bands applicable to ladies' skirts. (A com.)
2048. W. Rothwell, Carr House, Midgley, Halifax, and T. Watson, Midgley—Imp. in screw gill-boxes.
Dated 8th September, 1859.
2050. T. O. Small, Newcastle upon-Tyne—Imp. in the stereoscope, by means of tinted media, and by the application of the pulley and lever, or spring, in changing the lights.
2052. J. H. Johnson, 47, Lincoln's-inn-fields—Imp. in cocks and valves. (A com.)
2054. J. Tandy, Cavendish-grove, Wandsworth-road, Surrey—Imp. in locomotive and other steam boilers.
2056. G. Gowland, Liverpool—Imp. in nautical and surveying instruments for measuring angles.
Dated 9th September, 1859.
2060. S. Worsam, Chelsea—Imp. in sawing machinery.
2062. W. E. Gedge, 4, Wellington-street South, Strand—Imp. in the manufacture of nails. (A com.)
2064. A. V. Newton, 66, Chancery-lane—Imp. in the process of, and machinery for, manufacturing hat bodies. (A com.)
Dated 10th September, 1859.
2066. A. Smith, Mauchline, Ayr, N.B.—Imp. in strengthening umbrella and walking stick handles, and other articles or details wherein the cross or transverse grain of the wood or other material is subject to strains.
2068. W. Ross, Glasgow—Improved apparatus connected with the discharge of liquids.
2069. E. J. Mallett, New York—Imp. in axles.
2070. T. J. Perry, Biston, Staffordshire—An improved construction of hot air oven.
Dated 12th September, 1859.
2076. J. Eason, Oxford-street—Imp. in the manufacture of buff or lish and other oiled leathers.
2078. W. H. Morrison, Nottingham—Imp. in the manufacture of bonnet and cap fronts, and in the means or apparatus employed therein.
2080. J. Mason, Birmingham—An imp. in boxes or cases and cards to contain or hold pens.
2082. W. Elliott, Birmingham—Imp. in the manufacture of African or Guinea rods.
Dated 14th September, 1859.
2091. C. G. Gumpel, 2, Gordon-cottages, Holland-road, Brixton, Surrey—Imp. in the application of motive power to the propelling of vessels.
2093. Lieut.-Col. J. P. Kennedy, Torrington-square, Middlesex—Imp. in steam boilers.
2095. C. Beslay, Rue St. Sebastian, Paris—Imp. in preparing and obtaining printing surfaces with designs sunk as also in relief.
2097. J. S. Slocum, Providence, Rhode Island, U.S.—Imp. in projectiles, suitable for ordnance. (A com.)
Dated 15th September, 1859.
2099. J. Robinson, Sutton, near Hull—An improved agricultural implement.
2101. J. Brère, Brussels—Imp. in railway breaks.
2103. H. Winter, Albion-terrace, Hackney, Middlesex—A machine or apparatus for lifting and weighing loaded sacks, and also merchandize.
Dated 16th September, 1859.
2105. J. W. Hadwen, Kebroyd Mills, Halifax—An imp. or imps. in apparatus or machinery used for drawing fibrous substances or materials in any of the processes or machines for preparing to be spun, or for spinning the same.
2107. N. Heckford, Forest Gate, Essex—A method of purifying the Thames and other rivers, and of treating night soil.
2109. W. E. Newton, 66, Chancery-lane—Imp. in machinery for forming hat bodies. (A com.)
2111. H. Jackson, Oak-lane, Limehouse—Imp. in fire bars.
Dated 17th September, 1859.
2113. J. Luis, 1b, Welbeck-street, Cavendish-square—A new brick and tile making machine. (A com.)
2115. J. Luis, 1b, Welbeck-street, Cavendish-square—Further imp. in brakes for railway carriages. (A com.)
2117. J. Luis, 1b, Welbeck-street, Cavendish-square—A slip bridle for stopping runaway horses. (A com.)
2119. J. Luis, 1b, Welbeck-street, Cavendish-square—An improved disc and lantern signal with double repeaters. (A com.)
2121. S. N. Rodier, Prospect-cottage, Stand-on-the-Green, Chiswick, Middlesex—Imp. in the regulation of gas to burners, which he calls "Rodier's regulating gas valve."
2123. A. J. Norman, Gore-lodge, Turnham Green, Chiswick, Middlesex—Paving roads and surfaces.
Dated 19th September, 1859.
2125. F. N. Gisborne, 3, Adelaide-place, London Bridge—Paying out submarine telegraphic cables.
2127. W. Robertson and J. Tweeddale, Johnstone, Renfrew, N.B.—Imp. in hydrostatic jacks, or lifting apparatus. (A com.)
2129. J. Wright, 42, Bridge-street, Blackfriars—Imp. in the construction of carriages, coaches, omnibuses, and other such like conveyances. (A com.)
2131. P. Fairbairn, Leeds—Improved machinery for finishing the teeth of spur and other gearing.
2133. R. A. Brooman, 166, Fleet-street—Imp. in elevators or lifts, for hotels, warehouses, and other structures. (A com.)
2135. L. Engler and E. F. Krauss, 29, Boulevard St. Martin, Paris—A new or improved system of insulators for electric wires.
Dated 20th September, 1859.
2139. W. Weild, Manchester—Imp. in fluted rollers, used in machines for preparing, spinning, and doubling cotton, wool, flax, silk, and other fibrous materials, and in the manufacture of such rollers.
2141. J. Beads, Pendleton, near Manchester—Imp. in machinery or apparatus for spinning cotton, wool, or other fibrous substances, part of which improvements is applicable to other purposes.
2143. W. E. Newton, 66, Chancery-lane—Imp. in projectiles. (A com.)
2145. E. Collier, Myddelton-street, Clerkenwell—Imp. in ear dilators.
Dated 21st September, 1859.
2147. H. Corless, West Derby, Lancashire—Imp. in apparatus for washing, wringing, and mauling.
2151. W. E. Newton, 66, Chancery-lane—An improved mode of and apparatus for condensing the waste steam of marine engines. —(A com.)

WEEKLY LIST OF PATENTS SEALED.

[From Gazette, September 30th, 1859.]

<i>September 29th.</i>	
797. J. Cartwright.	880. N. A. Grumel.
798. Capt. C. P. Coles, R.N.	883. W. Henderson.
801. W. Smith and E. Smith.	885. E. R. Handcock.
807. A. Morton.	886. T. Spencer.
813. D. K. Clark.	891. J. H. Johnson.
814. F. P. A. Auburtin.	896. W. E. Newton.
822. Y. M. Thomas.	934. J. Gillett.
824. A. Ripley and J. Roberts.	957. W. E. Newton.
832. M. Coupland.	960. H. Harrison.
834. T. Williams and J. H. Fuller.	982. W. Parsons.
836. J. Eccles.	987. I. Dutton, R. Martin, and T. Phillips.
840. J. H. Burton.	991. A. V. Newton.
843. C. Russell.	1048. R. Main.
844. M. A. Crooker.	1051. J. H. Johnson.
846. E. Morewood.	1090. C. H. G. Williams.
848. A. Shanks.	1109. W. Sellers.
850. E. Fairburn.	1134. W. E. Newton.
852. F. C. Bakewell.	1135. W. E. Newton.
853. G. F. Chantrell.	1295. A. V. Newton.
855. J. Hetherington, T. Webb, and J. Craig.	1418. H. J. Nicoll.
861. J. A. H. Ballade.	1529. J. Boden and W. Clark.
862. W. Owen.	1538. G. Dawes and C. J. Carr.
864. J. Scoffern.	1580. T. J. Hart.
865. D. Moseley.	1587. J. Hollingworth.
871. J. Garrett.	1627. D. Mathews.
873. J. T. Pitman.	1639. C. Iliffe.
878. M. A. F. Mennons.	1658. A. Cooper.
	1720. S. A. Bell and J. Black.
	1738. J. Gillett and J. Morrison.

[From Gazette, October 4th, 1859.]

October 1st.
863. J. Rogers and E. J. Tweed.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

[From Gazette, September 30th, 1859.]

<i>September 26th.</i>	
2267. F. Ransome.	2279. R. Morrison.
2293. J. Daughlish.	2443. L. J. P. de Mirimonde.
<i>[From Gazette, October 4th, 1859.]</i>	
<i>September 29th.</i>	
2334. H. Mackworth.	2319. G. F. Wilson and A. I. Austen.
<i>September 30th.</i>	
2413. G. Hazeldine.	2320. D. O. Boyd.
<i>October 1st.</i>	
2305. E. Hardon and J. Henry.	2325. A. Dunlop.
	2348. G. F. Wilson.
	2349. W. Marriott and D. Sugden.
	2378. F. A. Gatty.

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

[From Gazette, September 30th, 1859.]

<i>September 21th.</i>		
56. J. Finlay.	6. M. Poole.	
77. S. Souly.	16. M. Poole.	
96. H. Bridson.	19. M. Poole.	
103. C. Lungley.	24. M. Poole.	
142. H. B. Barlow.	28. M. Poole.	
<i>[From Gazette, October 4th, 1859.]</i>		
<i>September 29th.</i>		
30. M. Poole.	172. J. Jobson.	
33. M. Poole.	237. H. Jager.	
37. M. Poole.	246. G. H. Cottam.	
43. M. Poole.	251. A. E. L. Bellford.	
123. R. Whytock.	<i>October 1st.</i>	
<i>September 30th.</i>		
9. G. Green.	41. J. Barrans.	
57. J. J. Macdonnell.	184. J. Needham.	
156. J. Brown.	187. A. Miller.	
160. J. Burch.	214. T. Kennedy.	
163. M. Poole.	272. J. Hill.	
	275. A. R. le Mire de Normandy.	