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THE IMPORTANCE AND WEALTH OF OUR FORESTS.

We are accustomed to read of the "inexhaustible forests of Canada," and to form from this stereotyped phrase very incorrect conceptions respecting the timber resources of the country.

The Canadian forests are no doubt very great, but they are far from being inexhaustible sources of national wealth. The circumstances attending the first settlement of a new country, necessarily involved an enormous destruction of valuable trees, which, at the time of the invasion of the wilderness by the pioneer of civilization, were hewn down, cut into lengths, piled into heaps, and consumed by fire as fast as possible, in order to admit the warm sunlight to the earth and fit it for the plough. Millions of magnificent trees, which would now command a fabulous price, have been destroyed in this way, so that the lumberman is compelled year by year to retreat farther into the wilderness, and this will continue until the inferior quality of the timber arising from a too rigorous climate will arrest his operations. The products of the Canadian forest consist chiefly of timber in all its forms, from the massive square timber to the crooked "knees" for ship-building, together with ashes, both pot and pearl.

One hundred years ago (1759) the exports of lumber amounted to $31,250; about half a century since (1808) the value of the exports of lumber did not exceed $400,000, so that within the memory of many who can recollect lumbering operations at the commencement of the present century, the foreign trade has increased twenty-fold, besides the enormous quantities which have been consumed by a population growing from 300,000 to 2,500,000 souls. The value of the imports of lumber in 1860 exceeded $10,000,000.

The most important and extensive timber territories of Canada are subjoined:—

1st. The country drained by the Ottawa, containing an area of 75,000 square miles. The white pine, red pine and ash are chiefly obtained from this region.

2nd. The St. Maurice and its tributaries, draining an area of 22,000 square miles. Contains large quantities of white, yellow and red pine, spruce, birch, maple and elm.

3rd. The Saguenay country, area 21,000 square miles. Rich in white and red pine, spruce, birch and tamarac.

4th. The north shore of lake Huron. White and red pine, spruce, cedar, birch and maple.

5th. The extensive Gaspé peninsula. White and red pine, spruce, tamarac and birch.

6th. The peninsula of Canada West contains oak, elm and walnut.

7th. The Ontario territory, north of lake Ontario, still contains a large amount of white pine, elm, maple, &c.

The Lumber Trade.

Not less than twenty-five thousand persons are directly engaged in lumbering operations. Government works, technically called slides, have been constructed on the sides of the falls on the great rivers down which the lumber is floated from the interior. Farmers have followed the lumberers far beyond the frontiers of the settlements in order to supply them with oats, potatoes, peas and hay. The lumberers are essentially the pioneers of civilization, and although they leave the marks of desolation behind them in their progress through the wilderness, these soon become obliterated, and the snug farm-house in the course of a few years occupies the site of the lumberer's rude log shanty, being the second stage of the transformation of the forest wilds into fruitful farms.

The amount of revenue accruing from timber dues and ground rent in 1861 was $327,503, and from slide dues $55,546, or a total of $383,060.

British American lumber is chiefly exported to the United Kingdom, but there can be no doubt that the trade is diminishing, while there is every prospect of an increased trade taking place between continental European ports and British America. Thirty years ago, one-third of all the British tonnage trading beyond the seas, or about 300,000 tons, navigated by 16,000 seamen, was engaged in the colonial timber trade. During the year 1830, out of 40,000 emigrants which arrived from Europe more than 30,000 were carried out by the timber ships. During the four years between 1857 and 1860, both inclusive, the proportion of British North American lumber imported into the United Kingdom was in

1857	50	per cent.	of the	whole.
1858	48	"	"	"
1859	44	"	"	"
1860	45	"	"	"

Hence it appears that the average *decrease* in the imports of lumber from British North America to the United Kingdom, during the above period, is about 11½ per cent., while the *increase* on the imports of foreign lumber is nearly 10 per cent

During 1861 about twenty cargoes of Canadian lumber were exported to the continent of Europe, and numerous enquiries continue to be made respecting the timber resources of the country. So rapidly is the price of timber increasing in France that standing timber worth 50 francs per 35 cubic feet in 1852 was worth 100 francs five years later.

The industry to which the manufacture of the different products of the forest gives rise, is very extensive. In 1851 there were 1,567 saw mills in Upper Canada, and 1,065 in Lower Canada. The number of feet manufactured during the year amounted to 391,051,820 and 381,560,950 respectively. Since 1851 the quantity manufactured has no doubt increased enormously, but no data are at present published from which satisfactory conclusions can be drawn, although some conception of the magnitude of the trade may be formed from the fact that planks and boards to the value of $1,507,546 were exported to the United States in 1861, being not far from half the total production of Upper Canada ten years previously; although the trade had suffered to a remarkable extent in consequence of the calamitous civil war which is now wasting the energies of our brethren across the international boundary.

The exportation of planks and boards to the United States is one of the most important sources of Canadian prosperity, as may be inferred from the following table:

Value of Exports of Planks and Boards to the United States from 1857 *to* 1861, *inclusive.*

1857.	1858.	1859.	1860.
$2,558,206	$2,890,318	$2,678,447	$3,027,730

1861.—$1,507,546.

The sudden diminution from more than $3,000,000 in 1860 to $1,500,000 in 1861, results from a temporary depression occasioned by the civil war in which the United States are unhappily engaged.

The year 1845 was a most prosperous one for the lumber trade. The quantity of square timber brought to market that season amounted to 27,704,344 feet, and the quantity exported was 24,223,000 feet. In 1846 the quantity brought to the Quebec market rose to 37,300,643 feet but only 24,242,680 feet were exported. Hence prices fell to a ruinous degree, and a great blow was given to the trade during that year. In 1847 there was a stock supply of more than 44,000,000 feet to meet the demand for 19,000,000 and in 1848 a total supply of 39,000,000 to meet a demand for 17,000,000. Under such circumstances it is not to be wondered at that the timber trade became exceedingly depressed. The excitement of high prices has fostered over production, and the diminished consumption of Canadian timber in Great Britain brought prices down to the lowest ebb. When the trade is in a prosperous condition the profits are sometimes excessive; speculation then ensues and ruin frequently follows. The character of the trade is changing as the timber groves become more remote, more capital being required to carry on lumbering operations on a profitable scale. Many lumberers now invest a considerable portion of their capital in clearing and cultivating farms in connection with their timber limits for the purpose of raising provender for their stock, and food for their hands.

A glance at forest industry would be incomplete if we were not to note a contingency to which the timber trade is becoming more and more liable each year. One of the most destructive agents in the vast pine forests north of the St. Lawrence, is fire. Thousands of square miles of the forest timber have been ruined by this ruthless destroyer. Fires in the woods do not generally extend so far as one at the first blush might suppose; they rarely go beyond thirty miles in length by ten in breadth; but it is the frequent occurrence of these fires which in the long run of years lays waste so much valuable property; and with the progress of the lumberers in the wilderness the chances of fresh conflagrations yearly become more imminent.

The produce of the forest of most importance next to lumber has always been pot and pearl ashes. Potashes are made from the crude ashes by dissolving the soluble salts with water, evaporating to dryness, and fusing at a red heat into a compact mass, which, although grey on the outside is pink colored within. Pearlash is made by calcining potashes upon a reverberatory hearth until the carbon and much of the sulphur is dissipated. Water is then added, and a lye formed, which, when evaporated to dryness, yields the pearlash of commerce. Canadian potashes contain on an average about 60 per cent. of carbonate of potassa. Pearlash contains generally about 50 per cent. of caustic potassa. The quantity of potashes obtained from the combustion of trees or vegetables on a given area of ground depends altogether upon the species. Thus, while the pine only yields 0.45 per mille, the oak gives 1.53, the willow 2.85, elm and maple 3.90 per mille, or .39 per cent. The value of ashes, both pot and pearl, exported from Canada during the years 1859 to 1861 inclusive, was as follows—three-fourths going to the United Kingdom:—

	1859.	1860.	1861.
Potashes	$769,612	$741,473	$705,228
Pearlashes	337,759	219,633	173,779
Total.........	$1,107,271	$961,106	$879,207

In adnition to these staple productions of our forests, we have a growing trade in Canada balsam, turpentine, pitch, spruce gum, oil of spruce, oil of hemlock, hemlock bark, maple sugar, bark of the basswood, bark of the butternut and of the hickory, sassafras, sumach, bark of the white oak and of the slippery elm, besides the medicinal plants common to Canada and the Northern States of the American Union.

General Results.

Comparative Statement of the Produce of the Forest, from 1853 *to* 1861, *inclusive*

1853	$9,421,010
1854	9,981,367
1855	7,747,923
1856	10,019,883
1857	11,575,508
1858	9,284,514
1859	9,663,662
1860	11,012,253
1861	9,572,645

Very few years have elapsed since the produce of the forest formed the most important of Canadian exports, as the following comparison will show. Of late years, agriculture has asserted a superior claim, and will no doubt maintain it:—

	1849.	1850.	1851.
Val. of Products of the Forests exported	$5,310,148	$5,442,936	$6,038,180
Val. of all other productions	4,000,108	5,237,086	6,038,180
Balance in favor of forests	$1,310,040	$205,830	$777,840
	1859.	1860.	1861.
Val. of Agricult. productions exported	$7,339,798	14,259,225	18,244,631
Val. of products of the Forest exported	9,663,962	11,012,253	9,572,645
Balance in favor of forests	$2,324,164		
Do. of Agricult.		$3,247,972	$8,671,986

The Lumberers.

A lumberer's life is full of that half-wild excitement which belongs to the wilderness, and few who have engaged in this apparently laborious and at times dangerous industry, are willing to relinquish it for the tamer pursuits of the farm. When any one intends to "make timber," as it is technically called — that is, to cut and bring lumber to market — the first operation is to take a "limit," and having thoroughly explored it, and laid out roads to the most convenient water-course or "drivable" creek, he engages his men, either for cutting the timber, or for cutting the timber and the "drive" (or from the time of commencing operations to the period when it is brought to Quebec or any other convenient port). A "grove of pine" having been found, and rough roads cut or laid out if necessary, the operation of making the timber commences. The hands are divided into gangs, which generally consist of four or more cutters, who fell the trees and bark them for the liner. The liner marks the tree for the "scorers," who block it off — that is, cut off branches, knots, &c. The broad-axe man follows, who squares and finishes the "pieces." During the winter, when the snow lies sufficiently deep on the ground, each piece is hauled by a yoke of oxen or a pair of horses to the bank of the drive, where the timber is piled on or near the roll-way, until the return of spring melts the frozen creek, and the waters rise to a convenient "driving condition." A lumber "shanty" generally contains three or four gangs, headed by a foreman, whose duty it is to call the men up in the morning, lay off their work, take their time, and superintend operations generally. The broad-axe man makes each night a return of the quantity of timber made during the day. When the rivers are in suitable driving condition, the most perilous and laborious part of lumbering operations begins. The pieces are pushed into the stream and floated down to its junction with the main river, where they are retained by a temporary boom. When the tributary streams on which the timber is made are narrow, it is a matter of some difficulty to accomplish the drive, and the men are often exposed for weeks together to all the inconveniences and dangers which attend frequent wading through cold water. Jams not unfrequently occur at the bends of the stream or above falls, and the utmost caution is necessary in removing the obstruction which retains the confused mass of pieces, apparently involved in inextricable confusion. The cutting away of a single stick or piece is often sufficient to set the accumulated mass in motion, and accidents of a fatal description are not unfrequent in endeavoring to loosen a "jam." The main river once reached, a number of pieces are fastened together by means of withes, and formed into a raft, which slowly floats down the river towards a sea or lake port. The great distance up the tributaries of the large rivers draining a timber territory to which the lumberers have penetrated, often causes the drive to occupy from two to three months. An idea of the immense distance from which lumber is now brought may be obtained when it is known that the lumberers travelling up the tributaries of the Ottawa are now meeting those who have ascended the rivers flowing into Lake Huron; and the broad height of land which sends waters to the St. Lawrence by the tributaries of the Ottawa, to Lake Ontario by the Trent, and to Lake Huron by the Muskoka and other rivers, resounds with the strokes of the axe and the shouts of lumbermen who have reached the same spot by traversing the rivers draining three different watersheds, after clearing the country of all timber groves conveniently situated for driving.

Ship Building.

Ship building was one of the earliest branches of industry cultivated in Canada. The memorial contained in the "*Documents de Paris*" inform us that as early as 1715 ship building at Quebec was pretty brisk, although there was great reason for complaint that the French would not import the fine timber of the country. The fur trade appeared to monopolize all the attention of the French rulers; and although the British drew large supplies of lumber from the Atlantic provinces, New France contributed no part of her immense forest treasures to increase the naval resources of the great rival of England on the seas. M. de Maurepas, the French Minister of Marine, in 1731, was fully alive to the importance of ship building; for he wrote some strong despatches to the Governor, urging the stimulation of this branch of industry, and promising that ships of war should be constructed in Canada, if some good merchant vessels were turned out. He offered a premium of 500 francs for every vessel gauging 200 tons or over, of colonial build, and sold in France or the Antilles, and 150 francs premium for each barge of 30 or 40 tons if similarly disposed of.

In 1752, ten vessels of 40 to 100 tons were built in Canada; but the materials were badly chosen, and the price high. It is remarkable that even at that early period of the history of French-Canadian industry, a number of vessels used in the trade of Canada were purchased from the enterprising New Englanders. With the finest forests in the world for ship building, unequalled facilities for bringing lumber to the seaboard, and the encouragement of a liberal bounty, French enterprise in Canada, towards the middle of the last century, was not equal to the task of seizing upon the only industry which would tend to secure to them the peaceable possession of the colony, in the event of a war with their great and industrious rival Britain, besides encouraging emigration, amassing wealth, and establishing political importance.

In 1734 there were 52 saw mills in that part of the Province which lies east of Ottawa. The population of the country being 37,252 souls, in 1827 or nearly one hundred years later the number of saw mills had increased to 565, with a population of 471,876. The following table shows the number of ships built at Quebec between 1791 and 1861:

Year.	No. of Ships.	Tons.
1791	12	574
1801	52	3,404
1811	54	13,691
1821	22	2,254
1831	38	6,170
1841	64	23,122
1851	66	41,605
1861	51	25,546

The average value of ships built at Quebec is taken at $40 a ton; the tonnage can be obtained at once by dividing the value by 40.

Since 1787 there have been 2,939 ships built at Quebec, being in the aggregate 890,201 tons burthen. The largest ship ever constructed on this continent was built at Quebec in 1825. It was called the "Baron of Renfrew," and measured to 5,294 tons. Another large wooden ship was built in 1824, measuring 3,690 tons; but these large wooden vessels were not successful.

This enumeration does not include other vessels which are constructed at the different ports of the valley of the St. Lawrence, and sometimes sent across the Atlantic for sale. Such vessels have been recently built on Lake Huron, at Toronto, &c.; but in consequence of the general depression in trade since the year 1857, little has been done in ship building in the lake districts, although there is every prospect that it will become an important branch of industry, now that ship communication between Lake Superior and Europe, without breaking bulk, is easily and profitably accomplished.

The lumber trade was long in growing to importance, in the early history of Canada. In 1723 nineteen vessels cleared from Quebec, containing cargoes of peltries, lumber and provisions; but there does not appear to have been any considerable trade in lumber between Europe and Canada until the close of the eighteenth century.

In 1786, the exports of fish, lumber, &c., from Labrador to Gaspé, were returned at £45,000 stg.; and furs and other colonial produce from Quebec at £445,116 stg.; but lumber is not specially included as an article of commerce. In 1808, the products of the forest became a separate item, and we find oak and pine timber, staves, masts, &c., exported to the value of £157,360 stg.; but from the United States the imports were to the amount of £70,000 stg., the greater part of which would be included in the amount specified above.

There is very good ground for the expectation that new markets in continental Europe will soon be opened for Canadian timber. Already the beginning of this trade has been made by the despatch of twenty cargoes to France, Spain and Germany, in 1861. The products of the forest hitherto exported have been confined to a few species of timber trees, not exceeding a dozen at the most. When it is known that there are upwards of thirty kinds of forest trees, out of some sixty or seventy species with which our forests are filled, well adapted to the wants of European manufacturers, it is confidently anticipated that a new impulse will soon be given to the lumber trade of the Province, in a different direction to that which it has hitherto taken.

Prior to 1858, England imported more timber from the British American Provinces than from all other countries. This predominance ceased in the next succeeding year, when the British importations stood thus:

1859,	from	British America.........	1,301,248	loads.
"	"	Foreign countries........	1,655,532	"
1860,	"	British America.........	1,264,360	"
"	"	Foreign countries........	1,537,920	"

Last year (1862) eight vessels sailed for German ports, their destinations and cargoes being as follows:

Port.	Ves.	Cargo.
Stettin	1 ...	Oak.
Hamburg...	3 ...	Oak and pine.
Bremen	4 ...	Red and white pine, walnut, &c.

This trade promises to be of the greatest value to Canada; and if the Government adopt wise and liberal measures to secure a foreign European market, the gain which will result to Canada in many ways is incalculable. Emigration from those countries can be fostered in no better way than by a growing trade in the natural productions of the British Provinces.

PETROLEUM AND WATER GAS.

The first and second January numbers of the *American Gas Light Journal*, for this year, contain some articles on the subject of gas from petroleum and water, which show the interest now excited in this important branch of illumination. We do not consider it necessary further to refer at present to a lengthy communication by "*An Advocate of Coal Gas*," on an article which appeared in the November number of this Journal, further than to notice the unusually violent strain in which it is worded—a characteristic which does not in the least degree improve the value of the many groundless statements made by the writer of that "ferocious" document. We are glad to find that other correspondents of the *American Gas Light Journal* join in our views. The attention which has been directed in Europe and America to the problems involved in the production of gas from hydrocarbons and water, is very great, and continually increasing; and in order to show what has been done in this obscure department of science, we have prepared, with some trouble, a condensed statement of the claims of a number of patentees in England and America, which will serve, we hope, to show not only the importance of the subject, but particularly the difficulty of deciding upon the validity of patents which do not involve some new principle similar to that which so excites the apprehensions of "*An Advocate of Coal Gas*," who has yet to learn much respecting the properties of water in certain conditions or states. The following list of English patents will supplement in some slight degree an excellent article on the "History of Water Gas," part of which is contained in the 74th number of the *American Gas Light Journal*.

LIST OF ENGLISH PATENTS

FOR THE MANUFACTURE OF ILLUMINATING GAS FROM COAL, HYDROCARBONS AND WATER, WITH REFERENCE TO THE WORKS IN WHICH THE DESCRIPTIONS WERE FIRST PUBLISHED.

IBBETSON, JOHN HOLT. 1824: No. 4954.

Admits steam into the decomposing chamber, when in operation, among the ignited coal or coke, alone or mixed with tar or oil.

Rep. of Arts, vol. V, p. 335; London Journal (Newton's) vol. IX, p. 69; Register of Arts and Sciences, vol. II (New Series) p. 594.

MONTAUBAN, HYPOLITE FRANÇOIS, Marquis de Bouffet and Meridos. 1838: No. 7581.

Uses steam or water in separate retorts; makes gas from bitumens, oils, &c., "or bitumenous matter in a liquid state."

London Journal, vol. XIII, p. 185; vol. XXI, p. 476, for disclaimer (disclaims apparatus).

RADLEY, WILLIAM. 1845: No. 10652.

Uses three retorts: the first supplied with the gas material, the third with water, and the middle receives the mixed vapours, gases and steam. The vapours from the first and the steam from the third are conducted into the second or middle vessel, which is filled with lumps of quick lime, coke and scrap iron, and is heated to redness. The gas or gases resulting from the action of these matters one upon another, is conducted into the main.

Mechanics' Mag., vol. XLV. p. 510.

MANBY, EDWARD OLIVER. 1839: No. 8062.

Uses steam passed into a retort containing anthracite or stone coal, charcoal, coke or bituminous coal heated.

Mechanics' Mag., vol. XXXII, p. 172; Inventor's Advocate, vol. I, p. 11.

Val Marino, John Alexander Phillip de. 1839: No. 8126.

A mode of decomposing tar, oils and other fatty matters, and also water. Uses three retorts, filled with coke; admits water into the first retort; the steam and gases pass into the second; and thence to the third, which is the retort supplied with tar, &c,

Rep. of Arts, vol. XIV, p. 65; London Journal, vol. XVIII, p. 99; Inventors' Advocate, vol. II, p. 34.

Chruckshanks, Alexander. 1839: No. 8141.

Uses superheated steam (red hot?); passes it into the retort; distills tar from coal.

Constable, John. 1845: No. 10690.

Employs air and steam (at 600 fahr.) to produce gas with anthracite. Enriches the oxide of carbon with oil of tar.

Rep. of Arts, vol. VII, p. 227, (enlarged series); London Journal, (N.) vol. XXIX, (conjoined series) p. 129.

Mechanics' Mag., vol. XLIV, p. 109.

Pollard, William. 1845: No. 10733.

Employs highly heated steam in conjunction with air and solid fuel for making the gas from.

New. London Journal, vol. XXVIII, c. s. p. 149.

Lowe, George. 1846: No. 11405.

Introduces highly heated steam into retorts when making gas from coal or other matters.

Mechanics' Mag., vol. XLVI, p. 579; Patent Journal, vol. II, p. 790.

Croll, Alexander Angus. 1848: No. 12251.

Employs steam in the manufacture of gas. Charges the same retort with coal and coke, and introduces steam at the end opposite to the eduction pipe.

Rep. of Arts, vol. XIII, p. 233; London Journal (New.) vol. XXXIV, (conjoined series), p. 196; Mechanics' Magazine, vol. L, p. 212; Artizan, vol. VII, p. 183, vol. IX, pp. 77, 124, 194; Patent Journal, vol. VI, p. 216; Eng. and Arch. Journal, vol. XII, p. 150.

Gillard, Joseph Pierre. 1849: No. 12858.

Recommends steam required in gas making to be distributed over the surface of the coal in the retort. Makes hydrogen from any hydro-carburets.

London Journal, vol. XXXVII, p. 236; Mechanics' Mag., vol. LIII, p. 437; Patent Journal, vol. IX, p. 106.

Webster, James. 1850: No. 12967.

Used heated steam with rosin.

Rep. of Arts, vol. XVI, p. 226; Mechanics' Mag., vol. LIII, p. 139; Pat. Journal, vol. IX, p. 238.

Barlow, Thomas Greaves, and Gore, Samuel. 1851: No. 13593.

Uses steam or water, coke and coal. Uses one retort with the required divisions, or three retorts working together. Superheated steam, if necessary, is introduced over incandescent coke, then over coal which is being converted into gas. Uses hydrocarbons by injection, or otherwise, into a retort containing incandescent coke.

Mechanics' Mag., vol. LV, p. 352; Patent Journal, vol. XII, pp. 73 and 96.

Hills, Frank Clarke. 1852: No. 13912.

1. Uses steam and the vapours of hydrocarbons in highly heated retorts filled with coke.

2. Decomposed steam, or steam and hydrocarbon vapour by heated coke, heating the coke to a great heat by air—introduces air and steam alternately.

3. Decomposes tar or other hydrocarbon alone or with steam, or with the gases formed by the decomposition of steam.

4. Passes tarry vapour in ordinary gas, with or without the use of steam, through red hot carbon.

Mechanics' Mag., vol. LVII, p. 97.

Isoard, Mathien François. 1857: Nov. 2, No. 2782.

He carburetts superheated steam, by causing the superheated steam to traverse hydrocarburets of any kind in a carburretting apparatus. He uses for gas lighting hydro-carburets.

Holmes, William Cartwright. 1855: Jan. 20' No. 1405.

He distills gas-producing substances by means of superheated steam, which passes to a retort containing the substance to be distilled which it vapourizes, and thence passes off with the steam to and through a second retort or vessel (heated), where it is decomposed into inflamable gas. Steam is also here decomposed.

Holmes, William Cartwright, and William Hollingshead. 1858: Feb. 2, No. 187.

Improvement on the foregoing. Conduct the vapours or gases thus produced or obtained from the retort or vessel to another retort or vessel where they are still further subjected to superheated steam, the formation of tar being prevented.

Gerner, Henry. 1858: No. 27, 2705.

Uses a retort with two pipes in the form of coils containing perforations; one supplied with a hydrocarbon the other with water. The coils are surrounded with water.

Ibbetson, Jo[illegible] Holt. 1824: No. 4954.

Admits steam into the decomposing chamber when in operation, among the ignited coal or coke, alone or mixed with tar or oil.

Rep. of Arts, p. 335; Newton's London Journal, vol. IX, p. 69; Registry Arts and Sciences, vol. II, p. 85; Engineers and Mechanics' Encyclopedia, vol. I, page 594.

Montauban, Hyppolite François, Marquis de Bouffet. 1838: No. 7581.

Uses steam or water in a separate retort.

Newton's London Journal, vol. XIII, p. 185; vol. XXI, p. 476, for disclaimer.

Ginty, William Gilbert. 1853: No. 2561.

Uses steam, or water and coke, to make water gases.

Kirkham, John, Kirkham, Thomas Nesham. 1854: Aug. 28, No. 1882.

1. Heats coke to a higher state of ignition by streams of heated air. Passes steam in both retorts or injects water, and collects the resulting gases.

2. In a mixing chamber introduces the water gas to a gas 'rich in carbon.'

Dimsdale, ——. 1854: June 23, No. 1389.

Uses superheated steam, and operates on carbonaceous or bituminous substances (capable of yielding gas for lighting and heating) causing the elements, in a nascent state, to combine with the gases.

Jacquelin, Augustin. 1854: Aug. 22, No. 1840.

Makes water gas—removes CO^2. Passes hydrogen through a retort containing coal heated by a sand bath.

Lancaster, William Henry, and Smith (James).

Uses coke, coal and water, (pouring the water in).

Newton, William Edward. 1856: July 29, No. 1794.

Uses water dropped into a steam generator, rosin, grease, oil, &c. The steam mixes with the gas in this retort, containing red-hot scrap iron. The water and hydrocarbon generate gas.

Murdoch, J. 1845: No. 10532.

Uses water with the gas from coal in a purifying retort.

White Stephen. 1847: No. 11654.

Brings water gas in contact with gas from hydrocarbons to produce a compound gas. Uses three heated retorts with coke, &c. Used a small stream of water in the first retort; the gaseous products proceed into the second retort, and thence into the third retort, where oil, fat, common tar, or substances of a similar character is allowed to flow in a continual stream, and to fall on a disperser. The compound gas passes on to the condenser.

London Journal, vol. XXXIII, (conjoined series) p. 163; Patent Journal, vol. III, p. 599.

REGENERATIVE GAS FURNACE, AS APPLIED TO GLASS-HOUSES, PUDDLING, HEATING, &c.*

The arrangement of furnaces about to be described is applicable with the greatest advantage in cases where great heat has to be maintained: as in melting and refining glass, steel, and metallic ores, in puddling and welding iron, and in heating gas and zinc retorts, &c. The fuel employed, which may be of very inferior description, is separately converted into a crude gas, which in being conducted to the furnace has its naturally low heating power greatly increased by being heated to nearly the high temperature of the furnace itself, ranging to above 3000° F.; undergoing at the same time certain chemical changes, whereby the heat developed in its subsequent combustion is increased. The heating effect produced is still further augmented by the air necessary for combustion being also heated separately to the same high degree of temperature, before mixing with the heated gas in the combustion chamber or furnace; and the latter is thus filled with a pure and gentle flame of equal intensity throughout the whole chamber. The heat imparted to the gas and air before mixing is obtained from the products of combustion, which after leaving the furnace are reduced to a temperature frequently not exceeding 250° F. on reaching the chimney, whereby great economy in fuel is produced, with other advantages.

The transfer of heat from the products of combustion to the air and gas entering the furnace is effected by means of regenerators, the principle of which has been recognised to some extent since the early part of the present century, but has not been carried out in any useful application in the arts, unless the respirator invented by Dr. Jeffreys be so considered. The discovery of this principle is ascribed to the Rev. Mr. Stirling, of Dundee, who, in conjunction with his brother, James Stirling, attempted as early as the year 1817 to apply it to the construction of a hot-air engine. Their engine did not, however, succeed, nor did Captain Ericsson's later attempts in the same direction lead to more satisfactory results. The economical principle of the regenerator having attracted the writer's attention in 1846, he constructed in the following year an engine in which superheated steam was used in conjunction with the regenerator. Many practical difficulties, however, prevented a realisation of the success which theory and experiments appeared to promise; but it is gratifying to find that one principle then adopted—that of superheating the steam—has since received the sanction of an extended application.

The employment of regenerators for getting up a high degree of heat in furnaces was suggested in 1857 by the writer's brother, Mr. Frederick Siemens, and has since been worked out by them conjointly through the several stages of progressive improvement. The results obtained by the earlier applications of the principle were communicated by the writer in a paper read at a former meeting of this institution (see *Proceedings Inst. M. E.*, 1857, page 103); and two or three of the furnaces then described, employed for heating bars of steel, remain still in operation. In attempting, however,

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* By Mr. C. William Siemens, of London. Read before the Birmingham Institution of Mechanical Engineers.

to apply the principle to puddling and other larger furnaces, serious practical difficulties arose, which for a considerable time frustrated all efforts: until, by adopting the plan of volatilising the solid fuel in the first instance, and employing it entirely in a gaseous form for heating purposes, practical results were at length attained surpassing even the sanguine expectations previously formed.

In the early form of the regenerative heating furnace, which has been in continuous work during the last three years for heating bars of steel at Messrs. Marriott and Atkinson's Steel Works, Sheffield, and also at the Broghton Copper Works, Manchester, there is a single fire-place containing a ridge of fuel fed from the top; and two heating chambers, in which the bars of metal to be heated are laid, with a regenerator at the end of each chamber, by which the waste heat passing off from the furnace is intercepted on its way to the chimney, and transferred to the air entering the furnace. Each regenerator is composed of a mass of open fire-bricks, exposing a large surface for the absorption of heat, through which the products of combustion are made to pass from the furnace, and are thus gradually deprived of nearly all their heat previous to escaping into the chimney; the end of the regenerator nearest the furnace becomes gradually heated to nearly the temperature of the furnace itself, while the other end next the chimney remains comparatively cool. The direction of the draught being now reversed by means of a valve, the air entering the furnace is made to pass through the heated regenerator in the contrary direction, encountering first the cooler portions of the brickwork, and acquiring successive additions of heat in passing through the regenerator, until it issues into the first chamber of the furnace at a very high temperature, and traversing the ridge of fuel produces a flame which fills the second heating chamber, whence the products of combustion, passing through the second cold regenerator, deposit their heat successively in the inverse manner, reaching the chimney comparatively cool. By thus alternating the current through the two regenerators, a high degree of temperature is maintained constantly in the furnace. This arrangement of furnace is evidently applicable only in exceptional cases where two chambers are to be heated alternately, nor does it admit of being carried out upon a large scale.

In heating a single chamber the expedient was resorted to of providing two fire-places to be traversed in succession by the heated air, with the heated chamber placed between, as in the furnace shown in the drawings accompanying the previous paper (*Proceedings Inst. M. E.*, 1857, plate 118). Here the difficulty arose that the air, the oxygen of which was already combined with carbon (forming carbonic acid) in traversing the first fire-place, took up a second equivalent of carbon (forming carbonic oxide) in traversing the second, so that the fuel of the second fire was consumed to no purpose. In order to diminish this loss, and also avoid impairing the draught by a double resistance, the ridges of fuel were discontinued, and the coal was fed into the furnace from the sides, resting on a solid hearth, to be there volatilised by the heated air passing over it. By frequently stirring the first fire its combustion was favoured until the current was reversed, when it was left undisturbed until the next change, and so on alternately. It was found very difficult, however, to maintain an active and uniform combustion, and to burn the purely carbonaceous substance that was left in the fire-place after the gaseous portion of the fuel had been volatilised; and it had frequently to be raked out in order to make room for fresh gaseous fuel. This circumstance led to the first step towards the employment of fuel in the form of gas, by providing a small grate below the heap of fuel, through which a gentle current of air was allowed to enter, forming carbonic oxide, which afterwards further combined with oxygen on meeting with the hot current of air entering the furnace from the regenerator. The two fire-places of alternating activity were, however, attended with considerable practical inconvenience: the furnace-men, in particular, disliked the idea of attending two fire-places instead of one, and being little interested in the saving of fuel, took no pains to work the furnace in a satisfactory manner.

It therefore became necessary to devise a plan of heating a single chamber continuously by one fire-place, in combination with the alternate reversal of currents through the regenerators, but without reversing the direction of the flame. This was accomplished by means of double reversing valves, and was practically carried out in a pudding furnace that worked for a considerable length of time at the ironworks of Messrs. B. and W. Johnson, near Manchester. The two regenerators were placed longitudinally side by side, with a flue between, underneath the puddling chamber, and the fire-place was put at one end of the puddling chamber, as in an ordinary puddling furnace, and fed with fuel from above. The heated air from the first regenerator was brought up at the back of the fire-place, and meeting there with the fuel produced the required flame in the puddling chamber; whence the products of combustion passed down at the end of the chamber, and were carried back along the flue below to the hot end of the second regenerator, through which they made their way to the chimney. For reversing the currents through the regenerators two valves were needed, connected by a lever, one at the hot end of the regenerators near the fire, and the other at the cool end next the chimney; whereby the heated air was made to enter the fire-place by the same passage as previously, and the direction of the flame through the puddling chamber was not changed. By this arrangement the regenerative furnace was assimilated as nearly as could be to an ordinary puddling furnace in form and mode of working. The few furnaces constructed in this manner produced a great heat with little more than one-half the consumption of fuel of ordinary furnaces in doing the same amount of work. A considerable saving of iron was also effected in puddling, owing to the absence of strong cutting draughts, a mild draught being found sufficient to produce the necessary heat. There still remained drawbacks, however, which prevented an extensive application of this form of furnace: the fire required frequent attention, and it was difficult to maintain a uniform volume of flame in the furnace; the reversing valve at the hot end of the regenerators was moreover liable to get out of order, and the furnace was costly in construction.

The most important step in the development of the regenerative furnace has been the complete separation of the fire-place or gas producer from the heating chamber or furnace itself. When a uniform and sufficient supply of combustible gas is ensured, it can evidently be heated just like the air, by being passed through a separate regenerator before reaching the furnace, whereby its heating power is greatly increased. The difficulty of maintaining a uniform flame in the furnace is thereby certainly removed, and there is no longer any necessity for keeping the flame always in the same direction through the furnace, since the gas can be introduced with equal facility at each end of the heating chamber in turn, and the periodical change of direction of the flame through the furnace tends only to make the heat more uniform throughout; whereas in the previous plan of employing solid fuel for heating in the furnace, the relative position of the fire-place and heating chamber being fixed and unchangeable, required the direction of the flame to be kept always the same, unaltered by the reversal of currents through the regenerators. The new plan of a separate gas producer has now been successfully carried out in practice, and there are already a considerable number of the regenerative gas furnaces in satisfactory operation in this country and on the continent, applied to glass-houses, iron furnaces, &c. In the neighbourhood of Birmingham, at Messrs. Lloyd and Summerfield's glassworks, a flint-glass furnace constructed upon this plan has now been in continuous operation for nearly twelve months, and affords a good opportunity of ascertaining the consumption of fuel of the regenerative furnace as compared with the previous furnace performing the samé work. At the glassworks of Messrs. Chance (Brothers) and Co., near Birmingham, the regenerative gas furnace has been under trial for the same length of time, and has latterly been adopted for the various purposes in crown and sheet glass making upon a very large scale. Messrs. James Russell and Sons, Crown Tube Works, Wednesbury, are also applying the furnace to the delicate operation of welding iron tubes, and, in a short time, will probably employ no solid fuel for any furnaces at their works. Another flint-glass furnace erected by Messrs. Osler in Birmingham, and several puddling furnaces erected by Messrs. Gibbs Brothers at Deepfields, and by Mr. Richard Smith at the Round Oak Iron Works, are amongst the latest applications of the regenerative gas furnace, the designs having in all cases been furnished by the writer, and carried out under his brother's immediate superintendence.

The gas producers are entirely separate from the furnace where the heat is required, and are made sufficient in number and capacity to supply several furnaces. The fuel, which may be of the poorest description, such as slack, coke dust, lignite, or peat, is supplied at intervals of from six to eight hours through covered holes, and descends gradually on an inclined plane, which is set at an inclination of from 45° to 60°, according to the nature of the fuel used. The upper portion of the incline is made solid, being formed of iron plates covered with fire-brick; but the lower portion is an open grate, formed of horizontal flat steps. At the foot of the grate is a covered water trough, filled with water up to a constant level from the small feeding cistern, supplied by a water pipe with a ball tap. The large opening under the water trough is convenient for drawing out clinkers, which generally collect at that point. Small stoppered holes at the front and top of the producer are provided to allow of putting in an iron bar occasionally to break up the mass of fuel and detach clinkers from the side walls. Each producer is made large enough to hold about ten tons of fuel in a low incandescent state, and is capable of converting about two tons of it daily into a combustible gas, which passes off through an opening into the main gas flue leading to the furnaces.

The action of the gas producer in working is as follows:—The fuel descending slowly on the solid portion of the inclined plane, becomes heated and parts with its volatile constituents, the hydrocarbon gases, water, ammonia, and some carbonic acid, which are the same as would be evolved from it in a gas retort. There now remains from 60 to 70 per cent. of purely carbonaceous matter to be disposed of, which is accomplished by the slow current of air entering through the grate producing regular combustion immediately upon the grate; but the carbonic acid thereby produced, having to pass slowly on through a layer of incandescent fuel, from three to four feet thick, takes up another equivalent of carbon, and the carbonic oxide thus formed passes off with the other combustible gases to the furnace. For every cubic foot of combustible carbonic oxide thus produced, taking the atmosphere to consist of one-fifth part by volume of oxygen and four-fifths of nitrogen, two cubic feet of incombustible nitrogen pass also through the grate, tending greatly to diminish the richness or heating power of the gas. Not all the carbonaceous portion of the fuel is, however, volatilised on such disadvantageous terms; for the water trough at the foot of the grate, absorbing the spare heat from the fire, emits steam through the small holes under the lid; and each cubic foot of steam in traversing the layer of from three to four feet of incandescent fuel is decomposed into a mixture consisting of one cubic foot of hydrogen, and nearly an equal volume of carbonic oxide, with a variable small proportion of carbonic acid. Thus, one cubic foot of steam yields as much inflammable gas as five cubic feet of atmospheric air; but the one operation is dependent upon the other, inasmuch as the passage of air through the fire is attended with the generation of heat, whereas the production of the water gases, as well as the evolution of the hydrocarbons, is carried on at the expense of heat. The generation of steam in the water trough being dependent on the amount of heat in the fire, regulates itself naturally to the requirements, and the total production of combustible gases varies with the admission of air. And since the admission of air into the grate depends in its turn upon the withdrawal of the gases evolved in the producer, the production of the gases is entirely regulated by the demand for them. The production of gas may even be arrested entirely for twelve hours without deranging the producer, which will begin work again as soon as the gas valve of the furnace is reopened, since the mass of fuel and brickwork retain sufficient heat to keep up a dull red heat in the producer during that interval. The gas is, however, of a more uniform quality when there is a continuous demand for it, and for this reason it is best to supply several furnaces from one set of producers, so as to keep the producers constantly at work. The opening leading from each producer into the main gas flue can be closed by inserting a damper from above in case any one of the producers is required to be stopped for repairs, or because part of the furnaces supplied are out of work.

It is important that the main gas flue leading to the furnaces should contain an excess of pressure, however slight above the atmosphere, in order to prevent any inward draughts of air through crevices, which would produce a partial combustion of the gas, and diminish its heating power in the furnace, besides causing a deposit of soot in the flues. It is, therefore, necessary to deliver the gas into the furnace without depending upon a chimney draught for that purpose. This could easily be accomplished if the gas producers were placed at a lower level than the furnaces; but as that is generally impossible, the following plan has been adopted. The mixture of gases on leaving the producers has a temperature ranging between 300° and 400° F., which must, under all circumstances, be sacrificed, since it makes no difference to the result at what temperature the gas to be heated enters the regenerators, the final temperature being in all cases very nearly that of the heated chamber of the furnace, or say 2500° F. The initial heat of the gas is, therefore, made available for producing a plenum of pressure by making the gas rise about twenty feet above the producers, then carrying it horizontally twenty or thirty feet through the wrought iron tube, and letting it again descend to the furnace. The tube being exposed to the atmosphere causes the gas to lose from 100° to 150° of temperature, which increases its density from 15 to 20 per cent., and gives a preponderating weight to that extent to the descending column, urging it forwards into the furnace.

In setting out each individual furnace, the heating effect required, the quality of the fuel employed, and the particular nature of the process to be performed, have to be considered. The amount of heat required determines the capacity of the regenerators; and the gas regenerators require fully as large a capacity as the air regenerators, and sometimes even a greater. This would perhaps hardly be expected, but will be seen to be the case from the following considerations. The gases proceeding from the gas producers are a mixture of olefiant gas, marsh gas, vapour of tar, water and ammoniacal compounds, hydrogen gas, and carbonic oxide, besides nitrogen, carbonic acid, some sulphuretted hydrogen, and some bisulphuret of carbon. The specific gravity of this mixture averages 0·78, that of air being 1·00; and a ton of fuel, not including the earthy remnants, produces according to calculation nearly 64,000 cubic feet of gas. By heating these gases to 3000° F. their volume would be fully six times increased, but in reality a much larger increase of volume ensues in consequence of some important chemical changes effected at the same time. The olefiant gas and tar vapour are well known to deposit carbon on being heated to redness, which is immediately taken up by the carbonic acid and vapour of water, the former being converted into carbonic oxide and the latter into carbonic oxide and pure hydrogen. The ammoniacal vapours and sulphuretted hydrogen are also decomposed, and permanently elastic gases with a preponderance of hydrogen are formed. The specific gravity of the mixture is reduced in consequence of these transformations to 0·70, showing an increase of volume from 64,000 to nearly 72,000 cubic feet per ton of fuel, taken at the same temperature. This chemical change represents a large absorption of heat from the regenerator, but the heat is given out again by combustion in the furnace, enhancing the heating power of the fuel beyond the increase due to elevation of temperature alone.

The chemical transformation is also of importance in preventing "sulphuring," for it is believed that the sulphur in separating from its hydrogen takes up oxygen supplied by the carbonic acid and water, forming sulphurous acid, a firm compound, which is not decomposed on meeting with metallic oxides in the furnace. This view is so far borne out by experience that glass containing a moderate proportion of lead in its composition may be melted in open crucibles without injury, instead of requiring covered pots for the purpose, as in ordinary furnaces. In dealing with the highest quality of flint glass, however, it is found necessary to retain covered pots; but every other description of glass is melted in open pots. In all branches of glass manufacture saving of fuel is of relatively small moment as compared with the improvement effected in the colour and general quality of the glass by the use of the regenerative gas furnace, owing to the absence of dust and cinders and the higher degree of temperature which may with safety be maintained throughout the heating chamber.

These advantages of the regenerative gas furnace are of equal value in the case of puddling and welding iron.

The four regenerators are in this case arranged longitudinally underneath the puddling chamber, which may be of the usual form. In order to complete the combustion of the gas and air in passing through the comparatively short length of the puddling chamber, it is necessary to mix them more intimately than is requisite in large glass furnaces. For this purpose a mixing chamber is provided at each end of the puddling chamber, and the gas and air from the regenerators are made to enter the mixing chamber from opposite sides; the gas aperture is moreover placed several inches lower than the air aperture, so that the lighter stream of gas rises through the stream of air, while both are urged forward into the puddling chamber, and an intense and perfect combustion is produced. The mixing chambers are sloped towards the furnace, in order to drain them of any cinders which may get over the bridge. The reversal of the current through the furnace is effected about every hour by reversing valves in the air and gas flues, the arrangement of which is exactly similar to that in the glass furnace. The supply of gas and air is regulated by throttle valves, and the draught through the furnace by the ordinary chimney damper.

This same arrangement, with obvious modifications, may be applied also to blooming and heating furnaces, the advantages in both cases being a decided saving of iron, besides an important saving in the quantity and quality of the fuel employed. The space saved near the hammer and rolls by doing away with fire-places, separate chimney stacks, and stores of fuel, is also a considerable advantage in favour of the regenerative gas furnace in ironworks. The facility which it affords for either concentrating the heating effect or diffusing it equally over a long chamber, by effecting a more or less rapid mixture of the air and gas, renders the furnace particularly applicable for heating large and irregular forgings, or long strips or tubes which have to be brought to a welding heat throughout. It has already been applied to a considerable extent in Germany for heating iron, having been worked out there under the direction of the writer's eldest brother, Dr. Werner Siemens, who has also contributed essentially to the development of the system. The furnaces at the extensive iron and engine works of M. Borsig, of Berlin, are being remodelled for the adoption of this system of heating, as have also been those at the Imperial factories at Warsaw.

Another important application of the regenerative gas furnace is as a steel melting furnace, in which the highest degree of heat known in the arts is required, presenting consequently the greatest margin for saving of fuel. This application of the regenerative gas furnace is indeed rapidly extending in Germany, but has not yet practically succeeded in Sheffield, where it was also tried. It is, however, in course of application at the Brades Steel Works, near Birmingham. The arrangement of the reversing valves and the air and gas flues is similar to that in the glass furnace previously described.

Other applications of the regenerative gas furnace are being carried out at the present time, among which may be mentioned one to brick and pottery kilns for Mr. Humphrey Chamberlin, near Southampton; for Messrs. Cliff, of Wortley, near Leeds; and for Mr. Cliff, of the Imperial Potteries, Lambeth; also to the heating of gas retorts at the Paris General Gas Works, and at the Chartered Gas Company's Works, London. The description already given, however, is sufficient to show the facility with which this mode of heating may be adapted to the various circumstances under which furnaces are employed. The important application of the regenerative system to hot blast stoves for blast furnaces, by Mr. E. A. Cowper, has already been separately communicated to this Institution (See Proceedings Inst. M.E., 1860, page 54).

The experience hitherto obtained with the regenerative mode of heating shows that it is attended with the greatest proportionate advantage in localities where good coal is scarce, but where an inferior fuel abounds. This applies most forcibly to the South Staffordshire district, where the best coal in lumps is worth 12s. 6d. per ton, whereas good slack can be had at 3s. or 4s. per ton. The question gains, moreover, in importance when it is considered that, according to the best authorities, the thick coal of the district is coming to an end, while millions of tons of coal dust have accumulated, of no present commercial value, which, on being converted into gas in the manner described by means of the gas producers, would acquire a heating value equal at any rate to the same weight of the best coal in the manner in which it is at present used. Considering, also, the proximity of the pits to the ironworks in this district, it may be suggested whether the gas producers, being of very simple construction, might not with advantage be placed near the banks of fuel above or even under ground, the gas being conveyed to the works by a culvert, so as to supersede carting of the fuel. Such an arrangement might notably contribute to perpetuate the high position which South Staffordshire has so long maintained as an iron producing district.

LIST OF MINERALS

GIVEN IN THE "MANUAL OF THE MINERALOGY OF GREAT BRITAIN & IRELAND," BY ROBERT PHILLIPS GREG, F.G.S., AND WILLIAM G. LETTSOM. LONDON (1858), VAN VOORST.

Class I.—Non-Metallic Minerals.

ORDER.—I.—CARBON.

1. Graphite.
2. Coal.
   - *a.* bituminous coal.
   - *b.* non-bituminous coal.
   - *c.* brown coal.

ORDER II.—WATER.

3. Ice.

ORDER III.—RESIN.

4. Amber.
5. Copaline.
6. Middletonite.
7. Retenite.
8. Schleretinite.
9. Burytite.
10. Bitumen.
    - *a.* Naphtha.
    - *b.* Petroleum.
    - *c.* Elaterite.
    - *d.* Asphaltum.
11. Torbanite.
12. Ozocerite.
13. Hatchetine.

ORDER IV.—SULPHUR.

14. Sulphur.

ORDER V.—FLUORINE.

15. Fluor-spar.
16. Fluellite.

ORDER VI.—CHLORINE.

17. Rock-salt.
18. Sal-ammoniac.

ORDER VII.–CARBONATES.

19. Arragonite.
20. Calcite, &c.
21. Strontianite, &c.
22. Witherite.
23. Barytocalcite.
24. Alstonite.
25. Dolomite.
26. Breunerite.
27. Ankerite.
28. Hydrocalcite.
29. Pennite.
30. Hydromagnesite.

ORDER VIII.—OXIDES.

31. Brucite.

ORDER IX.—SULPHATES.

32. Anhydite.
33. Barytes.
34. Celestine.
35. Mascagnine.
36. Epsomite.
37. Alum.
38. Gypsum.
39. Websterite.

ORDER X.—PHOSPHATES.

40. Apatite.
41. Wavellite.
42. Childrenite.

ORDER XI.—SILEX AND SILICATES.

43. Quartz, &c.
44. Opal, &c.
45. Garnet, &c.
46. Idocrase.
47. Epidote, &c.
48. Zoizite?
49. Felspar.
50. Labradorite, &c.
51. Albite.
52. Saussurite?
53. Muscovite.
54. Biotite.
55. Staurolite.
56. Andalusite, &c.
57. Kyanite.
58. Beryl.
59. Spodumene.
60. Killinite.
61. Obsidian, &c.
62. Isopyre.
63. Iolite (Cordierite).
64. Zircon.
65. Olivine.
66. Gadolinite.
67. Allanite.
68. Wollastonite.
69. Augite, &c.
70. Bronzite.
71. Hypersthene.
72. Diallage.
73. Babingtonite.

74. Hornblende.
75. Natrolite.
76. Scolezite.
77. Mesolite, &c.
78. Faröelite (Mesole).
79. Thomsonite.
80. Stilbite.
81. Epistilbite.
82. Heulandite.
83. Chabasite, &c.
84. Gmelinite.
85. Levyne.
86. Laumonite.
87. Phillipsite.
88. Brewsterite.
89. Analcime.
90. Harmotome.
91. Edingtonite.
92. Weissigite?
93. Prehnite.
94. Allophane.
95. Chlorite.
96. Aphrosiderite.
97. Kammererite.
98. Margarodite.
    a. Nacrite.
    b. Gilbertite.
    c. Talcite.
99. Talc-steatite.
100. Lithomarge.
101. Saponite.
102. Kaolin.
103. Pinite.
104. Apophyllite.
105. Pectolite.
106. Gyrolite.
107. Serpentine, &c.
108. Topaz.
109. Chondrodite.
110. Lepidolite.
111. Tourmaline.
112. Datholite.
113. Axinite.

Order XII.—Alumina and Aluminates.

114. Corundum.
115. Spinel.

Class II.—Metallic Minerals.

Order I.—Gold.

116. Gold.

Order II.—Silver.

117. Silver.
118. Argentite.
119. Pyrargyrite.
120. Horn silver (kerate)

Order III.—Platinum.

121. Platinum.

Order IV.—Iron.

122. Metallic Iron (meteoric).
    Appendix. Meteoric stones.
123. Hematite (specular iron).
124. Magnetite.
125. Gothite.
126. Limonite.
127. Siderite.
128. Ilmenite.
129. Iserine.
130. Cronstedtite.
131. Vivianite.
132. Scorodite.
133. Pharmacosiderite.
134. Boudantite.
135. Melanterite.
136. Iron alum.
137. Fayalite.
138. Chlorophæite.
139. Green earth.
    a. Glanconite.
    b. Kirwanite.
140. Pitticite.
141. Pyrites.
142. Marcasite, &c.
143. Pyrrhotine.
144. Mispickel.

Order V.—Manganese.

145. Pyrolusite, &c. (Varvicite).
146. Manganite.
147. Psilomelane.
148. Wad.
149. Diallogite.
150. Rhodonite.

Order VI.—Nickel.

151. Annabergite.
152. Emerald nickel.
153. Millerite.
154. Eisen-nickelkies.
155. Nickeline (kupfernickel).

Order VII.—Cobalt.

156. Asbolane.
157. Erythrine.
158. Smaltine.
159. Cobaltine.

Order VIII.—Copper.

160. Copper.
161. Cuprite.
162. Melaconite.
163. Pitchy copper.
164. Malachite.
165. Chessylite.
166. Lirocouite.
167. Tamarite.
168. Clinoclase.
169. Olivenite.
170. Cornwallite.
171. Erinite.
172. Libethenite.
173. Lunnite.
174. Blue vitriol.
175. Brochantite.
176. Chrysocolla.
177. Condurrite (Domeykite).
178. Copper glance.
179. Kupferindig (Covelline).
180. Tennantite.
181. Tetrahedrite.
182. Chalcopyrite.
183. Erubescite.
184. Bournonite.
185. Connellite.
186. Molybdenine.
187. Molybdenite.

Order X.—Tungsten.

188. Tungstic ochre (Wolframine).
189. Scheelite.
190. Wolfram.

Order XI.—Tin.

191. Cassiterite.
192. Stannine.

Order XII.—Titanium.

193. Rutile.
194. Anatase.
195. Brookite.
196. Sphene.

Order XIII.—Arsenic.

197. Arsenic.
198. Arsenite.

Order XIV.—Antimony.

199. Kermes (Red antimony).
200. Cervanite.
201. Antimony ochre (Stiblite).
202. Bleinierite.
203. Antimonite.
204. Berthierite.

Order XV.—Bismuth.

205. Bismuth.
206. Bismuth ochre.
207. Bismuthine.
208. Daphyllite (Tetradymite).

Order XVI.—Uranium.

209. Uran-ochre (Zippeite).
210. Pitchblende.
211. Chalcolite (Uranite).
212. Autunnite.

Order XVII.—Lead.

213. Lead?
214. Minium.
215. Plattnerite?
216. Cerussite.
217. Anglesite.
218. Linarite.
219. Leadhillite.
220. Susannite.
221. Lanarkite.
222. Caledonite.
223. Pyromorphite, &c.
224. Mimetite.
225. Vanadinite.
226. Stolzite.
227. Wulfenite.
228. Galena.
229. Jamesonite.
230. Kilbrickenite (Geocronite).
231. Mendipite.
232. Matlockite.
233. Cromfordite.

Order XVIII.—Zinc.

234. Calamine.
235. Aurichalcite.
236. Smithsonite.
237. Goslarite.
238. Blende.

Order XIX.—Cadmium.

239. Greenockite.

Order XX.—Chromium.

240. Chrome oxide.
241. Chromite.

SUPPLEMENT.

1. Apjohnite.
2. Agalmatholite.
3. Bole.
    a. Erinite.
    b. Rhodalite.
    c. Fuller's-earth.
    d. Rock-soap.
4. Calcareo-sulphate of barytes.
5. Calcareo-sulphate of strontian.
6. Doranite.
7. Leedsite.
8. Mineral charcoal.
9. Nitro-calcite.
10. Pipe-clay.
11. Potter's clay.
12. Pigotite.
13. Plinthite.
14. Rotten-stone.
15. Scarbroite.
16. Stannite.
17. Supersulphuret of lead (Johnstonite).
18. Tuesite.
19. Verrucite.

EXHIBITION LECTURES.*

Woollen Rags.

Woollen rags have become extensively useful of late years. They cannot be converted into paper, but they can be converted into a great

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* Abstract of Dr. Lyon Playfair's Exhibition Lectures.

many substances; and, perhaps, some of my lady hearers will not quite thank me for the information which I am going to give. It is interesting, nevertheless. After garments have been worn and have gone through their common use and wear, they are by no means useless. They possess still a high money value; and these woollen garments, these clippings of the tailor, old rags, and old worn coats, when we have done with them, are all cut up, and torn to pieces. They have a little oil placed upon them, and are blown through a blower to get them into a fine state of division; and then they are sold as wool under the name of "mungo," or of "shoddy." Now, this is sold at about one-third the price of ordinary wool. The wool obtained in this way by breaking up these old rags is sold at from sixpence to a shilling a pound, and it forms excellent cloths. For instance, those light ladies' cloths which they wear as mantles are almost all made from these old rags. This cloth here, for instance, is made from these old rags. It is also used extensively for mixing with wool, because it gives a greater lustre and a certain fineness to the cloth; and therefore it is often used for mixing in ordinary woollen cloths. The coarser varieties are used for druggets and other purposes; but it is all used up. There is a portion of it which becomes waste, which will not make good wool. This, for instance, is the mungo waste, as it is called, which cannot be worked up into a cloth; but it is only waste as regards cloth-making. This waste is powdered and dyed with brilliant colours, and is then made use of for making flock-paper, such as we have in our ordinary apartments. For that purpose the paper is printed in a pattern with gum or with size. This powdered waste wool which has been dyed and prepared is then sieved over the paper, and it sticks where the gum or size has been printed on. In that way it forms the ordinary flock-paper.

Muslin-de-laines.

As long ago as 1834, in the cotton districts they learnt how to put a cotton weft with a woollen warp. The cloths thus produced were finer in texture and cheaper than the woollen cloth, and therefore there was a great demand for them. It was, however, scarcely worth while to take these muslin-de-laines as rags after they were worn out and economise them. The reason of that was, that you had two fibres of different kinds, one of wool and one of cotton, and you had to sacrifice one in order to get the other. For instance, if you desired to get the wool, you steeped the muslin-de-laines in acids, and converted the cellulose or woody fibre of which the cotton consisted into sugar, and the cotton being converted into sugar was lost, but the wool was obtained and used. If, on the other hand, you wanted to save the cotton of this mixed fabric, you dipped the material into an alkali and dissolved the wool. The alkali did not dissolve the cotton, but the wool, being dissolved, was separated from the cotton, and the cotton was saved. Now, Mr. F. O. Ward has shown in the Exhibition a pretty process for economising both fibres, or at least for getting a chemical product from both fibres, and it is very simple. Here are the rags as they are presented—the rags containing both of the substances—cotton and wool. They are subjected to a current of steam at three or four atmospheres—that is to say, hotter than ordinary; and when this heated steam passes through the rags it converts the wool into a sort of bituminous or resinous matter which becomes brittle. There is a portion which has been acted on by the steam. I agitate it, and the wool separates as a powder, and the cotton is as firm and as strong as it was before. All the wool has gone away from it, because it has been converted into this resinous substance. When this wool becomes dry, it can be separated by a kind of combined beating and sieving process; and now there remains the cotton. The cotton in this state is sold as ordinary cotton rags to the bleacher who bleaches it, and is converted into paper. There is some paper made from the cotton rags bleached in this way. This substance which I have shaken off here, and which has come upon this paper, is the wool, and is still valuable. It contains 12 per cent. of nitrogen, and therefore is in a condition which makes it a good manure, and it is sold as such under the name of "ulmate of ammonia." I ought to tell you that the woollen rags are never too waste to be converted into manure. All the early broccoli which comes up from Cornwall is forced on by being manured with these woollen rags.

Prussiate of Potash.

Attempts have been made to improve the manufacture largely, but without any great success. Still, it is such an interesting application of the waste substances which contain nitrogen, that it would not do to pass it over in a lecture upon waste materials. In the making of prussiate of potash, almost all the things which are too waste and too refuse to be employed for the higher purposes of waste substances, such as I have shown you there, as cloths and paper-hangings, are employed for making this salt. For instance, the horns of cattle, the hoofs of cattle, clippings of leather, the cast-off woollen garments of the Irish peasantry, and all sorts of things which are refuse, are mixed up with pearlash, or carbonate of potash, which, you know, comes from the ashes which remain after the combustion of wood, and with old scraps of iron. Old iron hoops from beer barrels, broken hoops, iron nails, old iron horse-shoes, or any old scrap iron which can be obtained, is mixed up with this refuse, pearlash, blood, and other substances, and they are all fused together in a pot, and after they are fused in this way they are dissolved out in water, and then they are transformed from their ugly primary condition to this beautiful salt, which is yellow prussiate of potash. It is a cyanide of iron and a cyanide of potassium. The nitrogen combines with the carbon and forms cyanogen; and then the cyanogen combines with the iron and the potassium, and forms this prussiate of potash. This salt is very extensively employed, because it is the source of Prussian blue. I have here a solution of iron rust which I add to this solution of the yellow salt. You see immediately that a copious precipitate of Prussian blue is produced—that beautiful colour which we employ so extensively. Now, if you pass chlorine through yellow prussiate of potash, you remove one equivalent of potassium, and then you get this other salt, the red prussiate of potash, which, though it differs from the other merely in containing one equivalent of potassium less, yet is changed in its chemical characters considerably. The yellow salt is not poisonous, but the red salt is intensely poisonous. This also with another salt of iron—a proto-salt of iron—forms Prussian blue. If I put some of this red salt into the water, and add a lower oxide of iron, it forms a Prussian blue of a characteristic brilliancy, which enables it to be used in many cases in preference to that produced from the other salt.

White Gunpowder.

If I take 28 parts of that yellow prussiate, 23 parts of cane-sugar, and 49 parts of chlorate of potash, and then sieve them so as to mix them together, we get a description of gunpowder, as you see by its action [exploding some]. This gunpowder has certain advantages even above ordinary gunpowder. Weight for weight, it forms nearly double the volume of gas that common gunpowder yields ; and it leaves less residue behind. Although you may think that considerable [referring to the ash left by the white gunpowder which had just been fired], it is still less in quantity than the amount which is left by the ordinary gunpowder. But the temperature of the flame on ignition is not so high ; so that, although the white gunpowder produces double the amount of gas, that gas is not heated so much, and therefore does not expand so much as in the case of ordinary gunpowder, and the projectile force of this white gunpowder has not answered the expectations formed of it. Still it is so exceedingly easily made—by simply taking these materials, prussiate of potash, chlorate of potash, and sugar, sieving them separately so as to get them fine, and then sieving them in their proportions together so as to get them mixed, that it may have some advantages. There is required none of the mechanical applications necessary in the manufacture of ordinary gunpowder, such as the milling and glazing and granulation, which make its manufacture so troublesome and expensive.

Bones.

Rags and bones are naturally associated in one's mind. The same collector collects both ; although I confess that I am somewhat sorry for their association to-day, because the chemistry of bones is so extensive that I scarcely know how to handle it in half a lecture. I must therefore pass over their known applications—the applications which are so familiar to you. I can say nothing of their use as a manure, either in their ground or subdivided state, or as they are often used, after being treated with sulphuric acid, under the name of superphosphate of lime. I cannot even, interesting as it is, dwell upon the fact that within the last few years we have learnt actually to take up and apply the bones of extinct animals—of the old reptiles which during the Saurian period spread terror through the seas and estuaries of the time. The bones and exuviæ of these animals are now used as manure. They are ground and mixed with sulphuric acid, and sold under the name of "superphosphate of lime."

In this country the importation of bones for mechanical and chemical purposes amounts to from 70,000 to 80,000 tons per annum. The mechanical purposes for which bones are used are such as the making of handles for knives. The quantity imported represents a money value of £400,000.

When we examine the chemical composition of bone, we find it to consist of an organic matter 33 parts, of phosphate of lime 56 parts, of carbonate of lime 8 parts, and of fluoride of calcium and phosphate of magnesia 2 parts, making 100 parts. Now, I can easily show you the earthy matter, taking it generally, and the organic matter. I have here put a bone, which was of the form you see it here, in a little weak muriatic acid. That has dissolved out the earthy portion and left the organic matter of the cartilage as you observe, which you see is quite soft. Now, this cartilage is extensively used for purposes which I have not time to enter into, because that is not what I have to deal with. It is used extensively in making a glue or size used for stiffening calico prints, which is of a less stiff and firm character than the glue used for ordinary purposes. The bones are boiled, and this cartilage becomes converted into gelatine, or into the jelly with which you are familiar under the name of "calves-foot jelly," in which the cartilage is changed into a gelatinous substance. This is extensively used, and it is a subject which one would like to dwell upon, but I cannot.

Bone Black.

If instead of taking out this gelatine by boiling it, you take the bones and calcine them with this cartilage in them, the bones are converted into a black substance which is called "bone-black." The fact is, the cartilage becomes carbonised, the volatile matters are driven off, and the earthy matters of the bone become mixed with charcoal, which remains behind. This charcoal is extensively used for the purpose of decolorisation. It is that which is employed for the purpose of making brown sugar white. If any coloured organic substance be passed through these calcined bones, and you allow it to go gradually, you will find that it filters through with the colour, perhaps, not wholly removed by the first operation, but it will be removed by the second. You see this liquid is now passing through almost wholly decolorised, because this charcoal has a strong affinity for the colouring matter and unites with it. This bone-black is extensively used decolorising syrups and other things.

When this bone-black is formed by the calcination of the bones, there is also a large quantity of oils which distil over, and which are sold under the name of "Dippel's animal oil," useful for various purposes.

Phosphorus.

The earthy matter of bones consists of three equivalents of lime united with one equivalent of phosphoric acid. It is what chemists term "a tribasic phosphate of lime." Phosporic acid, as you are no doubt aware, consists of one equivalent of phosphorous united with five equivalents of oxygen In order to obtain the phosphorous, it is only necessary to take away those five equivalents of oxygen, which we can do by mixing the compound with charcoal after some preliminary operations, and heating them together. The charcoal takes away the oxygen and forms carbonic oxide with it, whilst the phosphorous distils over. In this way we get phosphorous in the condition in which you are very familiar with it. Here it is in the state in which we obtain it, by this distillation, after it has been again melted and filtered through chamois leather, and cast into quill tubes. You see it is a wax-like substance, which I must handle with care, because if I allow it to dry, the heat of my fingers would be sufficient to inflame it. Now, observe what this substance looks like. It is semi-transparent; it is soft; you can cut it like wax. It is exceedingly poisonous, and in the making of lucifer-matches it is found to be a very insidious poison. Lucifer-match makers are apt at first to be subject to an affection which does not draw much attention. They complain frequently of toothache, but they do not know the insidious disease which is creeping upon them. I will not pain you by describing this disease in its progress, but will merely say that the lucifer-match makers who make lucifer-matches from this phosphorous are subject to the most distressing of all diseases; the jawbone becomes destroyed, and frequently disappears or becomes useless, and some of them spend the greater part of their lives in the wards of hospitals.

It therefore became an important point for science to find some way by which this phosphorus should be deprived of its poisonous properties without losing those chemical characters which make it so useful in making matches for instantaneous light. Now, a gentleman who is at present in London, as one of the Jurors of the Great Exhibition, met this want of science in a very skilful way. Bodies are capable of assuming two conditions, and sometimes more, which the chemist calls "allotropic" conditions; that is to say, they are, in fact, old friends with new faces given to them by some artifice, but still the same body, and not having gained or lost anything. Now, here is our old friend phosphorus with certainly a new face. By taking common phosphorus and exposing it for some time to a temperature of 460°, this yellow, waxy, transparent substance transforms into a dark brick-like substance. It is no longer so inflammable as to ignite spontaneously. I place it in water because it will ignite upon the application of a light, and it is best to keep it away from the possibility of those conditions under which it might be accidentally ignited. It may be packed up in boxes without danger of spontaneous combustion; but what is more important, it has lost all its poisonous properties. The phosphorus, which was poisonous before, is no longer poisonous in this allotropic condition, and it is still capable of being used for making lucifer-matches. In passing into that allotropic state it has lost its power of dissolving in bisulphide of carbon, and if any of the old phosphorous remains in it, it may be dissolved out by this bisulphide of carbon. I have here some of this ordinary substance which is dissolved in bisulphide of carbon, and if I pour it now over this paper you will see the properties which it possesses in a very short time. It will ignite of itself as soon as it becomes sufficiently dry by the passing off of the bisulphide of carbon. When this evaporation takes place the phosphorus is left in such a fine state of division upon the paper that it bursts into flame. The allotropic phosphorus is altered very considerably in its chemical characters.

Lucifer Matches.

I cannot tell you who was the first inventor of a means of getting instantaneous light. Many admirers of Prometheus declare that it was Prometheus, but he does not do so himself. He says this:—

> "I am he who sought the source of fire,
> Enclosing it hid in my narthex staff;
> And it hath shown itself a friend to man,
> And teacher of all arts."

You recollect the circumstances under which Prometheus got the fire. Jupiter was so angry with Prometheus for having stuffed a bull's skin with bones and passed it off as a real carcase for a votive offering, that he took away fire from the earth to punish Prometheus. We might suppose that the father of the gods removed the fire lest the ingenious Prometheus should have made phosphorus from the bones, and thus become independent of the gods. Whether man would thus have been independent of the gods for fire I do not know, but fire was taken from the earth. What Prometheus actually did was only to steal fire from the chariot of the sun and keep it alive, until he reached the earth and gave it to man, by blowing it with the pith of the giant Fennel, which he used as a staff. We are told by Pliny and Virgil that the tinder-box, similar to those used by us, was well known in their time. They describe the properties of the flint and steel, and Virgil says that dry leaves may be ignited by means of the flint and steel with the rapidity of speech. The savages of various countries found for themselves a means of getting a light, which was far from instantaneous. I think that it would require much more dexterity than we can employ, to demonstrate how a light may be got by rubbing together two pieces of wood; but we can get sufficient heat in that way to ignite some substances which are more combustible than the wood itself. Mr. McIvor will rub these two pieces of wood together, and in a little time they become very hot. Now they are smoking violently Observe that there is now heat enough to ignite a piece of phosphorus readily. In this case the friction by a philosophical process, which I need not describe just now, is sufficient to produce a large quantity of heat; and savage tribes have been accustomed to use that friction to obtain a source of light. For a long time, as many of our older readers will recollect, our only means of obtaining an instantaneous light, even within my own recollection, was the tinder-box. The tinder-box with its trio was familiar to many of us—burnt-rag, flint, and steel. These were used to obtain a flame, and then in addition to this trio there was the sulphur-match, which was ignited after the flame had been obtained by the sparks falling among the burnt-rag. If the rag were not damp, and everything was in perfect order, you could get a light in a short time; but if the rag were at all damp, or the day was draughty, you might get a light in a quarter of an hour. [The lecturer here illustrated the use of the tinder-box.] There, now we have got a light, and by blowing it up I may succeed in getting the sulphur-match alight. I recollect when I was a boy remaining for at least half-an-hour in a castle which I was to be shown over, whilst a light was got in this way.

Dobereiner's Lamp.

The first invention which led the attention of chemists to the importance of a means of obtaining an instantaneous light occurred in 1820, when

Dobereiner produced a lamp of an elegant character. You will see it represented in this diagram. Here is a vessel in which hydrogen gas is collected. The hydrogen gas is formed by the action of sulphuric acid and water upon zinc. These acting upon the zinc produce hydrogen, and the hydrogen rises here, and as it is formed it expels the acid from the vessel, so that it no longer acts upon the zinc. I have in this way a reservoir of hydrogen; and now if I take a piece of spongy platinum, which has the power of absorbing oxygen from the air and condensing it within its pores, and bring this platinum in contact with the hydrogen, you see that it gets red hot, and ignites the hydrogen. Thus, you see that this plan of applying hydrogen for the purpose of acting upon the oxygen condensed in spongy platinum is a method by which a light can be obtained. The spongy platinum absorbing oxygen, presented oxygen to the hydrogen, and caused the formation of water, and in the formation of water so much heat was produced that the hydrogen became ignited, and a light was obtained. One disadvantage which prevented it being universally adopted was simply this: that the least speck or fouling of this spongy platinum puts the lamp out of order. For instance, this may have been in order five minutes ago, and it may be out of order now. Some dust or dirt may have got upon the spongy platinum. Still, the application was so elegant that it drew the attention of scientific men to the importance of getting an instantaneous light.

The next invention consisted in mixing phosphorus and sulphur in a bottle, and then taking them out upon a splint of wood, which was rubbed, and a light obtained in that way.

Then came the method of getting a light by means of chlorate of potash and sulphuric acid. Here I have some chlorate of potash mixed with sugar, and I place a little of it on a plate. I will not put too much because of the fumes. I now dip this rod in sulphuric acid so as to get a little on the end of it, and with this I touch the mixture of chlorate of potash and sugar. The sulphuric acid liberates the chloric acid, which gives oxygen to the sugar; the sugar burns, and an instantaneous light is obtained in this way. Captain Manby used this process for firing off his safety mortars, and thus drew considerable attention to this mode of obtaining a light. An application of this chlorate of potash and sulphuric acid to match making was now made. There were two applications: one was older than the other. The method which was first introduced consisted of having a little bottle of asbestos. Here is one of the old kind, which many of us can recollect. This asbestos is moistened with oil of vitriol, and the chlorate of potash and sugar, instead of being separate, as I showed you there, are put upon the end of the match, and you dip it in the sulphuric acid, and the chlorate of potash and sugar mixture gets ignited, and the light is got in that way. Well, that was the first application of the old experiment of chlorate of potash and sugar. Then there was another. I am sorry to say that I have only one or two of these ancient matches left, and they will soon be gone altogether. The plan was to take the chlorate of potash and sugar, and wrap it in a piece of paper, and to have the sulphuric acid sealed up in a little glass glolule inside the mixture. The mode of using it was, if you had a pair of pincers at hand, to break the globule with them, and so ignite the match; but if you had not a pair of pincers in readiness, you did it between your teeth; and if you were very clever, you might do it without getting the sulphuric acid into your mouth, or burning it with the explosion. This match had a great objection—that chlorate of potash and sugar always go off violently, and the sulphuric acid in the globule, although in small quantity, was spirted over the dress, and destroyed the dress whenever it came in contact with it.

The first friction-match was introduced in 1832. The mode in which these friction-matches are made, many of my hearers who lived in 1832 will recollect. I have a lively recollection of it. The mode was this—sulphide of antimony was mixed with chlorate of potash. Here the sulphide of antimony gave sulphur, just as the sugar gave a combustible to the chlorate of potash. This was put upon the end of a piece of wood; and the friction was produced by drawing this through a piece of sand-paper. I have there some antique matches of all kinds, which are now very valuable because they are very difficult to obtain. My experience as a boy with regard to these friction-matches was that with considerable adroitness you might get a light after pulling off the ends of half a box; and then when it did come, it came with such violence and explosion that it projected a considerable quantity of the ignited matter over the hands and burnt them. You might get a light for 6d. or 8d.; at least, that was my experience as a boy. My seniors may have been more successful.

In 1834 the phosphorus-match was invented. In this, after a time, sulphur became substituted for sulphide of antimony, and it was a great improvement upon the old congreve. At first the phosphorus match was violent in its action, and it projected its melted materials over the fingers unless you held it carefully, and the reason of that was that nothing but chlorate of potash was used as the oxidiser. The friction produced the heat necessary to ignite the phosphorus; the chlorate of potash gave it the oxygen, and it burnt violently. After a time manufacturers learnt that it was better not to take chlorate of potash by itself, but to mix it with some less energetic oxydising agent—as, for instance, with saltpetre or nitrate of potash, or with peroxide of lead, or with some agent less energetic than the chlorate of potash. In this way the phosphorus-match became much improved in character. The sulphur which was used to carry out combustion, and to get up sufficient heat to make the wood ignite, was also gradually substituted in the better kind of matches by melted stearine. The wooden match was dipped into melted stearine, and all possibility of fumes of sulphur was in this way obviated. The common phosphorus-match became gradually improved, and its use has now increased to such an extent, that it may surprise you to know that there are some chemical works in this country where they make nine millions of matches daily. In France and England alone 300,000 pounds of phosphorus are annually made into matches, and as three pounds of phosphorus are sufficient to tip five or six million of matches, you can conceive what a large industry this has become. But the larger the industry has become the greater has been the evil with regard to the workers. On account of the extreme cheapness of the phosphorus-matches there is a desire to make them of the cheapest materials, and as this waxy phosphorus is cheaper than this allotropic phosphorus, all the common matches are, of course, made with the ordinary phosphorus. I show you a better kind of matches, which I hope all my hearers will encourage, which are not made with the waxy phosphorus, but with the allotropic, or brown phosphorus. You may easily know them by their brown ends. The allotropic phosphorus fortunately answers equally well for the purpose, and is not at all poisonous to the match-makers who have to use it. There are two kinds of matches made with the allotropic phosphorus. One kind is made like the ordinary match, with the oxidising material and the allotropic phosphorus mixed together and put upon the end of the match. It, therefore, differs from the ordinary kind only in the fact of its being made with allotropic phosphorus. But there is another kind of match which has been manufactured, and it is an exceedingly beautiful invention. Here the oxidising material alone is put upon the match, the phosphorus not being put upon the wood. It is not, therefore, a match of the ordinary kind. You could not get it to ignite in the usual way. Here the oxidising material is put upon the piece of wood, and the allotropic phosphorus is put upon the friction-paper mixed with the emery. This piece of wood does not, therefore, become a match until I take off a certain quantity of that phosphorus along with my oxidising material, by rubbing it upon the paper upon which the emery and phosphorous are spread. The value of that device is great, because there can be no accidental firing, as in the ordinary matches. Trampling upon them, or leaving them too near the fire, cannot make them ignite, because the match is not a match until it is drawn over the sand paper and takes up phosphorus. Accidental ignition is thus prevented.

BOOKS ADDED TO THE FREE LIBRARY OF REFERENCE.

SHELF No.		
F. 24—	Cyclopedia of Biography, Appleton's, 8vo. 1856	*F. L. Hawks.*
G. 44 & 45—	Cyclopedia of English Literature, 2 vols. 8vo, 1850	*Robt. Chambers.*
G. 46 to 49—	Pictorial History of England, in IX books, each book containing chapters, respectively, on the Civil and Military transaction of a period; on Religion; on the Constitution, Government and Laws; on the National Industry; on Literature, Science, and the Fine Arts; on Manners and Costumes of the People; and on the Social Condition of the People, 4 vols. 8vo, 1846	*Craik & McFarlane.*
G. 50—	Classical Dictionary, containing an account of the proper names of Ancient Authors, &c., &c., 8vo, 1858	*Chas. Anthon.*
	Parliamentary Publication.	

BRITISH PUBLICATIONS FOR DECEMBER.

Builder's (The) and Contractor's Price Book, for 1863, revised by G. R. Burnell, 12mo	0	4	0	*Lockwood.*
Burke (Sir Bernard) Peerage and Baronetage of the British Empire, 25th ed., roy. 8vo.	1	18	0	*Harrison.*
Burn (R. Scott) Outlines of Modern Farming, Vol. 1; Soil, Manures, &c., 12 mo.	0	2	0	*Virtue.*
Fitz Roy (Rear Admiral) Weather Book, a Manual of Practical Meteorology, 8vo.	0	15	0	*Longman.*
Flemyng (Rev. Francis P.) Mauritius; or the Isle of France, fcap, 8vo.	0	2	6	*Soc. Pr. Ch. Kn.*
Francis (F.) Fish Culture; a Prac. Guide to Breeding and Rearing Fish, cr. 8vo.	0	5	0	*Routledge.*
Garbett (Edwd. L.) A Rud. Treatise on Principles of Design in Architecture, 2nd ed., 12mo	0	2	0	*Virtue.*
Gardener's Annual (The) for 1863, edit. by Rev. S. R. Hole, fcap. 8vo	0	2	6	*Longman.*
Gaugain (Mrs.) Lady's Assistant in Knitting, Netting, &c., new ed., pts. 1 and 2, obl., each	0	1	0	*Harrison.*
Hartwig (Dr. G.) Tropical World: the Animal and Vegetable Kingdom in Equat. Regions, 8vo	1	1	0	*Longman.*
Hodges (J. F.) Outlines of the Structure, &c., of the Animals of the Farm, 12mo.	0	2	6	*Longman.*
Hunt's Yachting Magazine, Vol. 11, 8vo	0	14	0	*Hunt & Co.*
Kirby (W. F.) Manual of European Butterflies, 12mo	0	6	0	*Williams & N.*
Kitto's Cyclo. of Bib. Litera., 3rd ed., enlarged, ed. by W. L. Alexander, Vol. 1, sup.-roy. 8vo.	1	0	0	*Black.*
Lectures before Dublin Young Men's Christian Association, 1862, cr. 8vo.	0	4	0	*Hodges & Smith.*
Lee (Edwin) Effect of Climate on Tuberculous Disease, sm. post 8vo. red to	0	4	6	*Churchill.*
Ranken (Major) Canada and the Crimea: Sketches of a Soldier's Life, 2nd edit., post 8vo	0	7	6	*Longman.*
Sutton (Thomas) Collodion Processes, Wet and Dry, cr. 8vo	0	8	0	*Low.*
Tate (Thomas) Key to Tate's Algebra made easy, 12 mo	0	3	6	*Longman.*
Timbs (John) International Exhibition; the Industry, Science, &c., of the Age, fcap. 8vo	0	6	0	*Lockwood.*
Trimen (Ronald) Catalogue of South African Butterflies, Part 1, 8vo.	0	7	6	*Trübner.*
Waters (A. T. H.) On the Nature, Treat., &c., of Emphysema of the Lungs, 8vo.	0	5	0	*Churchill.*

Board of Arts and Manufactures
FOR LOWER CANADA.

BOARD ROOM, MECHANICS' HALL,
7th January, 1863.

Your sub-committee have the honour to report:

That on assuming office for the year just closed, they had hoped to avoid the evil under which their predecessors laboured, and by which their efforts to realize the objects for which this Board was constituted, were rendered futile,—the want of the necessary funds to carry out the important trusts with which they were charged. This hope, however, they were unable to realize, for the renewal of the small pittance meted out to their predecessors in office, amounting to the sum of two thousand dollars, was all that was allotted to this Board for the year just terminated.

Previous to the establishment of the Boards of Arts and Manufactures in this Province, grants were annually made by parliament to all Mechanics' Institutes, and so called associations, and moneys were thus obtained for purposes far different from those intended, until the attention of the government was called to this abuse; and upon enquiry the facts elicited established the correctness of the allegations. By this means the appropriation of moneys to illegitimate purposes was prevented, and a large saving was thereby secured to the Province.

The originators of these Boards sought unsuccessfully, however, to obtain for them a position as regards Mechanics' Institutes and kindred associations, equivalent to that occupied by the Board of Agriculture in relation to the county Agricultural Societies, but they secured however the formation of these Boards whose duties are:

First. To take measures to collect and establish museums of minerals and other material substances and chemical compositions susceptible of being used in Mechanical Arts and Manufactures, with model rooms appropriately stocked and supplied with models of works of art, and of implements and machines other than implements of husbandry and machines adapted to facilitate agricultural operations, and free libraries of reference, containing books, plans and drawings, selected with a view to the imparting of useful information in connection with Mechanical Arts, and Manufactures:

Second. To take measures to obtain from other countries new or improved implements and machines (not being implements of husbandry or machines specially adapted to facilitate agricultural operations,) and to test the quality, value and usefulness of such implements and machines:

Third. And generally to adopt every means in their power to promote improvement in the Mechanical Arts and Manufactures of this Province.

Your sub-committee's predecessors in office established a free library of reference, containing all the English and American specifications and drawings, reports and other works of a suitable description, which your sub-committee have kept regularly open, and to which some additions have been made during their term of office. The whole number of volumes now in their possession amounting to one thousand and thirty six.

Shortly after the formation of this Board, intelligence, of the proposed visit to Canada of His Royal Highness the Prince of Wales was received, and this was considered by the predecessors of your sub-committee, a fitting occasion for this Board to put forth its best efforts to secure an exhibition of the raw and industrial products of this country. Their views were promptly seconded by government who appropriated for this purpose the sum of $20,000. The want of a suitable building for exhibition purposes had long been felt; and this Board, with an energy and alacrity unparalleled in this Province, procured a site and erected a building for that and future exhibitions. The efforts of the Board were successful as to the exhibition, which was one alike creditable to its originators and managers (your sub-committee's predecessors in office,) and to the country.

The building was not erected without involving the Board in liabilities it never would have assumed, but for the informal pledges made to it by members of the government, of an increased annual grant, and from the non-fulfilment of which have arisen its present inability to carry out the objects for which it was constituted. It was the intention of your sub-committee's predecessors to have removed their offices and library to the exhibition building, and to have taken measures to establish in connection with the library a museum for minerals, models, machines, and manufactures; but want of means to prepare the building for that purpose, prevented them from carrying out this intention.

The receipts of the Board for the exhibition building and the government grant having fallen short of the expectations of your sub-committee's predecessors in office, they were under the necessity of mortgaging the building to the contractor Mr. McNevin for the sum of $11,000 for two years, from the 25th January 1861, with interest at seven per cent. per annum, payable semi-annually, the first payment of the interest to be made on the 25th June, 1861; and in case the Board should make default in the payment of the said interest to accrue and become due on the said principal sum of $11,000 for the space of thirty days after the said interest payments should become due and payable: then the whole of the debt, with all interest then due, should immediately be and become due and exigible.

Owing to the non-payment of this interest previous to the 25th day of July, 1861, a suit was instituted against this Board for the recovery of the principal, although tenders had been made of the amount of interest previous to the institution of the suit. At the time of your sub-committee's assumption of office this suit was pending; and it was only in the month of April last that a judgment was rendered, condemning the Board to pay the amount demanded by the plaintiff.

Your sub-committee were unable to meet this demand; and execution was subsequently issued, under which the building was seized, and advertised to be sold on the 27th day of November following, now past.

A deputation was named by this Board to proceed to Quebec, to lay before the members of the government the affairs of the Board and its position with regard to the exhibition building; which they did, but the results of which have yet to be realized.

In the meantime the sale of the building was postponed by the action of the Royal Institution for the advancement of learning Governors of the University of Mc Gill. College, who claim that the building shall be sold subject to the restrictive clauses contained in the deed of the property from that body to this Board. As this claim is resisted by the contractor, some time must elapse before further steps can be taken. Your sub-committee strongly recommend their successors in office to bring this matter prominently before the government, that this Board may be relieved of the incubus of this debt to the contractor.

During the past year, the Agricultural Association, at the meeting held at Sherbrooke in September last, decided to hold their next exhibition in this city; and that a proper representation of the Arts and Manufactures of the Province may be secured. Your sub-committee recommended their successors to immediate action in the matter.

The importance and necessity of an increased grant, together with amendments in the constitution of these Boards, was deeply felt by your sub-committee's predecessors in office; and representations were duly made to parliament, and a bill containing the latter submitted, but without success. Your sub-committee, equally desirous of shaking off the trammels which limited them in their operations, made similar applications; but although supported in their views by the Upper Canada Board they were unable to effect any change.

The desirability of a change in the Patent laws, and the act respecting Trade Marks and Designs, was also a matter of serious consideration as well on the part of your sub-committee as of their predecessors; and although a bill containing such enactments as were considered desirable for the country was introduced during two successive sessions of parliament, the desired changes have not yet been made.

Your sub-committee now recommend to their successors the consideration of these three measures, the securing of which will do much towards enabling this Board to fully discharge their important duties.

A course of lectures on mechanical and scientific subjects was established by your sub-committee's predecessors; but the meagre attendance of those for whose benefit they were given, deterred your sub-committee from making a similar effort; they however recommend to the consideration of their successors, whether it would be desirable to make another effort in this direction.

The contribution of the Board in aid of the classes of the Mechanics' Institute has been renewed for the present year, and your sub-committee regret their inability to do more.

The exhibition building continues to be occupied as an armory for the Montreal Field Battery of Artillery under the arrangement made with the government by your sub-committee's predecessors. A small rental has been obtained by letting it for concerts and other amusements, a statement of which is herewith submitted.

It is highly desirable in the opinion of your sub-committee that arrangements be made for using the building for the purpose originally intended; and your sub-committee recommend the consideration of this matter, to their successors as one of their first duties; but, failing in this, they recommend that some definite arrangement be made for its occupation for other purposes, by which the Board may be relieved from further responsibility respecting it.

Your sub-committee cannot conclude without referring to the Exhibition of all Nations held in London during the past year, and which is now closed. They regret extremely that the contributions from this Province were, for the most part, confined to raw and mineral products, in consequence of the tardiness attending the appointment of Canadian commissioners, and the small amount appropriated for this purpose. Had more zeal for the prosperity of the manufacturing interests of the Province been exhibited in proper time; and had the appointment of commissioners been made, as it should have been done, when the attention of government was called by your sub-committee's predecessors to the restrictions of the Home Commissioners; and had a suitable sum been placed at the disposal of Commissioners to enable them to secure a proper representation of the progress made in the Arts and Manufactures of this country, Canada would have occupied a higher position than that allotted to her in the great exhibition of 1862. As it is however, she has her prizes, and her position among nations, which position it is now the province of this Board to assist in maintaining and elevating.

The Treasurer's accounts are herewith submitted for audit.

The whole nevertheless respectfully submitted.

(Signed)
William Rodden,
Vice President.

(Signed)
Dunbar Browne,
Sec. pro term.

Board of Arts and Manufactures
FOR UPPER CANADA.

TORONTO MECHANICS' INSTITUTE.

We have great pleasure in inserting the following circular, handed us by the Secretary of the Toronto Mechanics' Institute, and trust that it is but the commencement of a movement that will prove alike beneficial to the Institutes in the intellectual improvement of their youthful members, and to the workshops of the Province, in following the excellent example of the Directors of the Northern Railway, by securing to them a more intelligent class of workmen than would be otherwise obtainable.

Canadians may well congratulate themselves upon the excellent common school and collegiate systems established for the education of the rising generation, in all the ordinary branches of knowledge; but there is still an absence of sufficient facilities for obtaining that kind of practical education peculiarly adapted for youths intending to follow manufacturing and mechanical pursuits;

end we know of no organizations so well fitted for furnishing this kind of information as the mechanics' institutes of the province, by means of their classes and lectures on subjects bearing upon the future avocation of their members.

We shall, from time to time, notice the various operations and movements of the several institutes when informed of them, and especially of the METROPOLITAN MECHANICS' INSTITUTE of Upper Canada, so far as its plans may be suggestive to others.

Prizes and Apprenticeships.

The DIRECTORS of the NORTHERN RAILWAY of CANADA have placed at the disposal of the Directors of the Institute, the nomination from its members and classes of two apprentices for the present year, and one apprentice annually, to the machine shops of the Company; on condition that the nominees shall each pass a satisfactory examination in the subjects named in the annexed programme.

The Directors of the Institute have accordingly decided to institute the following regulations and examinations for the selection of two nominees for the apprenticeships of this year:

1. The candidates must, before entering upon the examination, present to the Directors sufficient testimony of moral character.

2. The candidates must not be less than 14, nor more than 17 years of age, and must be of good physical form and constitution, approved by the Company before entering on examination.

3. The names of candidates, with age and residence, must be fyled with the Secretary of the Institute on or before the first day of March next.

4. The examinations will be held in the last week of April next, of which due notice will be given.

5. Two examiners will be appointed, one by the Directors of the Institute, and the other by the Northern Railway Company; and they shall have full power to conduct the examinations according to their discretion and judgment, but subject to the programme attached.

6. The candidates who shall be placed first and second on the list by the examiners as having past examinations entitling them thereto, shall be nominated to the Northern Railway Company for the apprenticeships.

7. The nominees will be required, with the consent of their parents, to enter into articles of apprenticeship for a period of four years; during which period they will be paid per day for the first year, with an advance of in each succeeding year, on merit.

Programme of Examinations.

I. ENGLISH GRAMMAR AND COMPOSITION.
  1. Writing from dictation.
  2. Grammatical analysis of sentences.
  3. Composition on a given subject.

II. ARITHMETIC.*
  1. Fundamental rules.
  2. Proportion, simple and compound.
  3. Practice.
  4. Interest, simple and compound.
  5. Fractions, vulgar and decimal.

III. MENSURATION.

IV. MECHANICAL DRAWING.
  1. Geometrical Drawing of Machinery.

V. ALGEBRA.†
  1. Algebraical fractions.
  2. Square and cube roots.
  3. Greatest common measure.
  4. Least common multiple.
  5. Simple and quadratic equations, single and simultaneous.
  6. Ratio and variation.

VI. GEOMETRY.
  1. Solving geometrical theorems and problems, deducible from the first six books of Euclid.

NOTE.—It will be obligatory upon all candidates for the apprenticeships to pass examinations in subjects I, II, III and IV (English, Arithmetic, Mensuration and Mechanical Drawing); subjects V and VI will be optional with the pupil, but proficiency therein will be accounted to the advantage of the candidate.

The Directors of the Institute will award in each of the four classes—English, Mathematical, Writing and Book-keeping, and Mechanical Drawing—two prizes, of $10 and $6 respectively—the first prize for excellence, and the second for most satisfactory progress made during the session; and two prizes to the nominees for the apprenticeships, of $12 and $8 respectively.

The Directors will also award two prizes of $10 and $6 respectively, to members of any of the classes who shall most successfully pass a preliminary examination as candidates for the final examinations of the Board of Arts and Manufactures, in May next: the Board, in addition to granting certificates of three grades of merit, will award silver medals, in the proportion of one to every five candidates who shall pass its examination.

GEORGE LONGMAN,
January 28, 1863. *Secretary.*

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* Correctness of answers, excellence of method by which they are worked out, and neatness of working, will be taken into account by the examiners.

† Candidates will be required to give explanations of elementary principles, and proofs of fundamental propositions.

FLAX CULTIVATION IN CANADA.

We take the following interesting correspondence from the *Sherbrooke Leader*, C. E. The scutching machine referred to in Mr. Reid's report, is one of those imported by the Canadian Government during last year, and placed in charge of the Boards of Agriculture of Upper and Lower Canada, for the use of persons experimenting in the culture of flax. A description and engraving of this machine were published in the February No. of this Journal for 1862.

SHERBROOKE, January 20, 1863.

To the Editor of the Leader.

SIR,—I have the pleasure to hand you the enclosed report of Mr. George Reid, who has been employed to scutch the flax grown in the township of Eaton last year, on the farms of Mr. Cyrus A. Bailey, Mr. Osgoode, Mr. Cook and others.

It is intended to send two bales, of two hundred pounds each, to Europe, one to Belfast, and the other to Messrs. Marshall, of Leeds.

You will see from Mr. Reid's report that the flax was as good in quality, and produced as much in quantity as the average of Ireland, so that if this report be correct, there can be no doubt about flax paying in this country.

I am, Sir, yours faithfully,
R. W. HENEKER,
President Flax Association.

REPORT *of Mr. George Reid, on the Flax scutched for Mr. Cyrus A. Bailey, Mr. Osgoode, Mr. Cook, and others of the Township of Eaton.*

To R. W. HENEKER, ESQ.,
President Flax Association.

SIR,—I have just completed the scutching and dressing the flax grown and dew retted by Mr. Cyrus A. Bailey, Mr. Osgoode and other gentlemen, at Cookshire, township of Eaton.

I think the flax generally is of good quality—quite as good as the ordinary flax grown in Ireland, and yielding about the same amount of dressed flax as in Ireland.

Rowan's Machine was used by me, and the work was good, with not more than the ordinary amount of tow.

About 16 lbs. of dressed flax was the product per hour—one man's work.

The amount per acre is 500 lbs.

The flax was dew retted, but if water retted the color would be better.

The dew retted flax I have operated upon is, however, of good marketable quality.

(Signed) GEORGE REID.

Correspondence.

WARMING AND VENTILATION.

To the Editor of the Journal of the Board of Arts and Manufactures.

SIR,—In Mr. Ruttan's book on Ventilation and Warming, there occurs a passage which has given rise to a good deal of discussion, as it is totally opposed to all our pre-conceived notions on the subject. I refer to the statement in the preface that "*warmed air, under all circumstances, if not prevented,* NATURALLY *falls* DOWNWARD." Everyone is in the habit of thinking that air when heated, becomes rarified at the same time, and consequently ascends above all the air that is colder, and therefore of greater specific gravity than itself; how then does Mr. Ruttan make good his assertion that the contrary is the case ?

My own impression, after carefully reading the book, is that Mr. R. has reference only to the state of things in a room ventilated according to his own method, in which the cold air passes out at the bottom of the apartment, while the warm air, coming in at the top gradually proceeds down to the floor and takes its place, as explained in chapter III.

Many, however, think that the author must refer to something more than this, and do not accept my view of the case; we are anxious, therefore, that he should throw a little more light upon the subject himself, and thereby confer a favour upon many of his own readers, as well as yours.

As the work has already been favourably noticed in your columns, it is unnecessary, I trust, to apologise for occupying more of your valuable space by a further consideration of it, especially as it is a subject of great interest to many.

Very respectfully yours,
December, 1862. VENTILATOR.

Notices of Books.

A TREATISE ON SOME OF THE INSECTS INJURIOUS TO VEGETATION. By THADDEUS WILLIAM HARRIS, M. D. A new edition, enlarged and improved, with additions from the Author's manuscripts and original notes. Illustrated by engravings from nature under the supervision of PROFESSOR AGASSIZ. Edited by CHARLES L. FLINT, Secretary of the Massachusetts State Board of Agriculture. 1 vol. 8vo. pp. 640. With *eight* large colored engravings, and 278 wood-cuts. Boston: Crosby & Nichols. Toronto: Rollo & Adam.

The study of Entomology has of late years been making rapid advances on this continent, as well as in most of the countries of Europe. Abundant evidence of this progress is afforded by the numerous books and periodicals on the subject that are being published in quick succession. In Great Britain, where the list of Entomologists now presents the goodly array of upwards of *twelve hundred* names, in addition to a large number of scientific, as well as popular works on Insects, there are several periodicals especially devoted to the interests of the pursuit, among which may be mentioned a *weekly* paper for the record of new captures of insects, and other interesting matter of a similar description. In America, not only does Entomology occupy a prominent place in the proceedings of almost all the learned societies, but its students have also, during the last few years, formed an Entomological Society in Philadelphia, which, judging from its published transactions, appears to be in a very thriving condition, notwithstanding the unsettled state of the country, which must, of course, be exceedingly adverse to the study of this as well as other branches of natural science. In Canada, too, efforts are now being made to establish a club for the prosecution and advancement of this pursuit—efforts which, we trust, will soon be crowned with success.

But to turn to the work before us—this volume may well be adduced as an instance of the progress which Entomology is undoubtedly making; for both internally and externally—both in the manner in which it is written, and the form in which it is published, it is characterised by an unwonted degree of excellence. Not only is its style lucid and popular, free from technicalities, and adapted to readers of every class; but it is at the same time thoroughly and scientifically accurate —a combination of merits rarely to be met with. With regard also to its outward form, it is put forth with every attraction that fine toned paper, clear type, and beautifully executed illustrations can afford. It is, unnecessary, however, to descant upon its various excellencies: suffice it to say that the work has now reached its third edition, and is furnished with such additions and attractions as the progress of the science required. We will only add that the author has fully accomplished the objects he had in view in the preparation of the work, and which he thus states at the close of it: "It has been my design to present to the reader a sketch of the scientific arrangement of the principal insects which are injurious to vegetation, not only in New England, but in most of the United States. The descriptions of insects, being drawn up in familiar language, will enable him to recognize them, when seen abroad, in all their forms and disguises. The hints and practical details, scattered throughout the work, it is hoped will serve as a guide to the selection and the application of the proper remedies for the depredations of the insects described. My object will have been fully obtained, if this treatise should be found to afford any facilities for the study of our native insects; and should lead to the discovery and general adoption of efficient means for checking their ravages."

ABRIDGED SPECIFICATIONS OF BRITISH PATENTS.

1283. H. F. Broadwood. *Improvements in the construction of pianofortes.* Dated April 30, 1862.

This invention is not described apart from the drawings. The patentee claims, 1. The invention of screwed wrist-pins into plated wrest-planks, in the manner and for the purpose described. 2. Forming metallic pin-plates of a bent or compressed shape as described. 3. The mode described of fixing and retaining wooden pin plugs in their places by compressing the plugs before driving, and by forming notches or irregularities in the holes.

1727. J. A. Pols. *An improved method of refining oils.* Dated June 10, 1862.

In the case of rape, olive, or cotton seed oil, the patentee mixes with it American potash, quick lime, and white vinegar, to a strength of 36 degrees Beaunie. After subjecting the oil to this solution, it is filtered through charcoal, sawdust, and salt. By this process the patentee produces a good oil for burning. For machine oil he uses a solution of chloride of lime of the strength of 20 degrees, with 2½ to 3 degrees of sulphuric acid. By this process, after filtration, he produces a bright oil, free from grit, and not to be affected by cold.

1733. J. G. Appold. *Improvements in regulating the discharge of water and other liquids and air and other gases.* Dated June 10, 1862.

This invention relates to a novel arrangement of automatic apparatus, whereby the rate of discharge of water, air, or other fluids, supplied at varying pressures, may be equalized, or made nearly uniform. This result the patentee obtains by mounting in a suitably shaped chamber, through which the water or other fluid is passed, a swing valve, the movement of which (under the excess of pressure of the water), from its vertical position, will contract the discharge passage, and thereby limit the discharge of the water.

1717. A. Longbottom. *Improvements in the manufacture of artificial stone.* Dated June 13, 1862.

This artificial stone is intended for cleaning and scouring, and other household purposes. It is composed as follows:—For every hundred parts of the compound, the patentee takes sixty parts by weight of the ordinary dehydrated sulphate of lime or gypsum; to this he adds twenty parts of oxide of calcium or caustic lime, ten parts of steatite, and and ten parts of zeolite; or, by preference, eight parts of silica and two parts of hydrate of sodium. These substances are to be intimately blended by trituration, in any convenient apparatus. Water is now added in a sufficient quantity to form it into a plastic or semi-fluid mass, suitable for moulding it into any desired shape. The moulded compound when dry is white, but a colouring matter may be added.

1759. J. H. Glew. *Improvements in sewing machines.* Dated June 13, 1862.

This relates to sewing machines in which two needles and two shuttles are employed, and consists in an improved arrangement of placing the shuttles, and employing a web or vertical plate in the middle of the shuttle race. The patentee places the shuttles face to face on each side of the web, by which means two rows of stitching can be obtained much closer than by any other method, the web being employed to form part of the guide or race for each shuttle.

Selected Articles.

THE ACTON COPPER MINE AND ITS RESULTS.*

As soon as the ore has been brought to the surface it undergoes the process of coarse spalling; that is, it is separated from the waste rock, and broken into pieces having a diameter of from four to six inches. These pieces are sorted, according to the quantity of copper they contain, into first quality ore, second quality ore, crush ore and fourths. The first three sorts then undergo the process of fine spalling. The first quality ore is broken into pieces of the size of an egg, and any poor rock which these may contain is picked out. It thus yields marketable first quality ore, containing from eighteen to twenty-four per cent. The second quality pieces, treated in the same way, yield marketable second quality ore, containing from ten to thirteen per cent. The crush ore, after having been spalled down, and separated from the waste rock, assays from three to five per cent. It is further treated by crushing and jigging. The so-called fourths consist of limestone containing copper pyrites in coarse grains, small strings and finely disseminated particles. This quality is not worked up at present. It is piled in separate heaps, in order to be treated by stamping and washing, so soon as the apparatus for that purpose is procured. Besides the coarser rock, there is produced, in the various workings, smalls, which consist of pieces of ore and rock whose diameter does not exceed three or four inches, and which are usually so coated with mud as not to be easily separable from each other. These smalls are first thrown upon a screen, the bars of which are one and a quarter inches apart; the larger piece which remain upon it are sorted and spalled in the same way as the coarser rock; while the smaller pieces, which pass through, and assay from two to three per cent. are at once subjected to crushing and jigging.

The crush ore, and the finer part of the smalls, are reduced, by passing between cast iron rollers, to such a size as to pass through a sieve of twelve holes to a square inch. The crushed product is then brought into a jigging sieve, having sixty-four holes to a square inch. This sieve is wholly immersed in water, where it receives a succession of jerks, each of which causes it to descend, and suspends its contents in the water. These then arrange themselves, according to their relative specific gravities: the richest and largest particles at the bottom of the sieve, the poorest and smallest at the top. After the sieve has received a sufficient number of jerks, it is raised out of the water, and the upper layer, or skimmings, scraped off. These contain from one and a-half to two per cent copper, and are thrown aside. That part which collects at the bottom of the sieve, and contains twelve to fourteen per cent of copper, is called ragging, and is a marketable product. There is sometimes produced an intermediate sort called seconds, occupying a position on the sieve between the skimmings and the ragging. This is laid apart, and afterwards rejigged, the same products being produced as those above mentioned. In this process of jigging a considerable portion, the finest part of the crush work, falls through the sieve into the box below, which contains the water, and is called hutch-work. This, on being washed in a streak from the slime which it contains, assays from eight to eleven per cent. and is then in a marketable state. The costs of these various dressing operations were as follows:—Coarse spalling costs from fifteen to twenty-five cents per cubic yard of rock, according as the same contains less or more ore; fine spalling from fifty to eighty cents per ton of the resulting ore, according to the quality of the rock operated on. The processes of crushing and jigging cost during January, February and March, 1862, $5.60 per ton of products, and $1.15 per ton of crush ore. The total expense of coarse and fine spalling, and crushing and jigging, per ton, of all the products is at present $5.25.

The crushing and jigging processes are almost the same as those adopted in Cornwall for the dressing of crush ore, yet they are attended with the loss of much of the copper contained in the original crush ore. Having for a long time estimated the quantities, and assayed the samples of the crush ore put through the rollers; and ascertained the weight and contents of the resulting products, I have found that the loss of copper is much more than might at first sight be imagined. I subjoin a few of the results obtained: From the 17th of November to the 12th of December, 1861, there were crushed 956,760 lbs. of ore, containing 4.6 per cent, or 44,010 lbs. copper. From this there were produced 283,451 lbs. of products, averaging 10.95 per cent, and containing 31,052 lbs. copper. There were consequently lost 673,305 lbs. of skimmings and slimes of 1.92 per cent containing 12,958 lbs. copper. Thus 29.5 per cent of the copper contained in the crush ore was lost in the skimmings and slimes. Further, during January, February and March, 1862, there were crushed 2,881,100 lbs. of ore averaging 3.4 per cent, and containing 100,503 lbs. of copper; from which there were reduced 615,520 lbs. of products everaging 9.5 per cent, and containing 58,711 lbs. of copper. There were consequently, 2,265,580 lbs. of skimmings and slimes of 1·83 per cent, containing 41,592 lbs. of copper. Thus 41.5 per cent of the copper contained in the crush ore was lost. It is to be remarked, however, with regard to the foregoing results, that much of the copper contained in these skimmings and slimes is with proper appliances recoverable. Subsequent to the first of July, 1862, arrangements were made for dressing the ore by contract, and for working up a part of the slimes as these were being produced. Under this system the following result was obtained:—During the months of July, August and September, 1862, there were crushed 3,348,887 lbs. of crush ore and smalls, of from 2.0 to 5.9 per cent, averaging 4.1, and containing in all 137,969 lbs. of copper. From this there were produced 1,073,644 lbs. of products of from 8.0 to 12.6 per cent., averaging 9.9 per cent, and containing 106,625 lbs. of copper. There were consequently cast aside 2,275,243 lbs.

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* Being the concluding portion of a paper on the Acton Copper Mine, by Thomas Macfarlane, Esq.—*Canadian Naturalist.*

of skimmings and slimes, averaging 1.38 per cent, and containing 31,344 lbs. of copper; which is equal to 22.7 per cent of the copper contained in the original ore.

From the results here narrated, it would appear that at least one-fourth of the copper contained in the crush ore is lost in the process of dressing it. The actual value thus wasted goes far to counterbalance the saving of freight which results from concentrating the ore. It would not certainly be attended with greater advantage to send the crush ore of four or five per cent. to market instead of dressing it; but it admits of plain proof, that it would be better at once to sell an ore of seven per cent. and pay freight on it to Boston or New York, rather than to submit it to further concentration by crushing and jigging, and sustain the great loss of copper which occurs in these operations. The following calculations will be found to confirm this statement:

100 tons of 7.0 per cent. ore would bring in Boston $4.00 per unit; which for 6.5 per cent. (½ per cent. being deducted for the difference between dry and humid assay) is equal to $26.00 per ton.....	$2600 00
From this deduct freight, barrels, &c., at $9.00 per ton,................................	900 00
There remains..............	$1700 00

On the other hand, 100 tons of 7.0 per cent. ore would yield, by crushing and jigging about 43¾ tons of 12.0 per cent. products; which would bring, say at $4.30 per unit, for 11.5 per cent. $49.50 per ton...		$2163 43
From this deduct:		
Cost of crushing, &c., at $5.50 per ton	$240 70	
Freight and barrels at $9.00 “	393.75	634 45
There remains............		$1528 98

or $1.71 per ton less than when at once sent to market. It is thus evident that an advantageous concentration of a seven per cent. ore by means of crushing and jigging, is not possible. The question next arises, as to whether such an ore could not be smelted at the mines, and a large part of the cost for freight and barrels saved:

100 tons of this ore might, by smelting, be made to yield 16⅔ tons of regulus of 36.0 per cent. (even supposing that one-seventh of the copper were lost in the operation). This would be worth, at $4.50 per unit, or $162 per ton...........		$2700 00
From which deduct:		
Cost of smelting, at $5.00 per ton	$500.00	
Barrels and freight, $9.00 “	150.00	650 00
There remains............		$2050 00
The 100 tons of 7.0 per cent. ore sent to market, would have yielded, according to the previous calculation................		1700 00
Consequent profit by smelting.......		$350 00

or $3.50 per ton of seven per cent. ore. It would thus appear that the best mode of treating the crush ore would be to separate from it as much seven per cent. ore as possible, and to treat the refuse from this, which might assay two per cent., by stamping and washing. Of this two per cent ore, the fourths (now set aside) would, on being worked up, yield a large quantity; and although they might be unable to bear much of the mining expenses, would considerably more than pay the cost of their own concentration.

In order to ascertain the fitness of some of the products for metallurgical treatment, the following examinations were made towards the close of last year. A sample of first quality ore from No. 4 shaft gave

Silica	25.12	
Carbonate of lime..........	33.10	
Iron.....	5.81	
Copper	24.75	
Sulphur......................	11.22	by difference.
	100.00	

A sample of ragging gave :—

Silicious matter	16.92	
Carbonate of lime..........	53.07	
Carbonate of magnesia...	trace	
Iron...	4.06	
Copper.......................	13.07	
Sulphur.......................	11.62	by difference.
	100.00	

A sample of hutch-work gave :—

Silicious matter...........	24.32	
Carbonate of lime.........	53.10	
Carbonate of magnesia....	2.10	
Iron	3.36	
Copper.	9.95	
Sulphur	7.17	by difference.
	100.00	

From these results, and from others previously given, it will appear that silica and lime are almost the only slag-producing materials contained in these ores. Iron is present in small quantity, but without previous calcining, which in this case is inadmissible, it would go to the formation of the regulus. The compounds of silica with lime are all but infusible; but these substances form with iron oxide, easily fusible slags, which are frequently produced in copper-smelting works. In smelting the Acton ores, therefore, a flux containing iron oxide, such as puddling slag, or roasted iron pyrites is indispensable. The cost of these would not add very materially to the expense of smelting; but it would of course be better, if such could be had in the neighbourhood, to use in place of these fluxes, poor pyritous copper ores, previously calcined.

The total product of the Acton Mine during the period to which this paper has reference, viz., from September 1st, 1861, to September 30th, 1862, was 2,336 tons of 2,352 lbs., or 2,747 tons of 2,000 lbs., the average copper contents of which amounted to 12.0 per cent. This is equal to an average monthly production of 179 tons of ore of 2,352 lbs., or 211 tons of 2,000 lbs. In reality, however, the production was much greater in the summer than the winter months. For instance, the total produce during July, August and September last, was,—

366	tons first quality ore.
80	“ second quality ore.
150	“ ragging
312	“ hutch-work
84	“ buddle-work
992	tons in all, or 331 tons monthly.

With regard to the future of the mine, I see no reason to doubt that it will be as successful as its past; provided always that a due amount of prospective work is done, and that arrangements are made for saving freight, and increasing the value of the poorer ores, by smelting the products of the mine on the spot. To this must of course be added prudent and economical management, without which even the richest mines yield little profit.

WEBSTER'S PROCESS FOR MAKING OXYGEN GAS.

The announcement of an English company being formed for the manufacture of oxygen gas is exciting some interest, as there can be no doubt that if a cheap supply of pure or nearly pure oxygen can be obtained, its influence on some of the arts will be very great. The following is an abstract of Webster's Process, from the Report of Dugald Campbell Esq., F.C.S.

It may be well to add that the chemistry of the process described in the following paper is questioned; especially in relation to the quantities of the material used and the products derived from them.

The materials which I employed in my experiments were commercial nitrate of soda of the ordinary quality, and a common oxide of zinc; the first of value, I should say, at from £13 to £14 per ton, and the latter at from 30s. to 40s. per ton.

The mode of operating was as follows:—10 lbs. of the nitrate of soda, and 20 lbs. of the oxide of zinc, both previously dried, were mixed roughly together, and thrown into a red-hot retort. In a minute or two, when the oxygen gas began to come off, which was ascertained by the gas having the power of supporting combustion, the gas was made to pass into what was named the purifier, which I shall afterwards describe, and from thence into a graduated gasometer.

When the gas had ceased to come off, the gasometer was shut off from the rest of the apparatus, and the contents of the retort, emptied into a tray, and mixed roughly with an additional 10 lbs. of dry nitrate of soda, were returned into the retort, and distilled as before, and when no more gas was evolved the gasometer was again shut off, and the contents of the retort discharged into a tray, and again mixed in a similar manner with 10 lbs. of the dry nitrate, and distilled as before.

The material in the retort has now become, to some degree, pasty, and is considered no longer fit to have more nitrate of soda added to it, and, from the original weight of 50 lbs., it is now reduced to 37 lbs., or has lost 13 lbs. It consists as follows:—

In 100 parts.

Sand with oxide of iron	13·66
Oxide of zinc	30·20
Anhydrous soda	24·80
Nitrite of soda with a little nitrate	31·34

It will be seen from the above, that this material contains 24·8 per cent. of anhydrous soda, which is equal to 32 per cent. of hydrate of soda, and, by boiling it in water, this hydrate of soda, together with the nitrate of soda, are dissolved out from the oxide of zinc, and may be readily separated from each other by crystallising out the nitrate, leaving the hydrate.

But it sometimes happens, that from too great a heat being employed in obtaining the gas, or from the nature of the iron of the retort used, that, besides these salts of soda, a salt of iron and soda is formed, namely, the ferrate of soda. This salt is green, and is not separated by crystallisation from the hydrate, and consequently would much contaminate it, and render it much less valuable. In my opinion it is quite easy to avoid such an action taking place.

But in the event of such an action having taken place, the use to which the residual material may be afterwards put to in the process, namely, in the purifying of the gas as it passes through the purifier, alters it, and converts it into a substance more readily to be dealt with.

The purifier, spoken of before, consists of a deep jar, at the bottom of which 5½ lbs. of water are placed; the gas from the retort is made to enter just above the water, and passes up through perforated trays, on which are spread the 37 lbs. of residual material from the retort, broken into a rough powder, and moistened with 6 lbs. of water, making together 43 lbs.

In all my experiments the residual material remained in the purifier during the distillation of the 50 lbs. of the material only, when it was removed and weighed.

The water at the bottom of the receiver is now strongly acid, with a mixture of nitrous and nitric acids, and has increased in weight in my experiments from 2 lbs. to 3½ lbs., depending upon the degree of heat used in the process. That being the case, its specific gravity is variable, and, in the course of one distillation of 50 lbs., the acid water is not of much value: but it might remain in the purifier during several charges, when it would become strong and of real value, or it might be drawn off, and added to the dry residual material removed from the trays after it has done purifying the gas.

This residual material upon the perforated trays in the purifier, after the passing of the gas from 50 lbs. weight of the materials, has increased in weight in my experiments from 2 lbs. to 3 lbs., according to the temperature at which the materials are distilled, and also according to the nature of the residual material employed in the purifier, and it is now much changed, and the hydrate of soda is now almost totally converted into nitrate of soda, and any ferrate of soda is decomposed. Its composition is as follows:—

In 100 parts.

Water and sand	26·27
Carbonate of soda	5·00
Oxide of iron	6·00
Oxide of zinc	22·82
Nitrate of soda with a very little nitrite	39·91

The way which I would suggest of dealing with the above substance, is to add the acid water from the bottom of the purifier to it, so as to neutralise any carbonate of sods which it may contain, and boil it with water, which will dissolve the nitrate of soda from the insoluble oxide of zinc, and the solution of nitrate is afterwards evaporated for the nitrate.

The yield of gas from 20 lbs. of oxide of zinc and 30 lbs. of nitrate of soda in my experiments was very close, varying only from 157·85 to 159·03 cubic feet, and the time occupied in each working of 50 lbs. was, as near as may be, 9½ hours.

I was unable to fix exactly what the consumption of fuel was for one charge, but, from the data I obtained, I should say it was under 9d.

On analysing the gas, I was surprised to find that it contained a considerable per-centage of nitrogen, in my experiments varying from 26·50 to 32·80 per cent.; for, independently of its supporting combustion very well, and increasing the illuminating power of coal-gas to a great degree, I should not have expected nitrogen to be eliminated from the materials used, by the heat which was employed. However, finding the nitrogen there, it appears to me that it must have got there by using too high temperatures,[*] and I think, by experimenting at different temperatures, you may find out one, where little, if any, will be produced, or one, at any rate, at which much less will be produced.

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DISINFECTANTS—IMPURITIES IN THE ATMOSPHERE.[†]

Organic substances gradually change under the influence of the air, and gradually disappear. About 2000 years ago, when Julius Cæsar made his invasion of England, he describes England as covered with extensive forests, with large swamps, and moors. Where are all these gone to now? Of these extensive forests not even a piece of fossil wood indicates their existence. All the organic matters of which those forests, swamps, and moors were composed, have disappeared with the bodies of the skin-clad and wood-painted savages who inhabited the forests. They have disappeared under the influence of the oxygen of the air, which has converted all the substances of which they consisted into carbonic acid, water and ammonia,—the three substances which form the food of plants. Chemists now call this process of decay by rather a learned term,—by the term *eremacausis*, meaning "burning by degrees." Before this final decay, or eremacausis, of bodies takes place, there are a number of intermediate products formed, far more dangerous in respect to public health than anything resulting from the process of decay. These intermediate bodies depend in their character upon the nature of the ferment to which they are subjected. Even when the results of the fermentation are the same in kind, a mere difference in degree with regard to the nature of the ferment, or the temperature under which the decay is taking place, or the action of the atmosphere—its greater or less dampness,—causes a very great variation in the intermediate products before the final one is formed. Take a case in which you will see the result of a change in the character of these ferments. For instance, the virus from cow-pox produces, when introduced into the blood of an animal, the result of mild vaccination; whereas the same virus from small-pox produces a malignant disease, although the character of the fermentation is the same in both cases. The intermediate products which result are infinite in their number. They are continually changing, and they form a very large number of bodies, not by what we term the process of decay, but the process of putrefaction. The process of putrefaction consists in the elements re-arranging themselves so as continually to become more degraded. A highly complex molecule, such as the flesh of an animal, under the influence of putrescence continually changes, and gradually assumes more and more simple forms, until finally, as I shall afterwards explain to you, the products become, under the influence of decay, of extreme simplicity.

You may desire to know what is our evidence that the air during all these changes, which every organic body must experience, contains such impurities—bodies in the state of transition before they have been finally decayed. Well, the process by which this may be shown is a very easy one, and one by which you may easily satisfy yourselves. Suppose I had a large glass globe like this, filled with ice. The dew of the apartment condenses upon the outside of the globe, and may be collected. It brings down with it in solution those substances which abound in the atmosphere, and of which a large quantity can always be obtained in a lecture-room, such as this, if we desire it. Many of these matters are in a transition state; and when you collect this dew, it in a very short time becomes a putrid and has a very bad odour, because it has brought down these aerial substances which are in a transition state. In Russia, for instance, where the extreme cold in winter causes the moisture of the apartments of the peasants' houses to become condensed and frozen, a large quantity of these organic emanations are condensed and are preserved until the thaw in spring causes them to melt, and then they are again diffused through the air, and so produce those disagreeable odours which are so well known in the houses of the Russian peasantry. But it is possible to show the presence of these organic matters in the air by a very simple test, for which we are indebted to Dr. Angus Smith, of Manchester. Until lately we could not measure the amount of these emanations in the air, but it is now a matter of the greatest ease. Here is the whole apparatus required. Suppose I want to measure how much impurities there are in the air of this room, I first get the air of the apartment into this vessel by a very simple operation. I take a bellows which acts in the reverse way from what a bellows usually does, and I pump out by this operation the air from the bottle, which is of a specified size, and then I allow the air of the apartment to enter the bottle. I have now got the air of the room into the bottle. I am now to ascertain what impurities are in that quantity of air, and I do that by taking a weak solution of permanganate of potash—a body which I shall have to allude to, under the head of "disinfectants," more particularly. This is made of a certain strength, which is done by adding to it a known quantity of oxalic acid until it ceases to lose colour.

If I want to know how much organic matter there is in the air, I have only to add some of this solution of permanganate of potash until the colour ceases to be taken away. I add it by means of

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[*] Acting upon these suggestions, the proprietors have obtained a higher degree of purity in the gas, which they find to be improved also by the addition of more water to the materials in the purifier.

[†] ABSTRACTS of Dr. Lyon Playfair's lectures before the Royal Institution of Great Britain.

this measure. After I add a certain quantity I shake it up, to see whether it begins to decolorise, and then add more until the colour ceases to be discharged. I might show you the decolorisation in a much greater degree by breathing into the bottle—introducing organic impurities intentionally. I dare say I can decolorise a sufficient quantity to show you at a distance. We will allow it to stand a little, and this will gradually become decolorised until I take away all the colour from it. In this way I can measure the relative amount of organic matter which is present in the atmosphere. Now I wish to refer to you this table, and you will see how various the amount of impurities is in different localities. The numbers represent the graduations upon this measure.

Organic Matter in Air.

Hospice St. Bernard......	2.4
German Ocean..............	2.5
Pig-stye	94.0
Centre of Manchester......	52.0
Ditto to outskirts	44.0, 40.0, 42.0, 38.0, 36.0, 30.0, 27.15, 19.0, 16.0, 12.0,
Calton Hill, Edinburgh...	12.0
Princes Street..............	22.0
Cowgate........................	40.0
High Street	30.0

Air taken from the Hospice St. Bernard required only two and four-tenth measures of this instrument to be added to it before the colour ceased to be discharged. Air taken from the German Ocean required just about the same, so that we may suppose that this proportion gives us good and pure air. But look what a pig-stye requires! The air taken from the top of a pig-stye required ninety-four of these measures before the colour ceased to be used up. As soon as the colour remains all the organic matter is destroyed, because it is the oxygen in this permanganate of potash which burns up and destroys the organic matter. See how the amount varies from the centre of Manchester to the outskirts. In the centre of Manchester it requires 44 measures; as you go out towards the country it requires only 40, then 38, 36, 30, 27, and so on decreasing until you reach the outskirts, where it requires only 12 measures; showing that the amount of aerial impurities in a large town varies in the different parts. At the top of Calton Hill it requires 12 measures. You will remember that this is in the centre of Edinburgh; but as soon as you get down into Princes Street the number is increased to 22. Then there is the well-known Cowgate, where it requires 40 measures; and the High Street, which is a little better, where it requires 30 measures of this solution. This instrument enables you to find out with the greatest ease, the amount of organic matter or other deoxidisers, such as sulphurous acid, which are present in various atmospheres.

The organic substances which are indicated by this air test, are those which are in their intermediate state—a state of putrescence; and it is after this stage that the air manages to purify itself by converting these intermediate bodies into the simpler form of bodies which arise from decay.

Now, before we can understand in what way the air purifies itself, and how we must imitate Nature in obtaining substances to do as the air does, I must draw your attention to the different states of oxygen. Oxygen forms nearly one-third of the atmosphere which surrounds the globe; it exists in two states, in one of which it is a very active body, capable of uniting with a great many substances, and more decided in its affinities than the ordinary oxygen of the atmosphere. When we treated of phosphorus in the last lecture, I showed you that there were two kinds of phosphorus,—one of these was waxy and yellow, the other was like a piece of brick, and I described to you that they were different allotropic conditions of the same element; and exactly in the same way we have two allotropic conditions of oxygen, one of which is an extremely active body—far more active than the oxygen as it is ordinarily produced. We have had here two sticks of phosphorus in air, and these sticks of phosphorus polarise the oxygen which is present, breaks it up into two conditions, one of which is ozone, which is a very active body, and the other, which I shall explain to you, has been termed "antozone," that is also in an active state. The influence of this process is to polarise the oxygen, and break it up into two states, the two together forming common oxygen; at least, that is the theory which is most explicable, and then we obtain the air in a very peculiar condition.

Before I show you this, I should like to explain to you the meaning of the test which I am going to use. Here we have a weak solution of iodide of potassium and starch; if I add anything to liberate the iodine, the starch will become blue; I can do that by adding a little chlorine; here we have a bottle of chlorine, which I will simply open over it, and blow into it. Now look what is resulting. The chlorine liberates the iodine, unites with the starch, and produces that beautiful blue colour. Now, this ozone has the same property as this very active body—chlorine—has, and if I take a piece of paper moistened with the solution of starch and iodide of potassium, you see what the chlorine does to our paper. Here I take another piece of this paper, which has not been under the influence of chlorine, and I moisten it, and then I introduce it into this bottle, which contained phosphorus. You see exactly the same results as with the chlorine; I have got here starch-paper with a little iodide of potassium upon it, and introduce it into the oxygen; now the mere influence of the presence of the phosphorus has been so great that it causes the oxygen to liberate the iodine, and produces this action on the paper. This ozone is one of the great scavengers of nature; it is its presence in the air which causes these putrescent bodies to burn and pass from their intermediate state of putrescence, in which they are very dangerous, and which produce, if they act upon the blood, many diseases. This active form of the oxygen causes such bodies to be burned.

I have now to call your attention to the thing called "antozone." Whenever any state of oxidation takes place, and the body ozone is produced and unites with any body, antozone, which is its companion, or other polar state of oxygen, is also produced. I will try to show you this by a very delicate operation, which I may not succeed in. Here we have upon the funnel some common zinc, and I am going to oxidise that common zinc by moistening it with water, so that I do not cover it completely, but still allow it to be in contact with air. Now this water I must return several times, and whilst this is being done I will show you what are the tests for this other form of oxygen, or this antozone, which is also produced in common cases of oxidation. Whilst the ozone unites with the zinc, I hope to be able to prove to you also that there is antozone, or this other form of oxygen. Now let me show you what is the test for this antozone. Antozone, the other allotropic condition of oxygen, is soluble in water, and it forms with the water a solution which we know as the remarkable body—peroxide of hydrogen. Here is some of this peroxide of hydrogen ready formed, and I add to it first distilled water, and then a solution of starch, and iodide of potassium. Now, nothing takes place when I add that, because antozone has not the power,—is not strong enough to liberate the iodine. If I convert it into ozone by a peculiar action, by putting sulphate of iron upon it, the sulphate of iron having no action upon iodine, you see that a deep blue results, because I have converted this antozone into ozone, and the ozone has produced the blue colour by liberating the iodine upon the starch. Now, with that knowledge before us, let us return to our zinc experiment. The ozone having joined the zinc, its companion, antozone, ought to be found in the water. We will just see whether we can detect it in the water, if not we must pass it through three or four times, and ultimately it will be present. Now, I apply some of this test, iodide of potassium, and I will add a little of the test, sulphate of iron. It becomes a deep blue. Look what a beautiful experiment this is; the oxidation of the zinc in presence of air and water has liberated one of the conditions of polarised oxygen. One form of the oxygen is found in the water, which now contains peroxide of hydrogen. But now I want to try another experiment, which is still more delicate, and with which I will not promise success, but we will do our best to ensure it. I want to show you ozone in the air and antozone in the water. I will show you that by adding a little ether, and shaking this ether up with water. We will heat this piece of platinum over gas and plunge it into this ether, first allowing it to cool sufficiently, so that it may not set the ether on fire. Now I am producing ozone in the air of the bottle; but I want to show you, if I can, that I have also antozone in the water. I can show you both perhaps, showing that the common oxygen of the air is gradually formed into ozone, and that its companion, the antozone, exists in the water. Now we will try it; perhaps I have not got enough yet. We will now put this starch-paper in, and see whether we can detect any ozone present in the air. I find that it is there abundantly. There is proof that our ozone, at all events, is present in that air. There is the blue colour produced by this action, so that I have got ozone in the air. Now let us try whether we can find any antozone in the water. In this case I will apply the chromic acid and ether test so as to prevent confusion. If there is sufficient peroxide of hydrogen produced, if we have waited long enough, you will see a very beautiful polarisation,—not only that we have got ozone, but that its companion antozone also comes. You observe how beautifully the deep blue appears as a solution in ether. Now, in this case we had a complete polarisation of the oxygen; the oxygen separated into two forms, both of them very active,—one as it exists in peroxide of hydrogen, and the other as it exists in ozone. Now, this constantly occurs in the atmosphere. Whenever any organic substance is oxidised in the air it polarises the oxygen, and causes the air to oxidise it, and get rid of the body from the air.

Having explained these elementary points, I will show you their application to the process of disinfecting or deodorizing. Our knowledge of these has extended considerably within the last ten years, and the subject is well worthy of our attention. Let us, first, get rid of the term "deodorizers," and fix our attention on disinfectants. The word "deodorizer" is a more agreeable one to polite ears than the word "disinfectant," and we had better define them both. A *deodorizer* is something used to mask a smell without destroying it. A *disinfectant* is something which either prevents the smell or destroys it when it exists. When we read that in ancient Capua whole streets where devoted to perfumers' shops, the conclusion is obvious that ancient Capua was a very dirty place, and that these perfumes were used to conceal its smell. I allude now only to perfumes used to mask that which is disagreeable, and not to their use as a luxury; for from the time that Moses was commanded to offer a perfume on the golden altar until now, the odour of perfumes has been grateful to man. Only in a very modified sense are perfumes true disinfecters. Perhaps I can best illustrate my meaning by two quotations from the "Odyssey," which will explain to you what a deodorizer is and what a disinfectant is. You recollect that when Eidothea aided Menelaus and his three companions to circumvent her father, the old sea-god, she flayed four seals and dressed them in their hides, so that the sea-god might mistake them for part of his sea-flock. Menelaus, however, groans under the disguise of these odorous garments as follows:—

> "Dire was the ambush and the stench severe,
> Who could a rank sea-beast at such close quarters bear?
> But she delivering us a great help planned,
> And placed Ambrosia near the lips of each,
> Which in our nostrils breathed an odour bland,
> And the sea-monster's stench did overreach."

It is clear that Eidothea was a deodorizor. She did not understand disinfection. Ulysses, however, did; for after his terrible slaughter of the many suitors of Penelope, he used an excellent disinfectant. We read,—

> "'Bring sulphur straight, and fire,' the monarch cries.
> She hears, and at the word obedient flies.
> With fire and sulphur, cure of noxious fumes,
> He purged the walls and blood-polluted rooms."

In this case sulphurous acid was produced, and it is an effectual disinfectant. It causes the liberation of ozone by uniting with antozone, and the former battles with the putrid odours and destroys them.

Now, when we consider disinfectants, we divide them into two classes: first, those substances which act as ozone does—by destroying, or burning, or oxidising the organic matter, which is the way in which ozone acts; and second, those which act by preventing putridity, or preventing putrefaction taking place, do not allow decay to go on.

We will take the first action. I will illustrate this by the action of the soil on putrid matter.

When you bury a putrid piece of meat in the soil the smell disappears, but the piece of putrid meat disappears also. The porous character of the soil conducts oxygen to the substance, and burns the smell, but the piece of meat gradually is burnt away also and wholly disappears. I think I can show you this action experimentally. I am now going to burn a body which is very difficult of combustion, but which, under the circumstances, I think I shall be able to succeed in burning. I have here some ammonia, which is always one of the products of the change of organic matters which contain nitrogen, and I am going to pass this body over oxygen under conditions in which I can get oxygen condensed. This is spongy platinum, and I think I can thus show you that the oxygen which is condensed in that platinum will unite with the body I wish to burn, just as the oxygen which is condensed in the porous soil. Now, oxygen is passing over from this receiver, and ammonia from this vessel; and these two, acting together, will cause a burning or the formation of nitric acid and nitrate of ammonia, which you will observe by the fumes which will take place. You already see the fumes, but you will observe the action more distinctly presently. Look how abundantly the fumes are being produced there from oxidation. You see it is now going on so fast that the platinum becomes red hot. You see there how beautifully the oxygen is burning that ammonia—converting it into nitric acid and nitrate of ammonia, and completing the combustion. Those disinfectants which act in this way,—either by means of porosity or by their chemical character,—are bodies acting exactly as ozone does. Now, here is a very common disinfectant, and a very interesting one. Charcoal also has the power of condensing gases within its pores. If I take a piece of charcoal and heat it, it will absorb this ammonia gas. Here I have the means of applying this charcoal disinfecter in various ways devised by Dr. Stenhouse, and which form a complete example of the disinfecting character of a soil which absorbs oxygen and then passes it over to other substances. These different forms of application on the table are cases which may be filled with this porous substance—charcoal. When this perforated box, for example, is filled with charcoal and used as a filter for air, the organic matter in the air which passes through is brought into contact with this charcoal and becomes consumed, just as the fuel of a fire is consumed, and is converted into carbonic acid, water, and ammonia. Supposing you take a dead animal—a dead cat or a dead pigeon—you may make a grave for it of charcoal and keep it for a length of time. You must not suppose that it is not decomposing because there is no odour from it. You might as well deny that there were fires in a house because you do not see any smoke coming from the chimneys. If the combustion is perfect, inodorous invisible gases escape in both cases. In the case of this decomposition, the oxygen absorbed by the charcoal burns the organic matter completely, and prevents a smell. This circumstance has been applied to various purposes, such as filters and respirators. Here are various examples of them. Here is a respirator used for respiration in infected or badly ventilated places, or for removing the effects of foul breath in disease. Here are ventilators of various kinds to filter out effluvia from air before it enters our habitations.

The next disinfectant to which I shall direct your attention, which acts by burning up the noxious organic matter, is "Condy's disinfecting fluid," which is no doubt familiar to you. There are various samples of it which Mr. Condy has been good enough to send me, and which you may examine after the lecture. They are all compounds containing manganic acid, or permanganic acid. Manganic acid is a substance consisting of two equivalents of manganese and six of oxygen. In permanganic acid there are seven equivalents of oxygen and two of manganese. Both of these acids give over their oxygen readily to organic bodies, and in this way act as true disinfectants by burning them or destroying them. Look at the bottle into which I breathed some time since, the colour is nearly destroyed, the permanganate of potash which I employed having burnt out the organic matter; and so this substance, if it be used as a disinfectant, destroys the putrid effluvia by giving over its oxygen to it, and burning the organic matter. This can be illustrated. If I allow this fountain to act, the liquid will gradually become totally decolorised, because it burns away the organic matter which is present in the air of the lecture theatre. These permanganates have, in consequence of this property, become familiarly and extensively useful; but these are local disinfectants, and necessarily local disinfectants, although we try to increase their surface by moistening a cloth, and hanging it in the air. When we desire, however, to disinfect a whole room or the wards of an hospital, we must resort to some gaseous compound which can diffuse itself throughout the air, and combat the enemy in every inaccessible nook and corner, as is the case with the sulphurous acid which was employed by Ulysses. Perhaps the most effective of these gaseous oxidising disinfectants is nitrous acid. It was for this that in 1802 Parliament gave a reward to Dr. Carmichael Smith. In contact with the air, it forms nitrous fumes. Now, these nitrous fumes form an excellent disinfectant, but they are irritating to the lungs just as chlorine is. It may appear odd to those who know sulphurous acid gas chiefly in its character of an absorber of oxygen, that I should allude to it as an oxidising disinfectant; but, according to Schönbein, in the act of taking one portion of oxygen to itself, it converts another portion into ozone, which produces the disinfecting result.

The other class of disinfectants of which I have spoken are the non-oxidising, and I must allude to these very shortly. Their action is to prevent putrefaction by arresting it in a singular way without destroying the organic matter, and they do not allow the decay to go on. The most useful of this character of bodies is a mixture of sulphite and carbolate of lime—sulphurous acid united with lime—and carbolic acid united with lime. It is better known under the name of "McDougall's disinfecting powder." Now, in this case the carbolic acid prevents any decay. As an illustration of the preservative action of carbolic acid, I have on the table sheep-skins sent from Australia preserved by this means; they have simply been washed over with carbolic acid. When the disinfecting powder is applied liberally to organic matter, it arrests wholly the change. On one occasion, I preserved a human body for two months in this way until it reached a distant grave. If the mixed sulphite and carbolate of lime be applied only to a small extent, the carbolic acid prevents putrefaction, whilst the sulphurous acid acting in the manner I have explained, by uniting with antozone and liberating ozone, becomes a true decayer, and allows decay to progress.

I must now sum up generally the manner in which Nature acts in keeping our air perfectly pure. I will draw your attention to the fact that plants derive their food from the ultimate products of the decay of animals. Carbonic acid, water, and ammonia are the food of plants—simple forms of matter, which they take and mould into the complex organic forms of which the substance of plants consists. Animals feed upon these plants. Animals have not the power of producing complex organic matter out of unlike matter such as the simple inorganic forms of water, carbonic acid, and ammonia. They receive their nutriment from plants, and the whole act of their lives is to take those highly organised forms produced by plants, and convert them again into the simple conditions of carbonic acid, water, and ammonia, from which the plants derive their food. Look what a machine an animal is: how closely he resembles a steam-engine! A steam-engine in action takes fuel, which is its food, consisting of coal and wood, which are decayed vegetable combustible matter. An animal takes recent vegetable or animal combustible matter. A steam-engine takes in water, and so does an animal. A steam-engine breathes air, and so does an animal. A steam-engine produces, by the combustion of the air upon the fuel, a steady boiling heat of 212° by quick combustion; and the animal produces a steady animal heat of 98° by slow combustion. The steam-engine produces smoke from the chimney,—that is, air loaded with carbonic acid and vapour. An animal produces foul breath from the windpipe, which is air loaded with carbonic acid and vapour. The steam-engine produces also ashes, which is a part of the fuel which does not burn; and the animal produces refuse, which is a part of the food passing from the body unconsumed. The engine produces motive force or alternate push and pull in the piston, which acting through levers, joints, and bands, does varied work. The animal gives rise to motive force by alternate relaxation and contraction of the muscles, which acting through levers, joints, and tendons, does varied work; that is to say, an animal is, in all its chemical functions, a machine, which is producing certain results by combustion; and it takes these complex vegetable and animal combustible substances, and gives them out in a simpler form.

Now see how different animals are from vegetables in a chemical sense. Here is a table showing their differences and dependencies :—

Differences and Dependencies of Animals and Vegetables.

A VEGETABLE	AN ANIMAL
Is an apparatus of reduction.	Is an apparatus of oxidation.
Is fixed.	Possesses the faculty of locomotion.
Evolves oxygen.	Absorbs oxygen.
Absorbs heat and electricity.	Evolves heat and electricity.
Decomposes carbonic acid.	Produces carbonic acid.
Ditto water.	Ditto water.
Ditto ammonia.	Ditto ammonia.
Produces organic substances.	Consumes organic substances.
Transforms inorganic matters into organic matters.	Transforms organic matters into inorganic matters.
Derives its elements from the earth and air.	Restores its elements to the earth and air.

They are perfectly antithetical in their actions. They are always opposing each other, but without antagonism; they are rather co-ordinates, one acting in harmony with the other. The vegetable is constantly producing organic forms from the air, while the animal is converting these same materials back again into inorganic forms. There is always in this way a constant co-ordination between the two. The animal is able by its respiration to produce a certain quantity of carbonic acid, water, and ammonia; but after the death of the animal there remains a considerable quantity of matter which requires to pass into the state of carbonic acid, water, and ammonia. It passes into that state by putrescence, and afterwards by decay. Decay starts the putrescence; decay finishes the putrescence by converting the animal matter into those substances,—carbonic acid, water, and ammonia. The animal stands midway between the vegetable and mineral kingdoms. It is not his duty to mould mineral matter into organic forms. That is the work of vegetables, whose highest function is their vegetable growth. Animals with the demands of volition to obey cannot spare their force in this conversion. As chemical machines, animals are constantly undoing what vegetables have done. During life animals are continually reconverting organic substances into simple inorganic forms, and after death their bodies pass into the same substances. Thus there is alternate life and death. It is quite true that plants feed animals; but animals, in an equally true sense, feed plants. They furnish the carbonic acid, water, and ammonia of which the plant consists, and the death of one generation is absolutely necessary to the life of successive generations, giving the very materials out of which the next is built. Life is the consequence of death. Nature uses up her waste materials for the perpetuity of life. In all cases we are feeding upon our ancestors. The transmigration of souls is not true; the transmigration of matter is perfectly true. I do not know of how many millions of atoms of transformed matter my brain consists. A portion of the constituents of my brain may at one time have performed its part in the functions of the liver of an extinct King of Dahomey, babbled in the tongue of an Asiatic parrot, or danced a fandango in the legs of a Spanish South American. Thus, continually we observe that Nature uses up her waste materials by beautiful processes which we try to imitate in our hygienic measures, and produces of them substances which become of great utility in the economy of the universe. In several of my lectures I have endeavoured to bring before you the economy of chemistry. I have shown you that it takes substances apparently repulsive, and converts them into industrial utilities. We only imitate Nature in this respect. She allows nothing to be wasted in the universe, but always converts the refuse materials into substances useful to man. When you see Nature thus cherishing her waste materials, and carefully using up all effete, decaying, and putrid matter for great purposes in the economy of the universe, you will not be inclined to think that the economy of chemistry in converting waste substances into industrial utilities, is either ignoble or repulsive, or that the subject itself was unworthy of being brought before you.

Miscellaneous.

THE NEW METAL THALLIUM.

Properties of Thallium.

Thallium has all the characters of a true metal, and, in most of its physical properties, greatly resembles lead. Not quite so white as silver, it possesses a briliant metalic lustre when freshly cut. It appears yellowish when rubbed against a hard body; but this tint is doubtless due to oxidation, for the metal piecipitated by a battery from an aqueous solution, or fused in a current of hydrogen, is white, with a bluish grey tinge, which resembles aluminum.

Thallium is very soft, and very malleable; it can be easily scratched by the nail, and cuts with a knife. It marks paper, leaving a yellowish streak. Its density (11·9) is a little higher than that of lead. It fuses at 290° C., and volatillises at a red heat. Lastly, thallium has a great tendency to crystalise, for the ingots obtained by fusion crackle like tin when they are bent. But the phyisical property, *par excellence*, of thallium,—that which according to the beautiful researches of MM. Kirchhoff and Bunsen, characterises the metallic element,—that which led to its discovery,—is the property which it possesses of communicating to the pale gas-flame a green colour of great richness, and to the spectrum of this flame a single green ray as distinct and as sharply defined as the yellow ray of sodium, or the red ray of lithium. On the micrometric scale of my spectroscope, this ray occupies the division 120·5, that of sodium being at 100. The slightest portion of thallium, or of one of its salts, gives the green line with such brilliancy that it seems white. The fifty-millionth part of a gramme can, according to my calculations, be recognised in a compound.

Thallium tarnishes rapidly in the air, becoming covered with a thin pellicle of oxide, which preserves the rest of the metal from alteration. This oxide is soluble, is decidedly alkaline, and has a taste and smell similar to potash. By this characteristic, as well as by its optical properties, thallium approaches the alkaline metals.

Thallium is attacked by chlorine, slowly at the ordinary temperature, rapidly at a temperature above 200° C. The metal then melts, becomes incandesent under the action of the gas, and gives rise to a yellowish liquid, which solidifies on cooling to a mass of a little paler colour.

Natural State and Extraction.

Thallium cannot be considered as very rare in nature. It exists, indeed, in many kinds of pyrites, which are used at the present time in large quantities, principally for the manufacture of sulphuric acid. I may especially mention Belgian pyrites from Theux, Namur, and Philippeville, I have also found it in mineralogical specimens from Nantes and Bolivi, in America.

Strictly speaking, thallium might be prepared from these pyrites; but it is much easier to prepare it by using the deposits from the lead chambers, where it accumulates in relatively large quantities during the manufacture of sulphuric acid. It is from these thalliferous deposits that I have extracted, by a method given in my memoir, the chlorides of Thallium which formed the starting-point of the study which I have made of the new metal and its compounds.

As to the metal itself, it may be reduced from one of its saline combinations either by the decomposing action of an electric current, or by precipation with zinc, or by reduction with charcoal at a high temperature. The chloride may also be separated from its chlorides by potassium or sodium under the influence of heat; in this latter case the reaction is very energetic.—*Chemical News.*

Consumption of Tea in the World.

The following figures show the present annual consumption of tea, approximately, or as near as can be arrived at:

	Lbs.
China	1,408,000,000
United Kingdom	78,000,000
British America and West Indies	3,000,000
Australia, the Cape, &c	7,000,000
British India	3,000,000
United States	35,000,000
Russia	15,000,000
France	550,000
Hanse Towns, &c	150,000
Holland and its Colonies	3,200,000
Belgium	200,000
Denmark, Sweeden and Norway	250,000
Germany	500,000
Spain and Portugal	200,000
Italy	50,000
South America	500,000
Other places	500,000
	1,555,100,000

The immense traffic in tea is one of the most remarkable illustrations of the enterprise and energy of modern commerce. The trade in tea now gives employment to upwards of 60,000 tons of British shipping, and about £10,000,000 sterling of British capital, producing a revenue to the State of £5,500,000 sterling. Of all foreign imports, tea is the most important in Russia, and the whole of this comes to the fair of Nijnie Novgorod, with the exception of the very small quantity of sea-borne tea which is brough to Odessa. The middling classes make a more frequent use of this beverage than the rest. The declared official value of the tea introduced into Russia is about £1,500,000 sterling.—*London Grocer.*

Safety Friction Match.

The following is a condensed description of a mode of making safety friction matches, for which a patent has been obtained by M. Mearing, London. The wooden splints are first dipped into melted sulphur, and then coated with this mixture;—Chlorate of potash, eight parts; sulphur, one part; rotten stone, four parts; gum, two parts; and lamp-black one part; all mixed in a sufficient quantity of water to form a paste. After being dipped they are then dried, but will not ignite until rubbed upon paper made as follows;—Take amorphous phosphorus, four parts; powdered graphite, one part; and form a paste with these in four parts of water and one of silicate of soda. This when dried is the paper upon which the matches prepared as described are to be rubbed.

New Kind of Leather.

A short process of treating hides, with the use of very little tan bark, to make leather, has been patented by H. C. Jennings, London. In the preparation of thick ox-hides by this process, the hair is first removed in the usual manner, either by steeping them in lime baths, as in the old mode, or by sweating, according to the common American method. If lime is used, the hides are steeped in diluted muriatic acid, after they are unhaired and washed. This opens their pores and fits them for the succeeding operations. They are now piled in batches of a dozen hides in each, with a hurdle of wicker between each pair; and they are then alternately lowered into tanks filled with the following solutions;—Tank No. 1 is charged with a strong solution of alum, to which ten per cent. each of sulphuric and muriatic acids are added. Tank No. 2 is charged with a concentrated solution of soda-ash (carbonate of soda) to which is added five per cent. of the tungstate of soda. The skins or hides are immersed for six hours at a time in these tanks, then withdrawn and drained, and transferred alternately from the first to the second, and *vice versa*, until the hide is sufficiently hardened. This condition of the hide is known by cutting a small piece off one with a knife. At this stage they are immersed for six hours in a strong solution of tungstate of soda, alone; then lifted, drained and placed in a liquor of soap, made by dissolving 20lbs of soap in every ten gallons of water, and the hides agitated in this until the strength of the soap is exhausted by being absorbed in the hides. They are then washed well in soft water, and finally steeped for twenty-four hours in a common liquor of oak-bark, after which they are dried and finished in the usual manner.—*Scientific American.*

Paper for Backing Iron Plates

Hard wood has been used to support the armour of all the iron-clad ships hitherto constructed; but an impression prevails that a tougher and more unyielding substance might be advantageously substituted for it. Strange to say, paper has been thought to possess those properties, and in the form of millboard was tried at Shoeburyness in competition with wood. The presumption from the experiment is that paper has the advantage over hard wood.

A New Silk-Worm.

According to advices from the River Plate, an important item of commerce is about to be added to the recources of Monte Video. Eighty specimens of a hardy description of silk worm, *Gusano Recino*, were introduced into that country about eight months ago, and it is affirmed that at the present time they are counted in millions, being the produce of five generations in this short period. The plant upon which the worms feed grows spontaneously in the republic, and it is said to be of such fine quality and so appropriate for their food that the cocoons present a consistency and weight superior to those produced in Europe, or even in China, Specimens are expected in England by the next mail. The silkworms, it is added, have passed through an unusually severe winter, which they resisted without suffering the losses that occur with the China worm.—*London Express.*

Cement for Clay Retorts.

The cracks and leaks in clay retorts can be filled by the following cement:—

Fire-clay	42.5	per cent.
Loam-sand	42.5	" "
Glass	10.0	" "
Choride of Sodium	5.0	" "
	100.00	" "

The compound is ground well together with water, and applied as a lute.

New Iron Cased Vessels.

At the present moment no less than five iron-cased vessels, of the largest and most formidable class are being constructed. First and largest comes the *Minotaur*, an enlarged and improved *Warrior*, and building on the same slip from which that frigate—the first contribution to the reconstruction of the British Navy, and finest ship of war in the world—was launched. The *Minotaur* is 400ft. long, 59ft. 4in. broad, and nearly 7000 tons burden. She will be protected from stem to stern, differing in this respect from the *Warrior* (which only carries her armour amidships), and will be defended by 9in. of teak and armour plates of 5½in. thick, an inch thicker than those of the *Warrior*. A company are also building for the British Admiralty another iron-cased frigate, the *Valiant*, of 4100 tons burden, which will be launched in the spring of next year. Her protecting armour is similar to that of the *Warrior*, viz., 18in. of teak and 4½in. armour plates. In an advanced state of progress is also a floating battery for the Russian Government, 220ft. in length, 53ft. broad and 2800 tons, also protected by 4½in. armour plates on 9in. of teak, and intended to carry 26 68-pounder guns on a draught of 14 ft. The frames are also beginning to be erected of a frigate which a company have just undertaken to build for the Spanish Government, of about 5000 tons, with 5½ in. armour plates; and the slip is also being prepared for a similar frigate of 4300 tons for the Turkish Government, making altogether nearly 23,000 tons of iron-cased shipping under construction by one firm, which together constitute a formidable fleet superior to what is possessed by any but the first-rate naval powers. —*Mech. Mag.*