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PROGRESS OF MANUFACTURES IN THE UNITED STATES.

The facts revealed by the United States census for 1860, exhibit the marvellous progress which has been made throughout the Union in manufacturing industry. According to the census of 1850, the total value of domestic manufuctures was $1,019,106,616. The same branches of industry yielded a product in 1860, in part ascertained and in part estimated, of $1,900,000,000. The total value of manufactures in 1860 was in the proportion of $60 for every inhabitant of the Union. Nearly one-sixth of the whole population are actually dependent upon manufactures for their living, not including those indirectly engaged in this kind of industry. It is computed that one-third of the whole population is supported directly or indirectly by manufactures.

The total value of agricultural implements reached in 1860 seventeen million dollars. Ohio and Illinois have the largest manufactories in the west. In the southern states alone, which are not usually regarded as being much devoted to manufactures, the whole value reached the very respectable sum of $1,582,483, exhibiting an increase of over 101 per cent. in the last decade.

The construction of machinery, including stationary and locomotive steam-engines, all the machinery used in mines, mills, furnaces, forges, factories, bridges, railways, hydraulic machinery, &c., exclusive of sewing machines, acquired a value of $47,118,550 in 1860, showing an increase of over eighteen millions in ten years. It is remarkable that the greatest increase during that period has taken place in the southern states. The ratio of increase in the several sections of the Union being as follows:—

Southern States	387·0	per cent.
Western "	127·0	"
Middle "	55·2	"
N. England "	16·4	"

The sewing machines have effected a revolution in some branches of industry in the States during the last ten years. The returns show an aggregate of 116,330 machines made in nine states in 1860, the value of which was $5,605,345. The sewing machine has diminished the price of clothing, and in the manufacture of "ready made" articles has established a rapidly increasing industry. In four cities alone, namely, New York, Philadelphia, Cincinnatti and Boston, the value of manufactured clothing amounted to over forty million dollars. In Troy, N. Y., the worth of shirt collars now annually manufactured is nearly $800,000.

The products of the flour and grist mills reached a value of nearly $136,000,000 in 1850, and in 1860 the returns exhibit $223,144,369. The largest mill is at Oswego, which in 1860 produced 300,000 barrels of flour; the next two in Richmond, Virginia, which made respectively 190,000 and 160,000 barrels. The following is the ratio of production for different sections of the Union:—

	Value of Flour and Meal.
Western States	$96,038,794
Middle "	79,086,411
Southern "	30,767,476
N. England "	11,155,445
Pacific "	6,096,262

The manufacture of spirituous liquors employed 1,138 distilleries, producing the enormous quantity of eighty-eight million gallons, of a value exceeding $24,000,000.

The total production of the cotton manufactures of New England was estimated at over $80,000,000 worth, and during the same year the middle states produced similar articles to the amount of $26,000,000.

The returns of woollen manufactures show an increase of more than fifty-one per cent. in ten years. Their value in 1860 amounted to $68,865,963. Out of 1,909 establishments, 227 were in the southern states. The quantity of wool raised has not increased so largely as many other branches of agricultural industry upon which manufactures are dependent. In 10 years the increase has only amounted to 15·2 per cent. The yield falls far short of the consumption.

The manufacture of linen goods has made little progress. Farmers throughout the west have raised the crop simply for the seed, and thrown away the fibre as valueless.

The production of leather is a leading branch of industry, and its value in 1860 was represented by $63,090,751. It is remarkable that the manufacture of boots and shoes employs a larger number of operatives than any other branch of American industry. The statistics of this industry are very noteworthy. The following table shows its importance:—

Number of establishments in 1860		11,864
Capital invested		$24,050,983
Value of raw material, including fuel		43,621,438
Average number of hands employed	male	96,287
	female	31,140
Cost of labour		$31,540,556
Value in 1850		53,357,036
Value in 1860		89,549,900

The making and refining of salt yielded $2,200,000, being represented by nearly 12,000,000 bushels, at an average cost of 18½ cents a bushel.

The "Preliminary Report on the Eighth Census" concludes an abstract of the manufacturing industry of the United States with the following words: "The nation seemed speedily approaching a period of complete independence in respect to the products of skilled labour, and national security and happiness seemed about to be insured by the harmonious development of all the great interests of the people. Peace reigned within our borders and waited upon our name abroad. But in an evil hour the tide of prosperity has been stayed, whether to be rolled back or not, the ninth census will reveal."

THE FUTURE CAPITAL OF CANADA.

No part of Canada will ultimately possess so much interest for the people of the province and for foreign travellers, as the valley of the River Ottawa. The value of the region drained by this great river is but little known and still less appreciated. Few persons are aware of the fact that the Ottawa drains a country as large as England, and besides possessesing very considerable attractions for the tourist, it contains a very fair proportion of agricultural soil, a vast supply of timber, and great mineral wealth.

The Ottawa rises near the forty-ninth parallel of latitude in longitude 76° W. It is about 780 miles long, and 300 miles from its source it passes through Lake Temiscaming, 67 miles long. Above this lake the country drained by the Ottawa is little known; but below it, for a distance of 430 miles, the river has been surveyed. Montreal River, the canoe route to Hudson Bay, comes in from the northwest, 34 miles down Lake Temiscaming, and, six miles lower down, the great and almost unknown river Keepawa plunges into the lake in a magnificent cascade 120 feet in height. From the long sault at the foot of Lake Temiscaming, 233 miles above the city of Ottawa, the river is not navigable for a distance of 89 miles, except for canoes. Between the last-named point and Ottawa, a distance of 197 miles, numerous tributaries swell its waters, and one of these, the Matawan, coming from the west, is of especial interest at the present time, in consequence of its being on the line of a proposed ship-canal route between the Ottawa River and Lake Huron. Above the Upper Allumette Lake there is a navigable reach of water 43 miles in length. The mountains above Allumette Lake are upwards of 1,000 feet in height, and the scenery is magnificent. The mountains on the north side of Colongue Lake are 1,500 feet high, and the scenery grand and beautiful. The Petewawa, one of the largest tributaries, 140 miles long, drains an area of 2,200 square miles; the Black River drains 1,120 square miles; and 39 miles above Ottawa City, the Madawaska, one of its greatest feeders, and 210 miles long, drains 4,100 square miles. Six miles above Ottawa the rapids begin which terminate in the celebrated Chaudière Falls whose tumultuous waters plunge 40 feet and partly disappear in the "Lost Chaudière" by an underground passage whose subsequent outlet is unknown. At Ottawa the great river receives the Rideau, distinguished on account of its canal which connects the city of Ottawa with Lake Ontario at Kingston. Its largest tributary, the Gatineau, with a course of 420 miles, comes in from the north, and drains 12,000 square miles of territory. Eighteen miles below Ottawa is the Rivière du Lièvre, draining an area of 4,100 square miles; below this river there are numerous tributaries varying from 90 to 160 miles in length. The rapids below Ottawa are avoided by a succession of canals. One hundred and thirty miles below the future capital of the province the Ottawa's waters mingle with those of the St. Lawrence, and for many miles their yellow, turbid stream can be seen quietly gliding by the side of the blue waters of the St. Lawrence, soon to become blended in their onward course to the sea.

The valley drained by the Ottawa is 80,000 square miles in area, for the most part covered with valuable woods, particularly red and white pine; it is abundantly intersected with large rivers, and contains a very considerable area of the best soil. The country is generally beautiful and undulating behind what has been called the red-pine region, and sustains a growth of maple, beech, birch, and elm. No region of equal extent enjoys so much excellent water power with such ample supplies of timber and minerals to work up, or to apply to any kind of manufacture to which water power is applicable. It is a region rich in iron, lead, plumbago, marbles, ochres, and copper. The valley of the beautiful and bountiful river is capable of maintaining without difficulty twice the present population of Canada, or more than 6,000,000 souls. Such is the region in which the future capital of this vast province is situated, and where its government will be established. The City of Ottawa was founded by Colonel By, in 1827, at the time of the construction of the Rideau Canal. It is situated a below the beautiful and curious falls of the Chaudière, and stands upon a high and bold eminence surrounding a deep bog. Lord Sydenham recommended Bytown (now Ottawa) as a very favorable situation for the seat of Government of Canada. In 1850 the population was 6,016; but in consequence of its being the seat of the lumber trade, its inhabitants have always been of a very transient description, spending the summer in the town and in fall hastening far away to the great lumber districts, north, west, and east, to spend the winter in the glorious forests which still cover the Upper Country. The present population of Ottawa is 15,000.

The new Parliament Buildings are three in number—the parliament-house and two departmental buildings. They occupy an elevated piece of ground, about 25 acres in extent and 150 feet above the river, known by the name of "Barrack Hill." The view from this natural terrace is superb. The great river, with its moving rafts, steamers, barges, and canoes, rolls swiftly on through splendid hill ranges towards the south. In the distance the succession of bridges which span the majestic river just above the Chaudière Falls, attracts the eye, even though it be tempted to rest upon the wild beauty of the cascade sweeping by craggy rocks, between abrupt islands, and plunging into the basin below, where part of its waters disappear in the Lost Chaudière. Far beyond the beautiful cascade, glitters the broad river, swiftly rushing down the rapid Des Chenes; and in the remote background rise towering hills and mountains, often brilliant with purple and gold when the sun dips from view and gilds their lonely summits with his parting beams.

The buildings are constructed of a light-colored sandstone found in the township of Nepean in the valley of the Ottawa. This material is geologically interesting, as it comes from the most ancient fossiliferous unaltered rock in the world, the Potsdam sandstone. At Lyn, where some of the stone is obtained, the massive sandstone beds are seen resting on Laurentian gneiss. The walls are relieved with cut-stone dressings of Devonian sandstone from Ohio, and by red sandstone relieving arches from Potsdam in the state of New York. The roofs are slated with purple and green, and the pinnacles ornamented with wrought-iron cresting. The style of architecture is the Italian-Gothic, and the south front of the quadrangle is formed by the parliament building, 500 feet in length. The two departmental structures are 375 feet long. The rear is open and will be railed off with a suitable ornamental screen. The committee rooms occupy the front of the building. The library, a beautiful detached circular building with a dome 90 feet high, is in the rear of the central tower, 250 feet high. The two legislative halls are on each side of the library, but in the main building. The dimensions of these halls are the same as those of the House of Lords, namely, 80 feet by 45; they are situated on the ground floor and lighted from above. The library is constructed after the plan of the new library of the British Museum, and will hold 300,000 volumes. The speaker's rooms, and all other offices and conveniences required, are judiciously arranged within easy reach of the legislative halls. The speaker's and librarian's residences are detached buildings and do not necessarily form part of the main structure.

The two departmental buildings contain in the aggregate 300 rooms, and are intended to accommodate all the departments of the government of the province; and are so constructed as to be capable of extension at any future time without injuring the general architectural effect. The buildings cover nearly four acres, and some idea of their magnitude may be inferred from the following brief statistics. The plastering when completed will exceed ten acres in extent. The number of windows and doors is about 1,200; the length of the cornices, 12 miles; the number of brick used, 12,000,000; together with many thousand yards of masonry, cut-stone work, and much carving and decorations of a similar character.

The future of the City of Ottawa is full of promise, Besides being the capital of a powerful province equal to France and England together in area, it will become the great market of the produce of an immense country in its rear, to the north and west, which, besides very fair agricultural capabilities, has a larger proportion of water power than any other area possessing similar advantages. It lies, too, on the most direct line of land communication from the sea-board with the north shores of Lakes Huron and Superior, and when a winter communication with the north-west is established, it will doubtless take its starting point from the City of Ottawa.

STEAM FIRE-ENGINES.

The Corporation of the City of Toronto were the first to introduce steam fire-engines into use in Canada; having purchased from Messrs. Silsby, Mynders & Co., of Seneca Falls, N.Y., in the latter part of the year 1861, two of these invaluable machines; thus dispensing with the service of six hand engines and one hose company, and performing the work required of them in extinguishing fires in an infinitely more satisfactory manner than by the old system.

The present force is composed of 45 men and officers, namely, Chief and Assistant Engineers; two Engineers and two Firemen of Steam-Engines;

twenty-two Hose or Branchmen ; eleven Hook and Ladder men ; four Drivers and one Care-taker of buildings and apparatus. The Chief Engineer, and the Engineers and Firemen of Steam-Engines are under full pay, while the Hose and Hook and Ladder men receive a remuneration of from $50 to $90 per annum, according to the position they hold.

There are seven horses and five drivers required, which are always on hand, night and day, and are furnished by contract at a little over $2,000 per annum, the corporation furnishing stabling for the horses and sleeping apartments for the drivers at the fire-engine stations.

The old force of volunteer companies consisted of from 250 to 300 men and officers, under no efficient control, and constituted an organization at once ruinous to the morals of a large portion of the young men composing it, and highly detrimental to the peace and goodwill of the city.

The actual expenditure for the present brigade is little more than half that for the previous volunteer force, as shown by the following returns taken from the published report of the City Finances :—

Cost of Brigade in	1859	$15,581	63
" "	1860	14,884	37
" "	1861	11,250	57
" "	1862	8,992	27

Steam power was used for only a portion of 1861. In 1862 the Department had only the two steam engines in operation. The returns of cost of the Department here given do not include cost of new engines, hose, or hydrants, but include all salaries and other working expenses, and also water furnished by Water Company and by carters. The cost of new machines and apparatus will not be greater than with the system of hand power.

Another heavy item of expense under the old system, was the immense destruction of side-walks, from running the various hand engines and machines thereon when proceeding to fires, and the endangering of life and limb, which is now entirely obviated ; and the saving to the citizens in the decreased rates of insurance on all property, since these engines have been in operation, is far more than sufficient to pay the whole annual cost of the Brigade to the city.

We take the following history and description of the steam fire-engine from a paper read before the Society of Arts, England, "On the Suppression and Extinction of Fires," by Charles B. King, M.E., and published in the Journal of the Society for March 20th :—

The Suppression and Extinction of Fires.

By Charles B. King, M E.

In extinguishing fires of any magnitude the steam fire engine must ever hold the foremost place, not only on account of the development of power, but on the more important score of economy. A great check to their adoption and improvement in this country was the opposition so many years maintained by the London Fire Engine Establishment, acting under the advice of the late Mr. Braidwood, who subsequently became a warm advocate of steam fire engines.

The first steam fire-engine was constructed in England by Mr. John Braithwaite,* in the year 1830 ; it was worked at the burning of the Argyll Rooms, the English Opera House, and several other large fires. It consisted of a 6-horse power steam-engine, and the pumps worked thereby, which were swung upon a carriage drawn by two horses. Steam sufficient for working could be obtained in the course of thirteen minutes. This engine particularly distinguished itself at the conflagration of Messrs. Barclay, Perkins and Co.'s brewery, for, after the fire, and the total loss of the steam-engine and pumping apparatus of the establishment, it rendered considerable service to the proprietors of the brewery in pumping for twenty-five days the beer brewed in the part of the building that was saved, to the vats, 50 feet above the level of the street. As the pump was 6½ inches in diameter, and made 30·14 strokes per minute, it could pump in a day of ten hours 8,640 cubic feet, and in 25 days, 216,000 cubic feet of liquor to the height of 50 feet. Subsequently, Messrs. Braithwaite and Co. built three engines, one called the "Comet," for the Prussian Minister of the Interior, which is still in existence at Berlin.

The Americans then took up the subject, and Capt. Ericsson, an English engineer,† obtained the gold medal offered in 1840 by the New York Mechanics' Institute, "For the best plan of a steam fire-engine," which was very similar to the engines of Mr. Braithwaite. Soon after this Mr. Paul R. Hodge built a steam fire engine in New York, designed for auxiliary steam propulsion. About 1850, Mr. A. B. Latta, of Cincinnatti, U. S., constructed an engine, with self propelling gear weighing 10 tons, which was guided, and in difficult places helped forward, by a pair of horses, their use being advocated on the ground that a machine running alone had a tendency to frighten other horses. Within a few years steam fire engines have been adopted in Philadelphia, Boston, New York, Baltimore, and other cities of the United States; builders having variously and widely modified the earlier plans, while some have made entirely new ones. The main feature of all these plans is the boiler, which is constructed for the rapid generation of steam, and marvellous results have been obtained. Mr. Latta's engines have begun work in from three to five minutes from the application of the match. The engines built by the Amos Keag Company, of Manchester, New Hampshire, have begun in three and a-half minutes. Those of Messrs Silsby, Mynderse, and Company, Seneca Falls, New York, have begun in five or six minutes. These differences are doubtless due to the varied amounts of heating surface each boiler presents. The engines

* Messrs. Braithwaite and Ericsson.—[*Ed. London Engineer.*]

† Captain Ericsson is a Swedish Engineer, and, while a partner of Mr. Braithwaite, constructed the steam fire engine attributed by Mr. King to the last named gentleman. Captain Ericsson's New York Engine was similar to that built by him in London.—[*Ed. London Engineer.*]

of Messrs. Lee and Larned, of the Novelty Works, New York, are probably the most celebrated, and with good cause, as being remarkable for their strength, durability, and lightness, all being leading essentials in a successful fire engine. In these engines there is less water to heat, and the flues are extremely light, the grates are smaller than those of the Amos Keag engines, so that the time to make an effective fire is consequenty greater, which is no very serious objection. The 'Minnehaha' engine (of this make) has 201½ square feet of heating surface, having 199 tubes of 1½ inch diameter, and $\frac{1}{16}$ of an inch thick. The most celebrated engine of this make is that known as the "J. C. Cary." It is fitted with Mr. J. K. Fisher's steam carriage apparatus, to enable it to be self-propelling. The boiler contains 114 pairs of vertical tubes, arranged annularly, or one within the other, the outer of 2½ inch, and the inner 1¼ inch diameter, the annular space between the two being occupied by water. The steam cylinders are 7½ inches diameter and 14 inches stroke. The connecting rods from the engines act on cranks placed upon an intermediate shaft, revolving in fixed bearings upon the frame, and operating the pump, which is one of Cary's patent rotary force pumps of the largest size; the total weight is about eight tons; the length of the frame or body is about 14½ feet, its breadth 7 feet, and the total length of carriage 20½ feet. Sufficient fuel for two hours consumption can be carried on the foot plate at the back of the hinder-axle. Steam can be raised to working pressure in from six to ten minutes, but it is intended that steam shall be kept up at all times so that the engine can start at a moment's notice, which can be done at a comparatively trifling cost. At a public trial on the fifth November, 1858, before Commissioner Cooper and other officials, it threw from 700 to 750 gallons of water per minute through a 1⅝ inch nozzle a horizontal distance of 252 feet, and a vertical height of 160 feet.

Messrs. Shand and Mason, of Blackfriars, were the first to renew the manufacture of steam fire-engines in this country. Their first engine was constructed in 1858 for the Russian Government. A description of a public trial of this appeared in the *Times* Newspaper of October 25th, 1858. Steam was generated to a working pressure in ten minutes from the application of the match and threw jets to a considerable elevation. The engine is now in use in St. Petersburgh. The second engine was tried at Waterloo-Bridge Wharf, on the 1st July, 1859; a description of it appeared in the *Times* of July 2nd, 1859. Steam was generated to a pressure of 10lbs. in six minutes An inch jet was thrown 90 feet vertically, and 130 feet horizontally. The third that was made was somewhat cumbrous, but was successful in working, which encouraged its makers to build another. Accordingly one was made, and purchased by the London Fire Engine establishment for their station in Watling-Street. The boiler is a vertical one of peculiar construction, with a copper fire box, and Lowmoor shell plates of one quarter-inch in thickness; there are 199 tubes in the boiler, each 16 inches long by one inch in diameter, the boiler presenting a heating surface of 91·467 square feet. The cylinders are placed horizontally, the piston-rods being connected by a cross-head slotted to admit of the crank being actuated by its pin moving in the slide brasses. The steam cylinder is 8½ inches diameter, and the pump cylinder 7 inches with a stroke of 9 inches. Steam can be raised to the ordinary working pressure (viz. 80 lbs. on the square inch) in fifteen minutes from cold water. The weight, including water, fuel, and hose, is 6,500 lbs. Messrs. Shand and Mason have constructed three steam fire-engines for the London and North Western Railway Company, of the same dimensions as the last mentioned, but erected on an independent sole plate; they also constructed one similar to these (but fitted of course to a common road carriage), for the London Fire Engine Establishment. These makers took out a patent for a steam fire-engine. It consists of an upright conical steam generator, or boiler, formed simply of an external cone with an annular space between. The internal cone forms both fire-box and chimney. The hinder axle of the carriage is passed through the boiler by fixing a horizontal annular tube through the body of the boiler in a suitable position, the tube forming a water space in connection with the annular water space of the boiler. There are two single acting steam cylinders, and two single acting pump cylinders connected by tie-rods; the steam and water cylinders are cast in one piece. Messrs. Shand and Mason have made three of these engines, but in practice, owing to their mechanical design and construction, they are continually breaking down either at the crank-shaft or the plates of the boiler forming the top of the fire-box burn away, owing to there being no water circulation round them. The weight is very unequally distributed over the wheels, making the stern of the engine hang heavy. In consequence of the employment of a crank motion, these engines cannot be worked below a certain speed, owing to the difficulty of getting the crank over the centres.

Messrs. Merryweather and Son are now manufacturing steam fire-engines, and they have succeeded in bringing out two very good serviceable engines, named the "Deluge" and the "Torrent." The former of these consists of a vertical boiler, with a quantity of vertical copper tubes. The steam-chest at the top of the boiler is fitted with wrought-iron tubes for carrying off the smoke and creating a draught. Over the fire-box are a series of hanging tubes in which a perfect circulation of water is carried on. There is also an outer water jacket. The boiler is fed with one of Giffard's injectors. Steam is taken from four points, and supplied direct through the valve-chest into the cylinder, in its way passing under the cylinder. The steam cylinder is 9 inches in diameter, and 15 inches stroke; no fly-wheel is used, and by the valve arrangement a uniform speed is obtained; this is a great advantage, as the pump is worked steadily, and an even column of water is delivered. The engine can be started, at any point, by opening the steam-valve, and can run at any required speed —a great desideratum in fire duty. The piston-rod is coupled to that of the pump direct, and the two guide-rods connect the pump and steam cylinder together. The pump employed is De La Hire's double acting, but the valves are placed in easily accessible chambers beneath the pump barrel. Provision is also made for completely emptying the barrel at every stroke, thus getting rid of all grit and impurities brought up through the suction.

The piston is so constructed as to contain a quantity of oil, which continually lubricates the cylinder at every stroke. Air is contained in a sphere of elastic rubber within the air vessel, which prevents its total absorption. The internal diameter of the suction-pipe is five inches; the internal diameter of each of the two delivery-pipes is three inches. The weight of this engine with running gear complete is three and a-half tons. Steam can be raised from cold water to a pressure of forty pounds on the square inch in ten minutes from the application of the match. It has drawn water through the suction pipe vertically a distance of fourteen feet, and then discharged it over a building sixty feet high to a distance of 210 feet through an inch and a quarter nozzle. The engine named the "Torrent," by the same makers, differs in a few details, and can be easily drawn by one horse. The steam cylinder is 6½ inches diameter, with a 12-inch stroke. The pump is double acting, the same as used in the "Deluge," is 4¾ inches diameter, with a stroke of 12 inches; the two piston-rods being coupled directly, air-vessels are placed both on the suction side as well as on the deliveries. At a recent trial, cold water being used, a pressure of 37 lbs. of steam was raised in 8 minutes, and 100 lbs. in 9¼ minutes from the time of applying the match, and it is capable of discharging 250 gallons of water per minute to a height of 160 feet.

Mr. William Roberts, of Millwall, has constructed a very useful steam fire-engine, which can also be used as a hoist. The engine is 12 feet 6 inches long, by 6 feet 4 inches broad; the steam cylinders, two in number, are 6 inches diameter by 12 inches stroke, placed immediately in front of the boiler and over the shaft. The driving wheels are five feet diameter and each wheel has 2 springs, all being within the framing. The moving power is transmitted to the wheels from the main shaft, by a pitch chain gearing, 4 to 1; either wheel can be thrown in or out of gear at pleasure by means of a clutch. The steering-wheel is 3 three feet diameter, and will lock quite round, enabling the engine to turn completely round in its own length. The pumps are two of Mr. Roberts's Patent, 9½ inches diameter, with a stroke of 8 inches each pump, and they can be very readily connected to the engine or thrown out of gear. The boiler is Benson's Patent, with water tubes, and forced circulation. The engine will carry 60 gallons of water in the tanks, 5 cwts. of coal, 24 feet of ladder (4 feet 6 inches in lengths), 12 feet of suction hose (24 feet if wanted), 40 feet of 4 inch delivery hose, and 450 feet of 2½ inch ditto, 1 large and 4 small branch pipes, 12 buckets, and all the necessary tools, &c., the weight complete being 7 tons 15 cwts. On the end of the main shaft is a rigger, 2 feet in diameter, and a small windlass end to enable it to be used for driving machinery, hoisting, &c., and these are included in the weight of 7¾ tons. Steam can be fairly got up to 140 lbs. per inch in 19 minutes 25 seconds, with all coal, no wood being used except to light the fire in the first instance. With a 1½ inch jet it has thrown the water a distance of 186 feet, and with a 1⅜-inch jet a height of 140 feet; it is fitted with a regulator, so that it can be made to deliver the smallest quantity; with a jet $\frac{1}{64}$th of an inch it took 12 minutes 45 seconds to fill a quart measure. It can be made to use 2, 3, or 4 small jets instead of one large one when desirable to do so, and will deliver 450 gallons per minute. It has been propelled at a rate equal to 18 miles an hour, and has been taken through the High-street, Poplar, at from 12 to 14 miles an hour; it has ascended inclines of 1 in 14 with the greatest ease, stopping in the middle and starting again without difficulty. It has also been run over fresh Macadam road, and upon one occasion was taken to Woolwich and brought back, about three miles of road each way that had only just been made good from putting in the main sewer, the wheels sinking sometimes to a depth of 12 inches.

I have another engine to describe, and that shall be done in a few words. It is one invented by Mr. Wellington Lee, of the firm of Lee and Larned, of New York, and manufactured in this country by Messrs. Easton, Amos and Sons, of Southwark. The boiler is of novel construction, and is composed of gun metal, steel and Lowmoor iron, with a view of obtaining the two essentials of lightness and compactness, securing at the same time a large amount of heating surface, of which there are 228·5 square feet, and of fire-bar surface 4·58 square feet. The boiler is composed of a central furnace, surrounded by a shell, or wall, of vertical water-tubes, surmounted by a steam-drum, which, in ordinary work, is filled with water to about one-third of its height; and from this chamber depends a flat water space, or "suspended slab," the connection with the steam drum being made by a series of vertical tubes. Through these proceed internal tubes by which the products of combustion pass in an intensely heated state to the smoke-box, exposing by this means an annular water space to the action of the heat. A number of short tubes pass independently of these, through the suspended slab, and the steam drum respectively, through which the heated current also passes; and the entire arrangement is so adapted as to present the greatest possible amount of heating surface obtainable to the action of the fire. Tubes pass from the suspended slab to the water-bottom, into which the bottoms of the outer shell of tubes are secured, thus maintaining a complete circulation of the water throughout the boiler. The steam cylinders are two in number, and are placed immediately forward of the boiler; their diameter is 9 inches with a stroke of 9¼ inches, the two piston rods are coupled direct. The slide valve of one cylinder is actuated by means of a reducing lever placed on the piston-rod of the other cylinder, and operates in such a manner, that when one piston is at the end of the stroke, the other is at half stroke, and *vice versa.* This arrangement while ensuring the correct action of the slides for admitting and exhausting the steam, is not of itself sufficient to ensure the proper length of stroke, but avoids the breaking of piston or cylinder cover which might perhaps occur. To guard against this, two additional parts are provided, so arranged, that the exhaust is imprisoned shortly before the termination of the stroke, and the piston starts smoothly and evenly on its return, and however rapid may be the running, the motion is as certain and even as in two engines working with cranks at right angles upon one shaft. The pumps are two in number, each 5⅝ inches diameter; but the plungers and seats may be changed in about twenty minutes for others of larger diameter, in case a greater quantity of water may be required. The length of stroke is 9½ inches diameter, and being double acting, a steady and continuous stream is obtained from them. Each pump has eight suction and eight delivery valves of india-rubber working upon gun metal guards, offering an effective water way of fifteen square inches (in four valves), or very nearly two-thirds the area of the piston for the contents of one pump. The largeness of the water ways, combined with the peculiar stop at the end of each stroke, which is a main feature of the slide valve motion, causes the almost instantaneous closing of the valves, and the pumps run free from concussion or vibration at any practicable velocity. The net area of the suction opening is 16 square inches, and, having a continuous stream passing through it, the hose remains steady and quiet, when the pumps are running at their highest velocity; moreover, advantage is taken of the hollow spaces of the hand railing to connect them with the suction valve chamber, so as to form a suction air vessel. The engine is hung upon a wrought-iron framing, forged entire. Fisher's busk springs, as offering the greatest elasticity and lightness, are employed, with relieving screws for locking them out of gear when working. The nett weight of the engine is 3 tons 2½ cwt. Steam has been raised in five minutes.

Having received Mr. Hodges' directions to design a steam fire-engine, I carefully examined the plans of all the steam fire-engines that have been made. I came to the conclusion that Lee and Co.'s pumps were practically the best but was not prepared to say their boiler was. I designed the engine as shown in the diagram on the wall. The plan of the boiler I am not at present prepared to make known, and it will be seen that I use a springing fore-carriage, composed entirely of one flat spring, fastened at one end, and allowed to play at the other. I use by preference four 3 inch deliveries, and one 6 inch suction. The steam cylinders are 8¾ inches diameter by 9 inches stroke, and the pump cylinders 5 inches diameter by 9 inches stroke. On the top of the pumps is arranged a box for carrying hose and other implements, serving at the same time as a seat for the driver and two firemen, and behind, a standing room for three firemen, whilst the stoker and engine driver will ride on the foot plate behind.

I now come to a description of steam fire-engines used for service on the water, and here Mr. Braithwaite was also the first to advocate their use for he designed a floating engine, and submitted it to the London Fire Engine Establishment. Previous to the year 1852, the most powerful fire engines in London, were two floating ones on the river, belonging to the London Fire Engine Establishment. The largest of these was worked by 120 men, and, when well manned, was a very effective machine. The great increase, however, in the size of the dock and water side warehouses, led in that year to an alteration in this engine, whereby the apparatus for manual power was removed, and steam power substituted, doubling the power of the engine. The advantages accruing from this proceeding were so manifest that, in 1855, the Directors of the London Fire Engine Establishment caused an entirely new floating steam fire engine to be constructed. This was accordingly designed and constructed by Messrs. Shand and Mason, and has at various large fires performed efficient service. The steam fire engines propel the boat by means of two stern jets of water, thrown by a centrifugal pump; they are nominally of 80 horse power, but are frequently worked up to double that amount. It has two steam cylinders, each 14 inches diameter, and water cylinders of 10 inches, with a stroke of 18 inches. Two donkey engines are erected on the sides, to supply the boiler with water.

At the great fire in Tooley-street, this engine worked 384 consecutive hours. The London Fire Engine Establishment have recently had alterations made in the mode of propelling this boat, which may I think be termed most unsatisfactory. The propelling jets are now projected above the water, and against the air only. Action and reaction being in all cases equal, and the resistance of water being greater than that of air, it is manifest that the alteration just made, at a very considerable expense, is an injudicious one. I witnessed a trial of her powers, and the conclusions I formed were, that her speed was diminished, and the supposed improvements made her sluggish at the stern, taking over five minutes to turn round. Messrs. Merryweather and Son constructed two very efficient steam fire engines, which are fixed in the tug boats on the river Tyne. They were designed by Mr. Edward Field, C. E. They are fixed in the fore part of the tug boats, and connected to the ordinary boiler used for propelling. The steam being always kept for shipping emergencies, it will be seen that these engines are ready at a moment's notice. Each engine consists of two inclined steam cylinders, each 16 inches diameter and 12 inches stroke, both working direct on to one crank, from which the piston rods of the pump are worked. The pumps are of gun metal, and are 9 inches diameter by 10 inches stroke. The usual working speed is from 60 to 80 revolutions per minute, with a steam pressure of but 17 lbs. per square inch. These engines have been found to deliver continuously a steady stream of 1½ inches in diameter to a distance of 163 feet, and a one 1¼ inch stream to a distance of 134 feet. For fire duty two ⅞ inch nozzles are generally used, and are found very effective. They were designed to occupy a very small space, being only 8 feet long by 2 feet 6 inches wide. Working with a higher pressure of steam these engines would, of course, give greater results.

Mr. Wm. Roberts has fixed in the tug-boat *Lucy*, belonging to the West India Dock Company, a steam fire engine, in which he uses his patent pumps.

In bringing my paper to a close, I can only assure you that it was with considerable diffidence I approached a subject of such magnitude; but feeling the great importance of it to a great commercial community, and having had practical opportunities of making myself acquainted with the subject through all its minute details and workings, I was desirous of addressing this Society and, through it, the public generally. I trust my labour has not been in vain. Should there be in any portion of the paper any errors, either of detail or judgment, I am open to conviction from the gentlemen who will take part in the discussion, if they can adduce sufficiently good proof in support of any disputed point. At this juncture, I wish to convey my thanks to Messrs Hodges, Braddeley, Braithwaite, and the fire-engine makers for their courteous attention and kindness in supplying me with information. I will now leave the subject in your hands, trusting that it may be discussed in a fair and candid manner.

TABLE OF RESULTS OF ACTUAL PUBLIC TRIALS OF STEAM FIRE-ENGINES.*

ENGINE-MAKERS.	Steam pressure.	Horizontal Distance.	Vertical Height.	Size of Jet.	NUMBER OF GALLONS DELIVERED.
Messrs. Easton, Amos, and Sons. (Lee and Co.'s Patent.)	120 lbs. 140 "	222 ft. 202 "	175 ft. 160 "	1¼ in. 1½ "	448 Gallons in 1 minute 5 seconds, through 1½-inch jet.
Messrs. Merryweather and Son.	120 lbs. 140 " 145 "	215 ft. 220 " 190 "	165 ft. 170 " 150 "	1¼ in. 1⅜ " 1½ "	448 gallons in 1 minute 11 seconds, through 1⅜-inch jet.
Messrs. Shand and Mason.	120 lbs. 150 "	190 ft. 220 "	150 ft. 170 "	1¼ in. 1¼ "	448 gallons in 1 minute 15 seconds, through two 1-inch jets.

* The piston engine owned by the Toronto Fire Department gets up steam for working in from 3½ to 4 minutes, and the rotary engine in 4 minutes.

BRITISH PUBLICATIONS FOR MARCH.

Burn (Robert Scott) Year-Book of Agricultural Facts for 1862, 8vo	0	4	0	*Blackwoods.*
Cambridge Year Book (The) for 1863	0	2	6	*Macmillan.*
Campin (Francis) Engineer's Pocket Remem. an Epitome of Data &c., fcap. 8vo	0	5	6	*Atchley.*
Craik (Geo. L.) Manual of English Literature, &c., new edit., cr. 8vo	0	7	6	*Griffin.*
Ede (George) Management of Steel, including Forging, Hardening, &c., fcap. 8vo	0	1	0	*Tweedie.*
English Catalogue of Books (The) for 1862, roy. 8vo	0	3	6	*Low & Tucker.*
Fitz Roy (Rear Admiral) Weather Book; a Manual of Prac. Meteor., 2nd ed. 8vo	0	15	0	*Longman.*
Fownes (George) Manual of Elementary Chemistry, 6th edit., revised fcap. 8vo	0	12	6	*Churchill.*
Garden Manual (The), 7th edit., revised and corrected, fcap. 8vo	0	1	6	*Jour. Hort. Off.*
Girdlestone (W. H.) Mechanics & Hydrostatics, with an Appendix of Solutions, 8vo	0	5	6	*Macmillan.*
Jackson (G.) New Check Jour., upon the principle of Double Entry, 12th ed., 8vo	0	5	0	*E. Wilson.*
Jones (Edw. Jas.) Handbook of Phonography, fcap. 8vo	0	1	6	*S. W. Partridge.*
Little by Little: Graduated Lessons in Art of Reading Music, oblong.	0	3	6	*Griffith & Far.*
Sheriff (D.) Improved Principle of Single Entry Bookkeeping, roy. 8vo	0	3	6	*Longman.*
Smith (Goldwin) The Empire, a Series of Letters, post 8vo	0	6	0	*J.H.&J. Parker.*
Tomlinson (C.) Experimental Essays on the Motions of Camphor on Water, 12mo	0	1	0	*Virtue.*
Twisden (Rev. J. F.) Elementary Introduction to Prac. Mechanics, 2nd ed. p 8vo	0	10	6	*Longman.*
Tyndall (J.) Heat Considered as a Mode of Motion: Twelve Lectures, post 8vo	0	12	6	*Longman.*
Watson (J.) Theory and Practice of the Art of Weaving by Hand & Power, 8vo	0	10	6	*Kent.*
Wayland (Francis) Elements of Moral Science, Notes by G. B. Wheeler, cr. 8vo	0	2	6	*Tegg.*

Proceedings of Societies.

THE TORONTO MECHANICS' INSTITUTE.

The pupils of the various classes, and members and friends of the Institute, to the number of about six hundred, celebrated the close of the *class session* on the evening of the 15th ultimo. After tea in the Lecture Room, the company adjourned to the Music Hall, in the gallery of which the "Queen's Own Rifles" band was stationed, when the chair was taken by the President of the Institute, Rice Lewis, Esq.

The Chairman of the Class Committee, Mr. D. G. Carnegie, in addressing the meeting stated that seven classes had been in existence for a term of five months, and had numbered in all one hundred and fifty pupils. The subjects of study were English Grammar and Composition, Arithmetic and Mathematics, Book-keeping, Penmanship, Architectural and Mechanical Drawing, and Figure and Landscape Painting and Drawing. The sum of $116 had been offered in prizes, $100 of which had been liberally presented for this purpose by the Directors of the Northern Railway, in addition to the right to nominate from the classes two apprentices to the machine shops of the Company.

The various prizes, in appropriate books, were then presented to the successful competitors by his Worship the Mayor, as follows:—

Ralph Lillie	1st	prize	English class, value	$10 00
W. Ault	2nd	"	" "	6 00
J. A. Milne	1st	"	Bookkeeping "	10 00
W. Langley	2nd	"	" "	6 00
W. Graham	1st	"	Mathematical "	10 00
A. Cook	2nd	"	" "	6 00
J. Purcell	1st	"	Penmanship "	10 00
W. W. Willis	2nd	"	" "	6 00
A. Greenlees	1st	"	Mechanical Drawing	10 00
T. Cheshire	2nd	"	" "	6 00

William Marling, having passed a very satisfactory examination in English, Arithmetic, Mensuration, Mechanical Drawing and Geometry, was presented with a Mechanics' Institute Diploma, a prize of $12 in books, and one of the apprenticeships of the Northern Railway. Henry Crompton, for proficiency in Mechanical Drawing, was presented with a prize of $6 by the examiners. Honourable mention was made by the examiners of the attainments of Thos. McQuillan in Penmanship, Richard Woodsworth in English Grammar and Composition, Samuel Butt and J. B. Whitney in Mathematics, and Henry Doane and Wm. Forbes in Mechanical Drawing.

* "His Worship the Mayor then addressed the meeting, complimenting the citizens of Toronto upon the possession of so valuable an auxilliary to our educational institutions as the Mechanics' Institute. He dwelt upon the various subjects taught in the classes, showing the benefits to be derived from them by those who had not acquired a good education in their school-boy days, expressing the hope that the prizes now presented might induce many more in future seasons to enter for competition.

"The Chairman then called upon the Rev. Dr. McCaul to address the meeting. Dr. McCaul had formed one of the Board of Examiners, and could speak with all the more freedom respecting the attainments of the various candidates. They had done well, their answers to the various questions were very creditable, alike to themselves and to those who had taught them. He was only sorry that Dr. Connon, the other examiner in the English class, was not present. He had, however, expressed himself highly pleased with the answers to the questions which he had put. The Rev. Doctor made an eloquent and impressive address, and was frequently and heartily applauded.

"Mr. F. W. Cumberland was next called upon, and was received with loud and prolonged cheering. He made a pertinent and forcible address, and with so much humour as to keep the audience in roars of laughter. He had very great pleasure in listening to the Rev. gentleman who had just sat down, but he had stolen his speech, nevertheless. He (Mr. C.) had come there prepared to address them, but his Rev. friend had completely taken the wind out of his sails. He was, however, very much gratified to hear of the progress made by the pupils of the classes. The Directors had stated right: nothing was more necessary, and he hoped that the results would be commensurate with the efforts they had put forth. Mr. Marling, to whom the apprenticeship to the Northern machine shop had been awarded, had before him many great and good names, whose achievements and whose honours might well inspire him with industry in the calling which he had chosen, and he wished him every success."

The several Directors of the Institute then ascended the platform, when the following address, read by Mr. Ralph Lillie, was presented to them, and suitably acknowledged by the President.

To the Board of Directors of the Toronto Mechanics' Institute.

Gentlemen,—The classes in connection with this Institute, which have just completed their winter term of instruction, embrace with pleasure this most fitting occasion for giving expression to their grateful appreciation of the liberality and public spirit which prompted you to the formation of those classes.

The deficiency has often been keenly felt and lamented by many when placed in certain positions in life, who, either from accident or from the want of a proper appreciation of the value of learning in schoolboy days, have failed to acquire that requisite knowledge which is one of the great guarantees of success. On this account we feel all the more lively sense of what you have done in providing, at terms which place it within the means of all, instruction in the more essential branches required by the mechanic, the artizan, the clerk, and the man of business. This boon has been enhanced to us by the addition of comfortable class rooms, liberal prizes to excite emulation, and more important than all, the engagement by you of teachers second to none in the city in their several departments, and who have to us proved themselves so earnest and efficient. It is exceedingly gratifying to us to have this public opportunity of acknowledging our obligations to each and all of the teachers under whose instruction it has been our fortune to be placed.

The pupils of the English class under the charge of Mr. Richard Lewis will ever entertain towards him a sense of the liveliest regard. His most earnest desire has been to infuse into the minds of his scholars some of that knowledge of, and enthusiasm for, our own mother tongue with which he himself is animated.

The pupils of the Bookkeeping and Writing classes under Mr. W. R. Orr give spontaneous testimony to the benefits derived from his instructions in those two business acquirements so eminently indispensable to the success of the merchant.

The pupils of the French class under the charge of Monsieur Pernet acknowledge the efficiency of their instructor. A stranger to all or most of them, his abilities as a teacher and master of the French language have inspired their confidence, and his suavity has won their esteem.

The Mathematical class under Mr. Huggard also acknowledge their indebtedness to him for his instructions in the different branches of mathematics, in which he has shown that he has equal abilities for imparting to others that which he acquired with so much honor to himself.

The Architectural and Mechanical Drawing class under Mr. John Tully are gratified to have this opportunity of testifying their appreciation of his instruction in an art so essential to all who practice the mechanical trades.

Lastly, the Ornamental Drawing class conducted by Mr. H. Martin thank him for his instruction in an art so useful and also so fascinating. They feel that they cannot by their word add anything to the reputation he so deservedly enjoys.

It gives every member of the classes the greatest pleasure to learn that, while acting in such a liberal and public spirit, the Board of the Institute, in carrying on the classes, has not been at any pecuniary loss; and they can heartily say, in con-

* *Globe.*

clusion, that the efforts put forth by this Institute as a public educator have proved it to be what its name implies—a people's Institute—and have given it a fresh hold on the public for support.

"This closed the programme, so far as referred to the classes; the remainder of the evening was very agreeably devoted to reading, recitations, and music, the whole closing with "God Save the Queen," by the Band,—and the delighted audience broke up, hoping that this may not be the last opportunity they will have of meeting the members and friends of the Toronto Mechanics' Institute.

FIG. 1.

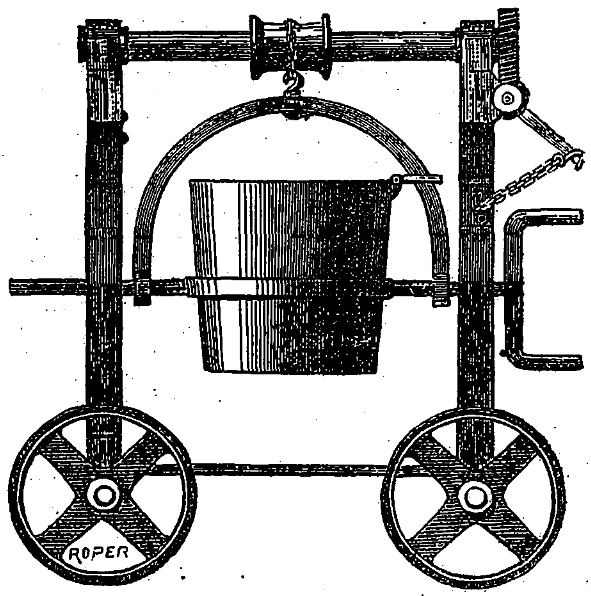
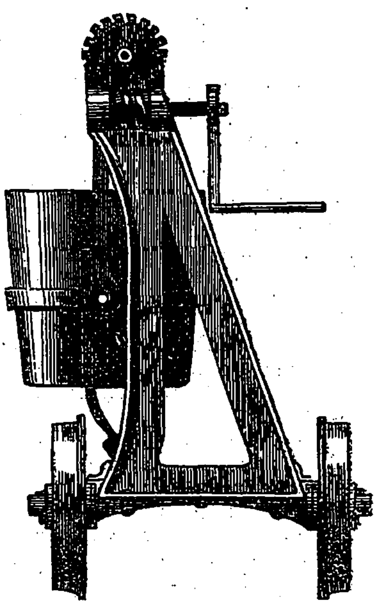


FIG. 2.



SMITH'S FOUNDRY LADLE APPARATUS.

This invention, patented by Mr. H. Smith, of the Teesdale Iron Works, Stockton-on-Tees, has for its object improvements in apparatus used when casting iron or other metal. For this purpose a carriage or truck is used with upright end frames suitable for receiving a ladle between them. At the upper part of these end frames there are bearings for an axis, on which axis there is fixed a barrel, on which is wound a chain to which the ladle is suspended, as illustrated in the above engravings. The axis is arranged nearer to one side of the carriage than the other by preference, but it can be placed in the centre if required, and the end framings are strongly braced or connected together. On the axis is fixed a screw or worm wheel, which receives motion from a screw or worm on a suitable axis, on which is fixed a handle or hand wheel, by which motion is given to the axis of the screw or worm, and consequently to the barrel, in order to raise or lower the ladle, or it may be raised or lowered by gearing or rachet wheel and lever. To facilitate the tilting of the ladle, the tilting bar is received into hooks or bearings at the two ends of the arched frame or bar which is suspended by the chain on the barrel. The four wheels of the truck, or carriage, are suitable for running on a rail or tramway laid down between the cupola or other melting furnace and the place where the moulds are situated.

Correspondence.

THE ECONOMY OF THE OPEN FIRE.

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

Sir,—I am convinced that much misunderstanding exists with regard to the economy of the open fire. It has been usual with writers upon the subject of heating to denounce the fire as wasteful of fuel; and to accuse the chimney of carrying up the main part of the heat that is generated. Some have estimated the loss as ⅞ of the value of the fuel, others have made the amount greater. My attention is now called to the subject by an extracted paragraph in your April number, in which it is stated, as the result of some experiments in ventilation, made in Paris, that "It appears that nearly the whole of the warmth produced by combustibles in an apartment is carried off through the chimney, and the only useful part of it is obtained by radiation." I do not know what kind of a fire-place the experimenters used; but having facilities at hand, I resolved to satisfy myself, as nearly as possible, by actual weight and measure, of the proportional amounts of heat carried out of the chimney and radiated into the room: also to form an approximate estimate of the amount of heat utilised from a given quantity of fuel, using a fire-place of the best Canadian construction.

Having the fire in vigorous action—being built of 18 lbs. of good bituminous coal—I suspended a plug of ice, of a temperature of 32° Fahrenheit, in the chimney; it was tapered downwards, and occupied one-fifth of the area of the horizontal section of the flue, 18 inches from the top. The object of this was to absorb one-fifth of the heat carried by the ascending current of air from the fire. The temperature of the current was 140° before and during the experiment. I took another block of ice at the same temperature, one of whose surfaces, containing 105 square inches, I exposed to the radiation from the fire 36 inches distant, taking care by means of thorough ventilation to keep the atmosphere as nearly as possible equal to the temperature without, which was about 40°, so that very little effect was produced except by radiated heat from the fire. The result was that the ice in the flue was melted at the rate of 3½ lbs. per hour, that exposed to radiation 3 lbs. per hour, giving the total melting power of the chimney heat 17½ lbs. per hour. The estimate of the quantity of radiated heat must be governed largely by the position of the fire relative to the jambs of the fire-place. If the fire projected from the jambs so as to present as much radiating surface laterally as it did in front, every 105 square inches of the concave surface of a hemisphere, whose radius was equal to the distance of the block of ice from the centre of the fire, would receive an amount of heat equal to the melting of 3 lbs. of ice per hour. But this is seldom practicable. The one I used had a projection equal to one-fourth of its front length, and as the effect of radiation is inversely as the square of distance, an object to receive the same amount of heat as one in front must be placed at half the distance at the side. I therefore consider that an isothermal surface will be sufficiently nearly represented by that of a spherical segment, the radius of whose base is equal to the distance of the lateral point of equal radiation from the centre of the fire, and whose height is equal to the frontal distance. This in the case before us (the length of the front of the grate being 18 inches) is 27 inches radius of base, and 40 inches height of segment, giving a segment of a sphere of 58 inches in diameter, having a surface of 7,280 square inches, equal to the melting of 207 lbs. of ice per hour, or about 12 times the amount carried out of the chimney.

It is said that there is due from the combustion of one pound of bituminous coal of the best quality, an amount of heat equal to the melting of 92½ lbs. of ice. I estimate that during the hour of my experiment 6 lbs. of coal were burnt, equal to 555 lbs. of ice. I have accounted for 224½ lbs. What becomes of the balance? It is probable that as much heat is conducted through the back and sides of the fire-place as is radiated from the front: but this is not lost, it becomes diffused through the body of the brickwork, and if this is within the building, will be radiated into some part of the house; and if not it may be utilised in furnishing the apartment with warm air, by means of Cardinal Polignac's caliducts, or air flues. Probably the full value of the coal may be accounted for thus:—

	Ice, lbs., Melting power.
Radiated into room	207
Carried out of chimney	17½
Absorbed by brickwork	207
Imperfect combustion, inferiority of coal, &c.	123½
	555

It therefore appears that the chimney of an open fire does not carry off such an enormous quantity of heat as we have been led to suppose; and I think we may enjoy its brightness and cheerfulness without that consciousness of waste which we have been wont to entertain Moreover, I think it will be ultimately established that heat vibrations emanating from sources of high temperature, have a greater physiological value than those from lower ones. They probably more nearly harmonise with, and are more readily convertible into vital force, and this may be the cause of our instinctive appreciation of the rays of a glowing fire, and our still greater enjoyment of those of the sun.

Yours respectfully,

Toronto, April 30, 1863. W. H. Sheppard.

Selected Articles.

CHATHAM DOCKYARD, AND THE TRANSFORMATION OF THE BRITISH NAVY.

The cost of these works for land defences are estimated at £1,350,000. They would mount 335 guns, and would require barrack accommodation for 3,550 men.

The "transformation of the navy," to use the euphemistic term in vogue for the substitution of iron for wood in the construction of men-of-war, has effected a radical change in the economy of Chatham Dockyard. The state of transition in which everything appears, the results of tantalizing essays that are to be met with here and there, show how great has been the change, and how laboriously it has been effected. Six timber ships are on the slips—the "Salamis," the "Myrmidon," the "Rundere," the "Belvidere," the "Berlinda," and the "Menia." On some there are perhaps half-a-dozen shipwrights at work on each; on the others none, and they are left to the care of a ship. Two covered slips of the most recent construction, by Gressel and Co., in 1856, are unoccupied, and from one of them, the "Royal Oak," now plating with armour in No. 3 dock, was lately launched. The timber-floating basin looks desolate, the mast houses abandoned, and the whole activity of the yard appears concentrated on the two armoured ships which are in the process of construction, and in the shops where their component parts and plates are being shaped and fitted.

Entering the yard we pass storehouses and workshops that give out no signs of life under the change, and the slips where a despatch vessel and other small craft are standing. Next is No. 1 dock, built for the reception of small vessels, but which has been covered on a level with the soil, and roofed over to serve as a fitting shop for the "Achilles," iron ship, which is building in the dock No. 2 alongside. It is here that the frame of the ship is prepared and fitted in parts before being built up. The frames, which answers to the ribs of timber ships, are composed of bars of angle iron, from ⅝ to 11-16ths of an inch thick, riveted together and bent into the desired shape. For this purpose a modern mould is made to each frame—that is to say, thin boards are sawn out to represent in their convexity the sectional lines of the ship. On the floor of the shop is the "levelling plate." It consists of massive iron blocks, pierced with numerous holes disposed quincancially, and solidly bound together to form a levelling plate of sufficient thickness. Opposite and close to one end is a pair of hot air furnaces for heating the angle iron. They both communicate by flues with one chimney, and other arrangements are adopted to ensure an economy of fuel, as well as the uniform and quick heating of the bars of angle iron. The furnace itself is at the end opposite the door, and in one case there was a furnace in either of the longitudinal sides. The heat and products of combustion pass from the furnace over the brick bed on which the bars are placed, and escape by a return flue to the chimney. The brick roof being arched, throws down the heat upon the iron. When the bar has been raised to the requisite temperature it is withdrawn, and laid on the levelling plate, whereon the sectional line or form of the set has been previously marked by pins inserted in the holes of the levelling plate. Then with hammers, tongs, and hand-spikes, the bar is rapidly bent to the required form. The turning up the portion resting on the plate is remedied by flat-headed punches, fastened to long withy handles, held by workmen, while others strike the punches on the head with huge sledge hammers until that portion of the bar is levelled. It cannot fail to strike the spectator that this mode of curving the frames is unnecessarily tedious, costly, and requires a degree of human labour unsuited to the inventive genius of the age—so fertile in contriving labour-saving machines. There can surely be no difficulty in devising a machine which would roll the bar to the sectional line in one operation, and in no more time than it takes to write this sentence. If a pair of rollers—one vertical to bear upon the portion of the bar resting on the levelling plate, and the other horizontal, to bear upon the upright portion behind, which are the pins—were placed in connection with a mechanical arrangement which would make them follow varying curves—an arrangement, in fact, something of the character of a pentagraph—then the operation would be simplified, and more expeditiously performed than now, when a dozen or fifteen men are required to bend a bar by dint of sledge hammering, for then all that would be required would be a sufficient number of hands to draw the bar from the hot-air furnace by an overhead traveller, and to arrange the pins according to the curve, while one man at the other end of what, for lack of better name, must be called a pentagraph, would suffice to cause the rollers to travel in the curve of the sectional line, as will be easily understood. It matters not whether this or any other mode be adopted of rolling the bars of angle iron into any curve that may be required; the essential point is to introduce machinery to shape the frames so that they may be more accurate, take less time in their production, and cost less money.

Each frame or rib is composed of two or more bars of angle iron, held together by "boiler riveting," so as to support the iron skin, teak backing, and armour plates on the outside, and supports for the planking inside. The frames for the stem and stern are more complicated, and composed of a greater number of bars, but the system of construction is the same; the rivet holes in the frames are punched out by the ordinary machinery, and the rivets are hand-fastened while cold, and this, although Fairbairn claims for machine-riveting a superiority of from 4 to 5 over hand-riveting. When finished so far, the frames corresponding are temporarily fitted together, and the parts carefully adjusted; after which they are placed in the positions they are permanently to occupy—the ship being built in sections. The beams are of iron rolled into the shape of double flanged girders. The combination of angle iron undoubtedly gives frames of great strength, but still, to the eye, a thickness of ⅝ of an inch appears slight when we remember the enormous weight they have to bear of armour plates, teak backing, skin, and outside planking. True, the frames are very close, and so would compensate for their apparent slightness.

The next point of novelty and interest is the preparation of the armour plates and their fixing to the ship's sides. They are manufactured by the Thames Ship-building Company, and are said to be superior to all others in quality, homogenity, and toughness, that have been sent in from the great centres of iron manufacture. If so, and there appears no reason to doubt the statement, the fact is noteworthy, as showing how good workmanship will overcome the disadvantages of increased cost of labour, raw materials, and fuel. As compared with northern iron manufactures, the Thames Company pays double the price for fuel, a fifth more for wages, high rent, and the carriage on raw material; while from the north the carriage is paid on the manufactured product. To judge from their working, the plates are of an unusually excellent quality. Their weight averages 3½ tons, including the large ones for the broadsides, and the smaller ones for the bows and quarters. The thickness of the first is 4½in., while the second, which present oblique surfaces to shot, are less.

The first step to putting on the ship's armour, above the iron skin, bolted to the frames by hot rivets, and a teak backing, 8 in. thick, overlaying the the skin, is to take a mould of the curved surface of that portion of the ship's side to which the armour plate is to be adapted. These moulds are taken in thin planks for the horizontal and vertical curves—that is to say, for the curves to be given to long and short sides of the plate. A number of wrought-iron bars, longer than the width of the plate, of about 5in. thick, and 3 in. broad, are bent to the vertical curves of the ship's side, which the plate is to assume, in order that it may fit closely to that portion which it is intended to protect. In front of a hot-air furnace is the bending cradle, which now first devised for shape the armour plates of the floating batteries constructed for the attack of Russian maritime fortresses during the late war. The cradle consists of two vertical and parallel open frames—pierced with numerous holes in the upper half—each of the length of the plate, and set apart a distance equal to the width of the plate. The open frames consist of a number of wrought-iron slabs, somewhat more than 3 ft. high, 8 in. wide, and 1 in. thick. The space between each two is equal to that of the shaping bars. The slabs have a double flange at bottom, by which they are securely bolted, in a vertical position to the bed plate, and a flange on the inside at top, to which a longitudinal slab is bolted throughout the entire length, to give increased rigidity to the frames, and at the same time to serve as *point-d'appui*, against which wedges are driven to force the armour plate down. At about the centre is another longitudinal slab, on which the ends of the shaping bars rest, and which is capable of adjustment, to give the required curve to one side of the plate. The longitudinal slabs, and cross or shaping bars being arranged according to the mould taken from the side of the ship the armour plate is to cover, the latter is withdrawn red-hot from the hot-air furnace, opposite and close to one end of the cradle, and laid upon the shaping bars. Immediately other bars are introduced above the plate, but below the longitudinal slabs, and with their ends passing beyond the spaces between each two of the vertical slabs. Wedges are next driven in between the tops of the upper bars and the bottom of the longitudinal slabs, until the armour plate is bent down to the curve required. The driving in of the wedges is tedious and laborious in the extreme. On either side of the cradle are iron rammers, weighing each about 600 cwt. They are balanced and suspended from the centre by chains attached at top to rings which are free to travel along horizontal iron rods over head. The rammers are worked by men horizontally in pairs, and against the wedges over the ends of the same bar simultaneously, so that the plate may be forced down gradually. Were all the rammers worked at the same time, as they should be, and with a minimum of four men to each, it would require twenty-four men to bend a plate in one heating. If this be persisted in, which we do not think likely, there is no reason why the wedges should not be driven in by moveable steam hammers, working in a horizontal plane.

The inventive facilities of our engineers are surely equal to devising some mechanical means to bend the armour plates, whereby human intelligence will be all that will be required to direct the force of steam. Whether it be by steam hammers travelling over the armour plate laid in a compound bed plate capable of being adjusted to the required curve, only adjustable rollers passing over the surface of the plate, in manner similar to the one above, or by a series of hydraulic presses with adjustable surfaces, that the problem will be solved, we know not, but we feel confident that it will be solved, and are strengthened in this belief by the fact, that an invention made at Plymouth, for effecting this object, by a series of hydraulic presses, and that an officer of the Admiralty has been despatched to examine and report upon it. However, the system of shaping cradles, which was employed to bend the plates of the "Warrior" and "Resistance," admits of the plates being bent to within ¼-inch of the required curve. Since the "Warrior" was plated, further advance has been made to accuracy, and the plates are now curved to fit quite close to the ship's side. For this purpose the plate, after it has been in the shaping cradle, is removed to a hydraulic press of peculiar construction, made by Messrs. Westwood, Baillie, and Co., and capable of increasing a pressure to 2,000 tons. The bed plate, so to speak, is carried above the piston by two pairs of stout cylindrical standards, having screws cut on the upper parts and fitted with nuts to admit of the bed plate being adjusted to any required height. The armour plate (cold) is carried in slings when not resting on stout wooden rollers; two on either side of the press, whereby it is shifted two and fro between the bed plate and piston. The workman is provided with moulds exhibiting the curves to which the plate is brought. Then, by blocks and sheet iron of various thicknesses, which he places between the armour plate and bed plate, he blocks up the first to the required curve, using the portion of the hydraulic press to bulge out the plate, as it were. After this the plate is carried to a horizontal planing machine, where the longitudinal sides are planed to obtuse angles, one entering and the other projecting, so that the plates may fit accurately to one another and hold fast together. The "Warrior's" were, we believe, tongued and grooved, and plates of this form may be seen in the yard; but the arrangement of angulated edges is undoubtedly the best. The ends of the plate are planed straight in vertical planing machines, and particular holes on two ranks are drilled in the plate if it be of the largest size. Instead of being cylindrical, the holes are conical, or diminishing in diameter from the outside to the inside, so that a considerable amount of the strain is transferred from the heads of the bolts, which are countersunk, to the whole of that likewise conical which hold in the thickness of the plate. Then the plate is carried on a horse to the side of the ship, where it is lifted by a pontoon steam crane, which travels fore and aft on a tramway alongside the deck, each on one side. In this position the inside of the plate is daubed over with red paint, and then lowered on to spars or inclined guides, down which it slides, and is applied to the part it is to protect. Afterwards it is removed to ascertain from the marks left by the red paint if it fits accurately. If it does not—and it very rarely fits the first time—the plate is carried back to the hydraulic press to be operated on again and again until the exact curve is attained. When this is done, the plates up to the walls are coated on the inside with tar, and fixed to the ship's sides with tarred felt. Above the walls, dry felt is used, and the plates are not tarred. The bolts which hold the plate are 1¼ in. in diameter, and look too slight to hold so great a weight as they will have to do in a rolling sea. But when it is remembered that Mr. Edwin Clarke deduced, from experiments made in connection with the Britannia-bridge, that it would require 24 tons to shear a rivet of 1 square inch sectional, it will be seen that the bolts which have a sectional area are nearly double; 1·76 in. are ample. Mr. Fairbairn gives something less; but taking the very minimum, there can be no fear of the plates shearing or dragging the bolts unless the elasticity of the timber back should, in the course of time, allow of too much play. The bolts are provided with screws on the inside, and nuts, so that the plates could be tightened. Nevertheless, the system of fastening receptacles is the weakest point in the whole method of construction. Both the "Achilles" and "Royal Oak"—the iron and timber ships—are plated in the same manner, and certainly nothing can surpass the workmanship. The plates are close home, and fit to one another with the greatest accuracy. They require no caulking or cement to hide the seams, like the "Warrior's." Plated from stem to stern, these new ironsides are a great improvement on the "Warrior," and their sides as smooth and sightly looking as any timber ship, with the exception of the sterns. The stern of the "Achilles" is not yet up, but that of the "Royal Oak" is as ugly as it is possible to imagine. It resembles nothing so much as the stern of a dummy at any of the landing piers on the river. It doubtless has its use, though it must prevent fire from the main deck in the same vertical plane as the keel—a faculty not to be despised in a stern chase. What makes the workmanship of the plating so noteworthy is that it has been executed by shipwrights. Some time back the engineers, to the number of 90 struck work. They were allowed to go, and their place supplied by shipwrights, who were doubtless glad of the chance, for they saw their trade threatened with extinction, consequently they took to their new trade with a will. In a couple of days they could drive rivets as fast and as well as a regular boiler-maker, and they may be now seen sledge hammering, punching, drilling, planing, and shaping iron, as if they had never done anything else all their lives. The lesson is a useful one, both for men and employers. It shows that among intelligent workmen the division of labour need not preclude the atainment of proficiency in several branches of handicraft by the same individual.

The stern post of the "Achilles" is a magnificent forging, and a marvel of Cyclopean working in iron, but its very massiveness and weight fills the visitor with apprehension for the safety and durability of the ship to which it is to be fixed. Placed at the extreme end of the keel, and as far as possible from the fulcrum, it must exercise great leverage, and shake the ship terribly in foul weather. So forcibly does this idea take possession of the mind, that one is disposed to ask whether it would not be possible to build the stern-post cellular fashion, of thick plates riveted together, and stiffened by stays and braces inside; or whether it is absolutely necessary the stern-post should be rectangular in construction; might it not be cylindrical and constructed after the fashion of Captain Berkeley's guns—*i. e.*, of tubes shrunk in one over the other until the requisite strength and stiffness are obtained?

THE WIDNES SOAPERY, NEAR WARRINGTON.

In continuation of our series of reports upon the manufacturing establishments engaged in the production of articles which are furnished to the public through the medium of our special patrons, the grocers, we have lately availed ourselves of an opportunity to extend our inspection to that part of the kingdom (Lancashire) in which the manufacturing industry of our countrymen has taken a development previously unexampled in this or any other country; and, although the great staple production of this county is at present in a state of depression, from which all must suffer, we trust this cloud will quickly pass away, and that our friends in that district will soon find the consumers of their articles restored to them as independant customers.

We commence with a report upon the soap works of Messrs. William Gossage and Sons, and shall follow this up at intervals by descriptions of other interesting establishments in the neighbourhood.

We had the good fortune to be conducted over this establishment by the junior partner, Mr. F. H. Gossage, whose whole time and attention are devoted to the manufacturing department of the business. We received from this gentleman the most complete details of the different operations, evidently explained to us with the desire that they should be fully comprehended. We were informed that the works, as a soap manufactory, were commenced on a small scale in the year 1855 by the head of the firm, Mr. Gossage, sen., whose long experience as a manufacturing chemist is well known, and whose position in this capacity was fully recognised by his being selected by the Royal Commissioners for the important appointment of Juror to assist in deciding upon the relative excellence of the various products submitted to the Chemical Class of the recent International Exhibition.

In the year mentioned, the war between our country and Russia was raging, and, as a consequence, the value of all kinds of fats and oils used in the manufacture of soap was greatly enhanced. Mr. Gossage directed his thoughts to finding a substitute possessing some of the properties of Russian tallow, and thereby decreasing to some extent our dependance upon Russia for a supply of this article. Mr. Gossage found that the compound known as soluble glass, or silicate of soda, was possessed of high detergent powers, and, when prepared and applied in a suitable manner, it proved to be a highly valuable compound for combining with ordinary soap. It was explained to us, that this compound is analogous, in several of its properties, to soap made from tallow and soda inasmuch as ordinary soap is a substance in which the alkali (soda) is held in a state of weak combination with tallow, and, therefore in a condition to exercise its well known cleansing power. In the like manner, silicate of soda is a compound in which soda exists in a state of weak combination with silica, thereby retaining its cleansing power, just in the same manner as it does ordinary soap. Mr. Gossage, having satisfied his mind of the correctness of these facts, devoted his attention to the means of preparing the silicate of soda of proper quality, and to the best manner of combining this with ordinary soap, so as to produce a compound soap at a greatly reduced cost, yet retaining equal cleansing power with the best tallow soap, and which should be suitable in all other respects for the ordinary uses for which soap is required. Mr. Gossage, having accomplished these objects, obtained a patent in 1855, and has since taken out other patents for subsequent improvements in the mode of working. Judging by the large quantity of this kind of soap which we saw in process of manufacture, as well as being forwarded from the premises, we may assume that the public has given the best of all approvals of the value of the articles so produced. This judgment of the public has also been corroborated by the award of a prize medal at the International Exhibition, by the Jurors of Class IV., for excellence in quality of the soaps exhibited by William Gossage and Sons.

We will describe briefly the process by which the very curious article "soluble glass is produced. The apparatus employed for this purpose consists of a large reverberatory furnace, in which are melted together certain proportions of fine white sand and dry carbonate of soda (soda ash) of best quality. Each charge weighs about 25 cwt., and requires six hours of very strong firing to effect its fusion and perfect combination of the materials. The melted charge is then withdrawn by opening a "tap-hole" in one side of the furnace, and it runs out as perfect glass. We were shown various articles such as decanters, vases, &c., blown and moulded from this glass and were not a little surprised when informed that these were soluble in water. The lumps of glass thus obtained are transferred to large vats, in which they are exposed to the action of boiling water, and the solution produced is run off into boilers, to be concentrated to a suitable strength for transport to other soap manufacturers. On examining and making trial of this solution we found there was "no mistake" in attributing to it the cleansing power claimed for it by Mr. Gossage.

Our attention was next directed to the alkali department, where the rough soda is prepared, from the solution of which is obtained, by purification and caustification, the alkaline lyes required for the manufacture of soap. (We shall have occasion to add the "soda manufacture" to the number of our reports, and will, therefore, reserve our description of this important chemical manufacture.)

We were shown a very ingenious and exceedingly simple arrangement by which the rough soda liquors are purified, and rendered suitable for the soap manufacture. It appears that the impurity in these liquors, which affects the colours and quality of the soap produced by their use, consists in a compound of sulphur, and this compound of sulphur, can be neutralised or rendered innocent by the action of atmospherical air. The knowledge of this fact was useless, until means were devised by which the rough liquors and air could be brought into intimate contact with each other. Mr. Gossage hit upon the happy thought of distributing the rough liquors over the innumerable surfaces presented by pieces of coke contained in a high tower, at the same time that atmospherical air passed through the tower. We saw the very impure liquor being supplied at the top of the tower, and flowing out from the bottom in a state of purity, the only agent employed being atmospherical air, which applied itself to its work of purification without any trouble or assistance. Truly this is simplicity itself! Mr. Gossage obtained a patent for this invention in 1853, and it has been adopted under license from the patentee, in many other soap manufactories.

The purified liquors are then treated with lime to deprive them of carbonic acid, and the caustic lyes thus obtained are run off for use. We were shown in this department of the works, another of Mr. Gossage's patented inventions. It is well known that the soap manufacturer requires a large supply of steam for boiling the contents of his soap coppers. This has heretofore been obtained by the evaporation of water in steam boilers. It is also a fact, that it is a desideratum with the soap manufacturer to be suplied with more concentrated lyes than he obtains from his caustisizing process. These he has hitherto obtained by concentration with special consumption of fuel. Mr Gossage has combined these two operations into one, by supplying his steam boilers with weak lyes, and applying the steam produced to boil the soap; and when the lyes become sufficiently concentrated, these are raised by the pressure of steam to a reservoir sufficiently elevated to supply the soap-pans. Thus, an important economy of fuel and a great convenience in the manufacture are simultaneously obtained.

Having now become somewhat familiar with the preparation of the alkaline solutions, or soda lyes, used in the manufacture of soap, and which solutions furnish the real detergent agent of the soap itself, inasmuch as the tallow, oil, or other material of this kind, is simply a vehicle for applying the soda to produce its cleansing effect in the most convenient manner, we were introduced into the boiling-house of the soap manufactory, where we found ten large soap coppers, arranged in one line, each of them being provided with pipes and troughs, by which melted tallow and oils were supplied to the coppers by engine power, and other pipes through which steam is introduced to effect the boiling of the soap; also other appliances by which the spent lyes are run off from the soap coppers without the usual labour of pumping.

Here again we found another of Mr. Gossage's many patented inventions. This consists in certain means, by which engine power is applied for transferring finished soap from the coppers to the frames or moulds for cooling. The method heretofore ordinarily employed for affecting this object has been by means of manual labour—a workman using a large scoop or ladle, and, by main strength lading out the finished soap from the copper and pouring it into buckets, which, when filled, were carried by a number of other workmen, and their contents emptied into frames, necessarily distant from the soap coppers. In this way, "to cleanse" a large boil of soap, probably twenty workmen would be required for three or four hours. Messrs. Gossage and Sons effect this operation in the simplest manner. They have adapted an iron lid or cover to each soap copper, which by means of a rope or band of India-rubber, can be made to effect a perfect closing of the upper part. They have also an iron pipe which passes through the cover, and extends nearly to the bottom of the copper.

The upper end of this pipe is sufficiently high to deliver into troughs, which extend into all parts of the framing room. To the upper part of the copper is also adapted a pipe, through which air is passed by means of a force pump worked by the steam engine, As the pressure of air, proceeding from this force pump, accumulates on the surface of the soap in the copper, the soap is elevated through the iron pipe, and escapes with much velocity as, from a powerful fountain, flowing into the troughs which convey it directly into the frames. In this way, with the attendance of only three workmen, as much as twenty tons of soap can be transferred from a soap copper into frames, at the most distant part of the house, in 20 minutes.

It would be useless for us to attempt to convey a technical knowledge of the manufacture of soap. This is an operation which, since the removal of the obstructions presented by the former Excise regulations, has been greatly advanced by the application of chemical science; in fact, it has become a chemical manufacture, and its success as a commercial pursuit, must be greatly dependant on the amount of practical science applied to the accomplishment of its details.

At the establishment of Messrs. Gossage we found that they were engaged in the manufacture of the various soaps used for domestic purposes. We were particularly attracted by their low priced scouring soap, and their "blue mottled soap." We recognised the latter as an old acquaintance, from having seen their specimen, as a handsome obelisk, at the International Exhibition, and subsequently at the South Kensington Museum. The perfection of form which this specimen still retains, after an exposition of nearly twelve months, may be regarded as an indication of its quality.

Messrs. Gossage have concluded to prolong the recollection of the Exhibition obelisk by providing their friends with *fac-similes* of this, on a reduced scale, enclosed in glass shades. By means of a few simple appliances and the use of ordinary carpenter's tools, they have succeeded in producing very creditable specimens of sculpture, carved out of blocks of their blue mottled soap.

In this department we were also shown some very efficient means by which bars of soap were divided, with great accuracy and quickness, into pounds and half pounds, which, being wrapped in printed covers, were ready to be supplied to their customers.

We have now cursorily described the means and appliances by which soap is manufactured at the Widnes Sopery. Judging by the statement, that these works have sprung up within seven years, from a very small commencement, to rank in capability of production with the largest houses in the kingdom, we may take it as an accepted fact, that their productions have merited the approval of our friends the grocers.

In conclusion we made a general survey of the position of this manufactory. We found it placed on the banks of the river Mersey, at Runcorn Gap, by means of which river, cheap communication is provided with the important port of Liverpool, from whence supplies of oils and tallow are obtained also, that a line of rails, from the London and North-Western Railway, is extended into every part of the works, by which coal is laid down at the furnace mouths, and the greatest convenience is given for the reception and transmission of goods; in fact, we saw the railway trucks actually within the packing-room being loaded with boxes of soap. A ship canal also forms one of the boundaries of the premises. In these respects it appears to us the works of Messrs. Gossage and Sons are particularly well situated for the transaction of an extensive business with the greatest practical economy.—*Grocer.*

CITY AND TOWN SEWERAGE.

We copy from the *Mechanics' Magazine* a few extracts on the subject of City and Town Sewerage, elicited during a discussion before the Institution of Civil Engineers, London, "on the drainage of Dundee," and "on the sewerage of Newport."

The question of *proper construction and ventilation of Sewers* is one of vast importance, not only to our municipal authorities, but to all residents of thickly inhabited localities.

In the course of the discussion "it was urged that it was dangerous to lay down a system of sewers over an entire town, without in the first place providing, as part of the scheme, for the fullest and freest ventilation particularly at the highest levels; and that care was specially necessary in towns presenting naturally steep gradients. Disease had broken out in well-sewered districts, which was traced to the connection of the house drains with unventilated sewers; the highest portions of the town suffering most severely. If the sewers of Dundee were sweet, it would lead to the inference that they must have been badly constructed, and that there were joints and crevices which let out the gases; for with a perfectly tight sewer, the gases must rise to the upper extremity, and escape into the houses through the house drains.

"It was thought that the sections of the Newport sewers were of the most approved forms, and that the bricks employed there were admirably adapted for the construction of such sewers with economy. But it was contended that there was no advantage in building brick sewers sufficiently large for a man to pass through, unless those dimensions were required to discharge the sewage flowing into them. In every instance where there were two rings of brickwork in the invert, there should be two rows of "headers" at or about the springing, so as to bond and tie the work together where the arch commenced.

"In a hilly town the whole system of sewers should not be so connected together as to allow of the accumulation of the sewage gases in the higher parts of the district. Where the gradient was steeper than 1 in 200, and a sewer was one mile in length, it should be divided by steps or falls, and there should be a flap valve upon the upper or discharging end of the sewer, and at least two street grates at this point, so as to ensure thorough ventilation. Where the sewage was discharged into a river, having a low summer level and a high flood level, it was not always practicable, or desirable, to carry the whole of the sewage in flood down below the summer level. In such cases the arrangement adopted at Windsor Castle might be followed. Formerly a large brick sewer discharged itself into the Thames, close to the Queen's private walk, and was a source of nuisance. By fixing a cast-iron pipe at the bottom of the sewer, and putting a slight dam in front of the junction, all the ordinary sewage was discharged by the iron pipe below the summer level. The brick sewer took away all the storm waters, which could be passed into the river with impunity, as they would be in extreme dilution, and the river itself would be in flood.

"It was stated that the invert of the main outlet sewer at West Ham, which was 4 ft. 6 in. in height by 4 ft. in width, was laid for about half-a-mile at the level of low water of spring tides, and then for 2½ miles with a fall of 3 ft. per mile. The surface of the ground was from 10 ft. to 12ft. below high water in the Thames, and the subsoil was so porous, that when the trench was excavated the water could not be pumped below a certain level. A cast-iron invert was therefore devised, and upon it cement blocks were laid to above the water line; the other portions of the sewer being built in the ordinary way. About three miles of that sewer had been in use for nearly two years, and no difficulty was found in keeping it clean, although the velocity of discharge was mainly that due to the surface gradient, or head.

"As the question of town sewerage was of daily increasing importance, the principles which should be adopted might be briefly stated. Every sewer should be straight from point to point, and at every change either in the line or the gradient, there should be a manhole or a lamp-hole, affording means of access to the sewer, as well as providing ventilation. A cesspit should be formed at the side of each of these ventilating shafts, to catch the detritus from the roads; and the gully grate and entrance should be over it, and not directly above the crown of the sewer, as was the case in some parts of the metropolis. Between the side chamber and the shaft charcoal filters should be fixed, so as to deodorise the foul gases before passing into the streets. Sewers of unequal dimensions should never be level at the inverts; it was safer as a rule, that they should meet at the crown. In the former case, the larger sewer would dam back the sewage in the smaller tributary, and prevents its being flushed out At Carlisle the main sewer had a fall of 1 in 700 for a mile and a quarter. It was frequently liable to be flooded, and at times the water line was from 18 to 20 feet above the level of the invert. That sewer had been in operation for six or seven years without requiring any outlay for cleansing. At every manhole there was a groove in the brickwork to receive a stop-plank, by which the sewers could be flushed out in sections, either by accumulated sewerage, or by the admission of water from the water works.

"It was remarked that the sewers on the south side of the River Thames were all provided with ventilators, having side-pits which prevented stones and mud from entering the sewers.

"With reference to the question of cleansing sewers, it was thought that the method adopted at Dundee was complicated and expensive; and that if a greater fall had been given to the sewers, and a supply of water had been obtained occasionally, as required, from the water company, both the first cost of the works, and the working expenses, would have been reduced. The plan pursued in the metropolis was simpler and cheaper. In the pipe or sewer a valve was fixed, which could be kept closed until a head of water accumulated; when this valve was opened, the rush of water cleared away any deposit, including macadamised matter and stones.

"It was contended that no system was perfect which permitted accumulations in the sewers; for if the velocity of the flowing sewage was insufficient to prevent the deposit of sand, grit, or other insoluble substances, such matter ought not to be allowed to enter the sewers, and by suitable gully traps this could be easily prevented. Street gullies should be so constructed as to prevent the entering of road detritus into the sewers, and to arrest the escape of noxious effluvia, while at the same time they should provide for the admission of a downward current of air, to aid in the ventilation of the sewer. With reference to the direction of the air passing through sewers, experiments shewed, that it was sometimes with and sometimes against the sewage flow, and that it was not governed either by the velocity, or the temperature, or the direction of the sewage, but appeared to be determined by the various points of ingress and egress, and by the number of gullies and ventilating shafts.

"There was still a diversity of opinion as to the proper size of sewers; but it was believed that, in ordinary town districts, calculating upon a maximum fall of rain of one inch in half-an-hour, and that it all passed directly into the sewers, the following proportions would prevent silting, if the district was thickly populated, and the house drains were connected with the sewers:—

Diameter of Sewer.	Inclination.	Drainage Area.
Inches.		Square Feet.
6	1 in 50	200
9	1 in 100	400
12	1 in 150	650
15	1 in 200	1,000
18	1 in 250	1,400
21	1 in 300	1,800

"To this it was replied, that no specific rules could be laid down which would apply to every town in the United Kingdom, each of which must be dealt with according to the local circumstances and peculiarities of the case. The character of the outlet, the rate of inclination and the nature of the surface of the ground, the rate and the amount of the rainfall, the number of houses draining into the sewers, the extent of the population, and other things, all required consideration.

"The extension of the main sewerage works of the city of New York, under the administration of the Croton Aqueduct Department, was alluded to, as affording an illustration of the application, to a particular case, of the results arrived at, after the consideration of the facts and arguments which had some years ago been elicited by what was properly known as the "small pipe controversy." The material adopted was brick, set dry, or in hydraulic cement, as the circumstances of the locality required; and the cross section was an eggshape. In determining the sizes of the sewers, the Croton Aqueduct Department assumed that the maximum rainfall on Manhattan Island never exceeded one inch in an hour, and the capacities of the several main sewers were adjusted to provide for that amount, in addition to the maximum prospective house sewage flow of the several districts to be drained. As the streets of the modern part of New York were laid down in right lines—right lines with confluent junctions were adopted for the sewers. The bottoms of the sewers were also as far as practicable, constructed on uniform gradients; but level lines for the bottom of sewers were considered objectionable, as decreasing the hydraulic mean depth of the sewer at the outlet, where it was most needed. Receiving basins for the road detritus, with connecting culverts for passing the water into the sewers, were erected at the corners of the streets, and in other suitable localities, and it was stated that these arrangements were found sufficient to keep the sewers free from any permanent deposit.

"In conclusion, the necessity for the thorough ventilation of sewers was insisted on; and as the only way to render sewer gases innocuous was by a large admixture of atmospheric air, there should be frequent inlets for the admission of air, as well as numerous outlets for the escape of the foul gases. With regard to the fouling of rivers, no doubt by vastly increasing the local burdens upon trade and manufacture, means might be provided for depositing the heavy matters, and for deoderizing and disinfecting the fluid portions of sewage; but such nuisances were, to some extent, the penalty incurred for concentrating the population in dense masses, and it was hopeless to expect, that the rivers in the neighbourhood of large manufacturing towns could ever be restored to their former clearness."

DR. FITCH ON THE GRAIN APHIS, THE ARMY WORM, AND THE WHEAT MIDGE.

The grain aphis made its advent in a most remarkable manner. That an insect never seen before and not known to be present in our country should suddenly be found everywhere in New England, and most of the State of New York, in profuse numbers in every grain field of this wide extent of territory, and literally swarming upon and smothering the crop in many fields, was a phenomenon which probably has no parallel in the annals of science. How it was possible for this insect so suddenly to become thus astonishingly numerous was a mystery which seemed to most persons to be inexplicable. It is the most prolific of any insect which has ever been observed. I find it commences bearing when it is but three days old, and produces four young daily. Thus the descendants of a single aphis will in twenty days amount to upwards of two millions, each day increasing their number to almost double what they were the day before. This serves to account for the surprising numbers which we had of this insect.

The aphis was everywhere supposed to be a new insect, and one writer went so far as to name and describe it scientifically, in full confidence that the world had never before known anything like it. My examination, however, fully assured me that it was identical with a species which has long been known in the grain fields of Europe. And on my announcing this, the erroneous views which one and another were adopted were speedily abandoned.

Our best European accounts of this insect are very imperfect. They only speak of it as occuring in June and July, whereas I find it is present on the grain the whole year round. And when the grain is but a few inches high, if half a dozen of these insects happen to locate themselves on the same plant they suck out its juice to such an extent that the plant withers and dies.

As yet I have never been able to find a male of this species. They are all females. This is proved by placing any one supposed to be male in a vial; next morning two or three young lice are always found in the vial with it. The general habits of insects of this kind are well known. The aphis on the apple tree and other fruit trees, when cold weather arrives, give birth to males. The sexes then pair, and the female thereupon deposits eggs, which remain through the winter to start these insects again the following year. I had supposed it would be the same with this aphis on the grain. I thought, when autumn arrived, I should meet with males and find eggs dropped on the blades of the grain. But there were none. The females and their young continued to appear on the grain till the end of the season. They are everywhere on the grain now, buried under the snow, ready to swarm into life and activity again when the spring opens. And on grain growing in flower pots, on which I am keeping these insects in full activity through the winter, to notice what I can of their habits, no males have yet appeared. When, and under what circumstances this sex will be produced, is a most curious subject, still remaining to be ascertained. It at present looks as through the female and their descendants were prolific permanently, without any intercourse of the sexes.

Last summer such multitudes of parasites, and other destroyers of this aphis, had become gathered in the grain fields at harvest time that it seemed as though it would be exterminated by them. But at the end of the season this insect appeared as common on the young rye as I had noticed it at the opening of the spring. The present indications, therefore are that this aphis will be as numerous on the grain the coming summer as it was the past, if the season proves favourablo to its increase.

As to the *army worm*, it may be remarked that for almost a century it had been known that in this country was a kind of worm whose habit it was to suddenly appear in particular spots in such immense numbers as to wholly consume the herbage over an extent frequently of several miles, and then abruptly vanish, nothing being seen of it afterwards. Thus it was one of the most singular and also one of the most formidable and alarming creatures of this class that was known to be in our world. Yet, what kind of worm this was, and what insect produced it, remained wholly unknown down to the present day. Appearing here and there all over the country the past season, this army worm became an object of the deepest interest and from Illinois on the one hand, and Massachusetts on the other, specimens of the moths bred from these worms were sent to me for information as to what the name of this insect really was.

With regard to the *wheat midge*, I would observe that in this country injurious insects are much more numerous than in Europe, occasioning us far greater losses than are there experienced. A year ago I received from France a vial filled with insects as they were promiscuously gathered by the net in the wheat fields of a district where the midge was doing much injury. It then occurred to me that by gathering the insects of our wheat fields here in the same manner, it would furnish materials for a very accurate comparison of the wheat insects of this country with that of Europe. As the result of a comparison thus made, I find that in our wheat fields here the midge formed 59 per cent. of all the insects on this grain the past summer; whilst in France, the preceeding summer, only seven per cent. of the insects on wheat were of this species. In France, the parasitic destroyers of the midge amounted to 85 per cent.; while, in this country, our parasites form, only 10 per cent. And after the full investigation of the subject which I have now made, I can state this fact with confidence—*we have no parasites in this country that destroy the wheat midge.* The insect so common on wheat, and which resembles the European parasites of the midge so closely that, in the New York Natural History, it is described as being one of that species, and in the Ohio Agricultural Reports it is confidently set down as another of them, I find has nothing to do with the wheat midge, but is the parasite of an ash grey bug which is common on grain and grass, laying its eggs in the eggs of this bug and thus destroying them.

I stated to the society, a year since, that the wheat midge had wholy vanished the previous summer; not one of its larvæ could I find, on a careful search over an extensive district around me. But the past season this insect appeared in the wheat again, as numerous as usual. This has led us into important changes in our views of the habits of this insect. How was it possible for it to utterly to disappear from the wheat one year and be back in it in swarms the next year? Obviously it must have other places of breeding than in the wheat. And, therefore, if no wheat was grown in this country for a few years, as has so often been proposed, it would not starve and kill out this insect. The insect would resort to other situations, and would sustain itself there, returning into the wheat again as numerous as before, when its cultivation was recommenced. And what could it be that banished this insect from the wheat in 1860, and brought it back again in 1861? The remarkable difference in the weather of these two years furnishes an answer to this question. When the midge fly came out to deposit its eggs in June 1860, the weather was excessively dry; in 1861 it was very wet and showery. And thus we learn the fact that these flies cannot breathe a dry, warm atmosphere; they are forced to retreat to places where the air is damp and moist. When the uplands, the ploughed fields, are parched with drought, the midge cannot abide in them; it must go to the lowlands along the margins of streams, where it must remain so long as the drought continues. Here it must lay its eggs and rear its young, depositing them, probably, in the grass growing in these situations. And hence we also learn that if the last half of June is unusually dry, our wheat that year will escape injury from the midge; but if the last half of June is very wet and showery, this crop will be severely devastated.

PAPER.

Among the botanical specimens sent over from Japan to to the Societé d'Acclimatation by M. Eugene Simon, there are a few young trees, out of the bark of which the Japanese make very good and strong paper. In China the bark of the *Broussonetia papyrifera*, a kind of mulberry tree is used. That of Japan is a variety of the species to which Von Siebold has given the name of the *Broussonetia Kaminoki*. Considering the difficulty of meeting the demand for rags, which are sold at about 2*l.* per cwt., the bark of this tree imported from Japan would prove extremely valuable to the paper trade, inasmuch as it would not cost more than half that price. The *Broussonetia Kaminoki* might be easily acclimatised in various parts of Europe; it prefers a stony soil, especially of a calcareous nature, and should be planted at intervals not exceeding three feet; otherwise the branches would extend, whereby the bark would become full of knots, causing much loss of substance in the manufacture. The soil is not manured until the second year; in the autumn of that year the plant is lopped close to the root, and this operation, as well as that of manuring slightly, is repeated every second year. 100lb. of branches thus obtained, stripped of their leaves, yield 10lb. of bark. The branches, on arriving at the manufactory, are put into hot water for half an hour; the bark can then be easily stripped off by the hands, and is afterwards left in the sun to dry. It is next macerated for three days in river water and bleached in the sun. These operations having been several times repeated, the bark is at last boiled in a lye of ashes for the space of three hours, then manipulated for some time to separate any epidermis that may have remained; and, lastly, when dry, the mass is pounded fine and made into a pulp with water, to which a glutinous liquid is extracted from a shrub called Neboolcko—probably the *Acacia-Nemu*—is added in the proportion of about two pints per cwt. of pulp. The latter is then made into sheets much in the usual way. Sir Rutherford Alcock states that the barks of different shrubs are used, and his collection in the International Exhibition contained some 60 or 70 different kinds of paper, with the various applications for pocket-handkerchiefs, bank-notes, printing and room-paper, waterproof-clothing, imitation leather, &c.

Esparto (Lygeum Spartum, *Lœfl.*) is a grass common to the shores of the Mediterranean, and has of late years assumed great commercial importance for paper-making. A city broker assures me that in the course of this year not less than from 10,000 to 12,000 tons will be imported into England alone. Nearly every coal ship returning from the Mediterranean to England brings a cargo of this grass, the demand for which is constantly increasing, and it is stated that some of our largest daily papers are entirely printed on paper made of it. Of all substitutes for rags this fibre seems about to carry off the palm. It is procurable in any quantity both on the European and African shores of the Mediterranean, where it grows on land otherwise unproductive, on arid, rocky soil, having a basis of silica and iron. It is indigenous to Portugal, Spain, Sicily, Naples, Algiers, and, judging from a specimen in the British Museum collection, also in the Island of Crete. But we have hitherto chiefly imported it from Spain and Algeria. On the spot it fetches from 42*s.* to 50*s.* per ton; but in England, at the present time, 4*l.* 10*s.* from the ship's side. So readily is this valuable fibre converted into paper, that a cargo which arrived in the Thames in the morning was made into paper in the evening—at least so a city merchant assures me.

Botanists have long been familiar with this grass. Pliny, to go no further back, has much to tell about the innumerable uses to which it is applied in the Iberian peninsula, and Ray, many centuries later, reported that the inhabitants of that country did the same in his time, and it may be added that there has been no change in this respect till our own days. Mats, baskets, ropes, brushes, are manufactured of Esparto by the Spaniards and Portuguese as of yore, and even a coarse kind of paper was made of it in Spain. In Algeria it is known by the name of Alfa, and the attention of the French Government has for years past been directed to it as a substitute for rags: and in the London Exhibition of 1851 samples of Alfa, as well as paper made from it, were shown in the Algerian section of French products, and in 1862 in the British department. In consequence, however, of the difficulty of transport and the imperfect methods then employed in its preparation, little progress was made in spreading its fame among the commercial communities of this country. But the recent legislative enactments in England respecting paper, and the increasing price of rags abroad, have caused manufacturers to pay more attention to this grass, and not only established its superiority to straw, but its perfect adaptability to making paper, either by itself, or when mixed with straw, rags, or other material.

The Rev. H. Tristam, in his book called "The Great Sahara," says that the Esparto is "the principal dependence of both horse and camel for forage during a journey." I should think they find it rather tough, for tough the plant certainly is. Its chemical constituents are said to be: yellow colouring matter, 12.0; red matter, 6.0; gum and resin, 7.0; salts forming the ashes, 1.5; paper fibers, 73.5. The Esparto grows naturally in tufts or clumps, but to quote a broker's circular, only such leaves and stalks as have come to maturity and are full of sap, ought to be gathered. If collected too green, Esparto produces a transparent fibre which is mere waste; if on the other hand too ripe, the constituent elements of silica and iron are with difficuly removed. The proper months in Africa are therefore from April to June. It must be gathered by hand, and left to dry for a week or ten days before being removed for packing. From the green to the dry state it loses forty per cent. of its weight, but even in this latter form it is so cumbersome, that when shipped in loose bundles it occupies from four to five tons space to one ton weight. When placed under an hydraulic machine, however, it can be packed into pressed bales with iron hoops, and reduced to half the above volume, as far as space is concerned, each bale weighing about 2½ cwt., and ten bales weighing about 1¼ ton. Reduced to this volume, the Esparto fibre can be transported not only with greater facility, but this method of packing (resembling in fact, bales of pressed hay) keeps the fibre clean, and renders it of easy stowage. Indeed, could such a method have been adopted formerly, Pliny's regret that its great bulk unfortunately prevented so valuable a fibre from being carried a greater distance than about thirty leagues, would have been impossible.—*Berthold Seeman in Gardener's Chronicle.*

PRODUCTION OF INSTANTANEOUS PICTURES ON LARGE PLATES.

BY LIEUT.-COL. STUART WORTLEY.

I shall begin by mentioning that, in the short paper I am about to read to you, I shall avoid as much as possible entering into details of manipulation, &c., all practical men having their own way of working.

I may, however, start by impressing upon every one the absolute necessity of clean plates, both for the sake of avoiding marks in the original negative and to guard as much as possible against loosening the film during the intensification. The collodion I have been in the habit of using is very alcoholic, the following being the proportions:—

Ether	1 oz.
Alcohol, 802	2¾ oz.
Iodide of lithium	15 grs.
Bromide of lithium	6½ grs.

or rather more than double alcohol to ether, between 4 and 6 grs. of iodide and 2 grs. bromide to the ounce of collodion. The pyroxyline is first steeped in the iodo-bromized alcohol, and the ether then added. The quantity of collodion varies very much in different samples. I thus obtain a very fluid collodion, which I find a great advantage in coating large plates where a very even film is required, and in all instantaneous pictures where there is much sky.

The utmost precautions must be used to avoid streaks, spots, or stains of any kind. This is one of the great difficulties of working out of doors. I have lost many good negatives by accidental spots from dust, and such unavoidable causes.

The silver bath is made from Stephens and Williams's pure recrystallized nitrate of silver, 35 grs. to the ounce. I iodize by leaving a couple of coated plates in the bath for several hours.

I then find it necessary to add from 2 to 3 drops of pure nitric acid to the ounce of bath. The more bromide in the collodion, the more nitric acid, I find, is required in the bath. I leave the plate rather longer in the bath than I should were I using simply iodized collodion, as I find the maximum of sensitiveness takes longer to produce with a collodion containing much bromide than with a simply iodized or lightly bromized collodion.

I drain very carefully, and place blotting-paper all along the bottom of the plate when in the slide.

My pictures in the Exhibition are taken with Dallmeyer's triplet lenses, and usually with full aperture—necessarily so when facing the sun, as any diaphragm in the lens produces rings on the plate, when the sun shines into the lens.

My developer I make as follows:—

Sulphate of iron	20 oz.
Distilled water	120 oz.
Dissolve.	
Acetate of lead	0½ oz.
Water	5 oz.
Dissolve.	

Mix the above solutions; and when the precipitate has all settled, decant off very carefully. Add

Formic acid	5 oz.
Acetic ether	1½ oz.
Nitric ether	1½ oz.

This I keep as a stock solution, and filter off as much as I require for use at a time, adding acetic acid in proportion, according to the temperature of the weather and the class of picture required. The developer should move freely over the plate, and should remain on the plate some seconds before any sign of the picture appears. As the acid loses its restraining power, the iron acts, and the result is a simultaneous action over the whole plate, and the picture flashes out all at once. You will have noted that the developer is a very powerful one; and I use a very liberal amount of acetic acid as a restraint to the energetic action of the iron and formic acid.

I keep the developer on the film till I have obtained the necessary detail, and then, washing the plate very thoroughly, bring it home in a grooved box, to be fixed in the evening with a weak solution of cyanide of potassium. Many of my negatives were taken in Italy, and brought home, after fixing, for the intensification to be done in England. The edges of the plate must be carefully varnished, and the film moisted with distilled water. A saturated solution of bichloride of mercury is then poured on, and poured off as soon as the film has taken the proper colour, on which, after a good washing, a five-grain solution of iodide of ammonium in water is poured on and off till the desired depth is attained. I then use two solutions, composed as follows:—

1.	Pyrogallic acid	12 grs.
	Water	1 oz.
2.	Citric acid	50 grs.
	Nitrate of silver	10 grs.
	Water	1 oz.

Pour a few drops of No. 2 into No. 1, and pour on and off. The negative can now be made to assume any depth you may require.

If you have a negative from which you desire to print vignettes, keep the negative tolerably transparent. If you intend to print your negative to the edges, see that it has force conjoined with softness. Many a negative, which is too transparent to give an effective print if printed to the edges, will give a beautiful vignette.

Every one should print from their own negatives. Taste and knowledge are shown as much in the printing as in the production of the negative. Many amateurs who produce moderate negatives send them to professional photographers to print, and thus obtain the taste and talent of another man in the production of the pictures, which they then speak of as their own. This is not, in my opinion, at all right, as the printer certainly deserves to share the credit of the finished picture.

I use, for printing, a silver bath of 100 grains to the ounce of water, acidified with citric acid, and use as toning-bath a solution of chloride of gold and phosphate of soda, of which I keep a large quantity in stock, and prefer to use some weeks old. I fix in fresh hyposulphite of soda, and mount the finished picture with fresh starch.—*The Photographic Journal.*

NATURAL COLORED PHOTOGRAPHS.

The celebrated French chemist, Mr. Niepce De Saint Victor, has been for many years devoting himself to experimental heliochromy, for the purpose of discovering the art of taking fixed photographs in their natural colors. He has lately presented his fifth memoir on the subject to the Academy of Sciences, Paris. The following are some extracts from it:—

"I have always found yellow the color most difficult to obtain in the same space of time as the other tints; but I have recently discovered the means of developing it with certainty, and of obtaining it in the same time as other colors. I had previously obtained, with great facility, red, green, and blue; I have arrived at obtaining yellow, by employing as an agent for chloridizing my plates, a bath composed of hypochlorite of soda, in preference to the hypochlorite of potassa. This bath must be in the following conditions:—Take newly-prepared hypochlorite of soda, marking six degrees of the areometer; dilute it with one-half of its bulk of water, and then add alcohol in quantity equal to ½ per cent of the soda, and heat the bath to a temperature of 180° to 190° Fah.; then pour it into a flat capsule, half-plate size, stirring the liquid for a few seconds, immerse the plate in it at once, a time sufficient for the plate to take a black tint. It is then rinsed in abundance of water, and dried over a spirit lamp. In 200 grammes (6½ oz.) of this bath we can chloridize five or six quarter-plates, among which some will give better results than others, according to the thickness of the film and the degree to which the plate has been heated. In these conditions of chloridization the colors are produced (especially by contact) with very vivid tints, and very frequently the blacks appear in their full intensity. To operate in the camera obscura, we select plates which, by the action of heat, have received a fine cherry-red tint, as well as those which are more slightly re-heated, because they are the most sensitive to light. On this account the film of chloride of silver must not be too thick. But, to obtain the effects which I now describe, the chloridized plate must be covered with a varnish with a base of chloride of lead.

"With regard to the problem of fixing the colors, I have only succeeded in doubling the time of duration announced in my last report. Many substances added after the action of the heat upon the chloride of lead, give a greater fixity than if the chloride of lead was alone; such are, among others, the tincture of benzoin, chloride of tin, and aldehyde. But what has given me the best result is the tincture of Siamese benzoin, applied to the plate while it is yet warm, and, after the plate has become dry, heating it until a little of the benzoic acid is volatilized. It is by means of this lead varnish that I have been able to preserve colors during three or four days, in an apartment strongly illuminated by daylight, in the month of July. If we incline a heliochromic image, at a certain degree of incidence, the colours appear much more vivid, and the blacks assume the greatest intensity. I have also remarked that, according to the manner in which the figure of a doll (which I used) is illuminated by the solar rays, the obtaining the colors in the camera obscura becomes singularly modified, and produces very advantageous effects as to intensity of color and of brilliancy; as for example, gold and silver lace, precious stones, &c. But what is very extraordinary, is that, having placed a strip of unglazed black paper upon a large piece of silver lace which the figure wore as a belt, the black of the paper was reproduced with the white of the silver lace. Black is reproduced with a violet hue, viewed direct; but if the plate be inclined at a certain angle, it assumes its greatest intensity, and the silver lace its metallic splendor. Light, in changing the heliochromic colors made in certain cases, changes green into blue, and yellow into green; as, for instance, if we cover them with a varnish having chloride of tin for a base, which, moreover, greatly retards the activity of the light; if it had not this objection, it would serve as a temporary fixing agent, for the reds are preserved a very long time.

"I have proved that all the binary colors are decomposed by heliochromy. If the green be natural like that of the emerald, arsenite of copper, oxide of chrome, sulphate of nickel, green carbonate of copper, they are reproduced green by heliochromy; but if the green be a compound, like that, for example, formed by a mixture of Prussian blue and chrome yellow, or that of stuffs dyed by means of a blue coloring material and a yellow, or of certain glasses colored by blue and yellow pigments, these greens, I repeat, give blue only by heliochromy, either by contact, or in the camera obscura. A light blue glass, superimposed upon a light green glass, give by transparency, a very fine green; but, being applied to a heliochromic plate, they only produce blue; whatever be the time of exposure to the light, or whether the blue glass be uppermost or below, the results are the same. Certain kinds of green glass reproduce green very well; others give only blue or yellow effects. There are also other examples: a red glass superimposed upon a yellow glass, giving an orange by transparency, produces only red upon the sensitive plate. A red glass, superimposed upon a blue glass, giving violet by transparency, first produces a violet, then blue follows: the red being replaced by an orange green, also quickly reproduces blue. A white paper, colored green by green leaves, is reproduced only very slowly by contact; the sensitive plate remains red a very long time, as if the light had no action; and if the exposure be prolonged, a bluish grey tint is produced; the same result takes place if we attempt to reproduce natural foliage in the camera, such as, for instance, the herbage of a green meadow; but if the foliage be a blue-green, as, for instance, the leaves of the dahlia, the blue tint will be more vivid. If the foliage be yellow or red, like that of dead leaves, the color reproduced will be a yellow or a red, more or less pure, according to the greater or lesser absence of the blue matter, which, with the yellow, constitutes the green color of leaves. The dye of a peacock's feather is well reproduced in the camera, that is, the color appears under a certain degree of incidence, now green, now blue."

SOME REMARKS ON LIGHTS.*

The translucency of white materials having been acknowledged, the question, "Is anything opaque?" was next considered; and it was shown that no definite line could be drawn between transparent and opaque bodies; for while nothing is found to transmit light without some loss, nothing is found absolutely impervious to light when reduced to a thin film. In most cases where much light is obstructed, some rays pass more freely than others, as indicated in the following table:—

Light Transmitted.

	Through	gold-leaf	is green.
	"	" tempered	" brown.
†	"	gold chemical films	" grey violet
†	"	" " powders	" red, purple, or blue.
	"	silver-leaf	" grey violet.
	"	chemical films	" purple or brown.
	"	copper	" green.
	"	antimony	" grey.
	"	arsenic	" brown.
†	"	platina	" grey.
†	"	palladium	" grey.
†	"	rhodium	" brown or blue.
	"	charcoal	" grey.
	"	iodine	" red brown.

Taking the word "opaque" in its ordinary acceptation, the question, "Are all opaque bodies black when in a fine state of division?" was next discussed; and it was shown by diagrams how the breaking up of a smooth surface diminished the amount of light availably reflected from it. It was also shown that comminution produces subjacent surfaces which reflect some of the light transmitted by the first surface, and that with a certain degree of fineness the more transparent the material the more light will be reflected from the subjacent surfaces; and it was concluded that bodies become lighter coloured by powdering if their power of absorbing light is so small that the reflection from the subjacent surfaces more than compensates for the loss of reflection from the breaking up of the primary surface; and they become darker if the absorbing power is so great that the reflection from the subjacent surfaces does not compensate for the loss of reflection caused by the breaking up of the primary surface.

The doctrines of correlation and conservation were then briefly treated, and it was argued that light falling upon black bodies was neither annihilated nor absorbed; but converted into some invisible form of force; the power of the black body being, in some degree, the converse of that possessed by fluorescent and phosphorescent bodies, by which they convert invisible into luminous rays.

The fact, that reflection is not purely a superficial phenomenon, was then pointed out, as indicated by those parts of a soap-bubble which are too thin

* From a lecture before the Newcastle Microscopical Society.

† These are quoted from Faraday in *Phil. Mag.*; the others were exhibited to the meeting.

to reflect light being still possessed of two surfaces; and the questions were raised—If matter at some depth, however small, beneath the surface, continues to reflect light, at what depth does it cease to do so? Does it ever cease to do so? Or does the transmitted ray, as it speeds on its journey, always send back a beam in the opposite direction?

Different kinds of reflecting surfaces have different appearances; this is probably due, in some measure to the effect produced upon the light by its passage into and out of that thickness of matter which is concerned in ordinary reflection.

Of homogeneous matter, we have opaque and transparent; the former giving metallic lustre, the latter vitreous. As a general rule, if not a universal, we find the more nearly a substance approaches the metals in opacity, the more it resembles them in the nature of its lustre. Thus sulphurets are in many cases very nearly opaque, and very like metals in the nature of their lustre. Carbon in its opaque form is a brilliant steel grey; while its transparent form has the vitreous lustre.

A micaceous or pearly lustre is the result of the superposition of a number of films of transparent material; the reflection from the first surface being added to by the reflections from the subjacent surfaces.

When light falls upon glass and is reflected, it is commonly said that the glass reflected. The speaker drew attention to the important part played by the air or other medium in contact with the reflecting surface, and illustrated it by obtaining total reflection from the surface of a prism when air was in contact with it, and only feeble reflections when the air was replaced by water or oil of turpentine; even a film of silver deposited on the prism was shown to reflect less light than a film of air. By a simple contrivance it was then shown that white paper reflects more light than a looking-glass, and that the appearance of lustre depends upon the reflection of shadows as well as of lights.

Mr. Proctor concluded his subject with the following words:—

"Sir D. Brewster, and other writers on optics, give the length of a wave of white light, the number of undulations in an inch, and the number in a second, calculating it as the *mean* of the number of undulations in the coloured rays; apparently forgetting that it is not the mean but the sum of the colours which forms white light—the mean being, according to Brewster's own table, yellow, with a tinge of green. Various writers have, probably, copied from the same source without investing thought upon the subject; one indication of which is, that several say so many millions of millions, whereas it would be more natural to say so many billions. I will just give you Brewster's figures, and then pass on:—

Length in parts of an inch.		No. in an inch.	No. in a second. Millions of Millions.
White	0·0000225	44444	541
Yellow	0·0000227	44000	535
Yellow Green	0·0000219	45600	555

"You observe the numbers given for white light are the same that would belong to a colour between yellow and yellow-green. White light, we may conclude, is not a definite undulation, nor a definite mixture of undulations, but a variety of mixtures of undulations, in any of which mixtures the average length of an undulation is that given by Brewster and others, but the number in an inch or a second is incalculable and indefinite. The length of the undulations in a pure unmixed colour is probably definite, and we have no reason to object to the measure and number usually adopted; we shall, therefore accept them for further argument.

"The length of an undulation of violet light is seventeen-millionths of an inch; the red undulations twenty-six-millionths, or about one-half longer; undulations, longer or shorter than these not being visible. The colours observed in soap bubbles and other thin films are produced by interference of the luminous waves. The colour produced depends upon the relation between the thickness of the film and the length of a wave of light. A film of air, four-millionths of an inch thick, produces the same colour as a film of water three-millionths, or of glass two-and-a-half-millionths of an inch thick. Therefore, we conclude that the length of the light wave varies with the medium. An undulation in air, measuring four, will measure only two-and-a-half when it enters glass, and will again elongate to its former measure on its exit. From these premises we may deduce various interesting conclusions. Faraday found that gold films were iridescent when they were only one-tenth the thickness at which air ceases to be iridescent. May we, then, conclude that light, while passing through gold, consists of undulations only one-tenth the length of those in air. Newton found that the thickness of films of a given colour was inversely proportionate to their indices of refraction. May we, then, conclude that gold has a refracting power in like proportion? If we say that luminous undulations, which in air measure twenty-two millionths of an inch, look yellow when they enter the eye, and in that organ measure one-third less in consequence of its refracting power, then we come to the singular conclusion that the blue sky is yellow, sunshine is red, and the rosy tints of evening are not luminous at all until they enter the eye. If the colour depends upon the length of the light wave, and the length of the wave depends upon the refracting power of the medium through which it is passing, every beam of light changes colour; red it may be on its passing through the region of the stars, yellow or green it may be when it enters the air, blue or violet when it enters water, non-luminous as it passes through glass. But if light, which we perceive as violet while it exists in the aqueous humour of the eye, was red originally what colour must that light be which we perceive as red? Its undulations in air must be too long to be luminous. This introduces us to the solemn thought that all this vast universe is dark! Light exists only in the eye. It is only a sensation—a perception of that which in nature exists as a force capable of producing a sensation. We would feel grieved at the thought of light and sound having no tangible existence independent of ourselves, were it not for the glorious hope that all nature is full of forces equally grand—forces which we have not the power of perceiving, but which, with a higher developement of our organism, may be sweet as music and genial as sunshine.

ON ALUMINUM BRONZE.

Lieut-Colonel Strange has communicated to the Royal Astronomical Society some interesting observations on the use of aluminum bronze as a material for the construction of astronomical and other philosophical instruments. Col. Strange remarks that, "the qualities of most importance in instrument making are—(1) tensile strength; (2) resistance to compression; (3) malleability; (4) transverse strength or rigidity; (5) expansive ratio; (6) founding qualities; (7) behaviour under files, cutting tools, &c.; (8) resistance to atmospheric influences; (9) fitness to receive graduation; (10) elasticity; (11) fitness for being made into tubes; (12) specific gravity."

Tensile Strength.

The mean of experiments made by Mr. Anderson at the Royal Gun Factory, Woolwich, shows that the average breaking tensile strength of aluminum bronze is 73,185 ℔. per square inch, while that of gun-metal is 35,040 ℔., the ratio being rather more than two to one in favour of aluminum bronze.

Resistance to Compression.

Experiments made by Mr. Anderson show that no effect was perceptible until 9 tons 2 cwt. per square inch was applied, when the specimen gave ·006 of an inch; on removing the weight an elasticity of ·001 was observed, giving the first permanent compression as ·005 of an inch. The ultimate amount of compression applied was 59 tons 2 cwt. 1 qr. 4 ℔. (132,416 ℔.,) under which the specimen became too much distorted to permit of more weight being applied with any true result.

Malleability.

Mr. Anderson states that, "the qualities of this metal for forging purposes would appear to be excellent; with the exception of the part heated to a red-heat in the shade, all show that it is a good workable material under the hammer almost up to the melting point." Col. Strange adds, that there were specimens exhibited in the Industrial Exhibition at London which showed that the alloy could be drawn out under the hammer almost to a needle point.

Transverse Strength, &c.

Messrs. Simms found by experiment that aluminum bronze was 3 times more rigid than gun-metal, and upwards of 44 times more rigid than brass; and, in regard to its *expansive ratio*, they found this alloy less affected by change of temperature than either gun metal or brass—a little less than gun-metal, and much less than brass. Its *founding qualities* are such that it produces admirable castings of any size. It does not clog the file, and in the lathe and planning machine the tool removes long elastic shavings, leaving a bright smooth surface. It can be worked with much less difficulty than steel, and, notwithstanding its greater cost, the Messrs. Simms think that screws made of it would in the end prove less expensive than steel. It tarnishes less readily than any metal usually employed for astronomical instruments. It is remarkably well fitted to receive graduation, as it takes a fine division which is pure and agreeable, surpassing any other *cast* metal in this respect. Col. Strange remarks that in its elasticity it is said to surpass even steel, and it would therefore appear to be the most proper material for the suspension springs of clock pendulums. Regarding *its fitness for being made into tubes*, it can be soldered with either brass or silver solder; it can be rolled up into sheet metal, and it can be hammered and drawn. Gun-metal does not admit of being rolled, so that hitherto the tubular portions of telescopes and other instruments have been made almost exclusively of yellow brass, an alloy very deficient in rigidity. The *specific gravity* of the alloy containing 90 copper and 10 aluminum is according to Messrs. Bell, 7·689 very nearly that of wrought iron.

Col. Strange adds "It appears from these experiments and from the concurrent testimony of those who have given it a fair trial, that the 10 per cent aluminum bronze is far superior, not in one or some, but in every respect, to any metal hitherto used for the construction of philosophical apparatus and that for such purposes it may be employed in the dimensions that would be proper in the case of cast steel. All parts which would otherwise be made of steel may with perfect safety, and even with advantage, be made of the new alloy, particularly such parts as bolts, and fixing, tangent, and micrometer screws. Its hardness and comparative inoxydizability point it out as peculiarly adapted for pivots, axes, and bearings. If employed for receiving the graduation of circles, the necessity for inlaying another metal will be obviated, by which two advantages will be gained; the hammering which forms part of the operation of inlaying, and which, more or less, must cause unequal density and tension in the circle subjected to such treatment, will be dispensed with; and the effect of inequality of expansion, in the circle and the inlaid strip, will no longer be a cause of apprehension. With respect to the due visibility of divisions cut on this metal, opinions will perhaps differ. I can only say that I should be well content to observe with them."

This alloy has been selected by Col. Strange as the most appropriate metal for the construction of the large theodolite for the use of the Trigonometrical Survey of India. The horizontal circle of this theodolite is three feet in diameter, and the effect of using this alloy will be to keep the weight of the instrument within reasonable limits, notwithstanding its possession of means and appliances not hitherto bestowed on such instruments. In the manufactnre of the alloy, Col. Strange says that extremely pure copper must be used; electrotype copper is best, and Lake Superior copper stands next, giving an alloy of excellent quality. The ordinary coppers of commerce generally fail, owing, it is said, to the presence of iron, which appears to be specially prejudicial. Further, the alloy must be melted two or three times, as that obtained from the first melting is excessively brittle. "Each successive melting, up to a certain point determined by the working, and particularly the forging properties of the metal, improves its tenacity and strength. It is probable that after several meltings there will remain in combination with the copper a somewhat smaller proportion of aluminum than 10 per cent. The present price of English-made 10 per cent. aluminum bronze is 6s. 8d. per lb. This is four or five times that of gun-metal, but a much smaller quantity of the new alloy than of gun-metal will give the same strength; and when it is considered how small a ratio the cost of material bears to the cost of workmanship in refined apparatus, it will be found that even at the present price of the new alloy its cost is not prohibitory, whilst the advantages attending its use promise to outweigh the increased expenditure."—*L. E. and D. Phil. Mag.*, [2], xxiv., p. 508.

C. Tissier, director of the aluminum works at Rouen, shows that one per cent. of aluminum in copper makes the latter more fusible, giving it the property of filling the mould at casting, at the same time preventing it from rising in the mould. The action of chemical agents upon it is also weakened, and the copper gains in hardness and tenacity without losing its malleability, thus producing an alloy which has the malleability of brass, with the hardness of bronze.

In transverse strength this alloy was found to be more than twice as rigid as either brass or copper. Tissier also finds that one part of aluminum, added to bronze consisting of 96 copper and 4 tin, gives an alloy of a fine colour, of remarkable homogeneity, of great hardness and malleability. During casting, this alloy does not oxydize at all, and it is therefore free from the oxyde coating with which ordinary bronze castings are covered. The transverse strength of the castings of this alloy Tissier finds to be two and a half times that of the original bronze, and that of the hammered alloy is four times as great as that of bronze. Ordinary cannon bronze, 89 parts copper and 11 tin, has the same transverse strength as castings of the new alloy. In reference to the hardness, tenacity, and malleability, it is equal in these respects to aluminum bronze, made of 90 parts copper and 10 parts aluminum, and, as it is considerably cheaper, it can with advantage be substituted for this more expensive alloy.—*Polytechnisches Journal*, clxvi., p. 430.

THE MOST RECENT SPECTRUM DISCOVERIES,

BY PROFESSOR WM. A. MILLER, F.R.S.*

The subject of the lecture, the learned Professor said, was perhaps the most extensive and fascinating which presented itself to scientific men. On the present occasion he intended to limit himself to but a few of the interesting discoveries made in this great field of research, and hoped he should not be considered egotistical if he referred to his own experiments. Among the rays emitted by the sun there were three kinds, interesting as endowed with special action—those which conveyed heat light, and chemical action. With heat he should have but little to do on this occasion; about light he had something to say; but he was now principally concerned with the rays which manifested themselves by producing chemical action. It was well known that transparent substances did not transmit all these rays with equal facility. Glass was only imperfectly transparent to the chemically active rays, which were found in the most refrangible rays of the spectrum, heat rays being in the least refrangible portion, and light occupying the middle place. It had been found that rock crystal was one of the few substances which perfectly transmitted rays, those highly refrangible, which glass absorbed.

* Royal Institution Lecture.

The Professor then showed that some kinds of light were without chemical action, the light from a mixed air-gas flame possessing scarcely any, while that from an ordinary gas flame did possess a little. The oxyhydrogen flame, while attended with intense heat, was endowed with very little chemical action. A prepared collodion plate exposed to this light for twenty seconds gave a very faint picture. But when the flame was thrown on lime, although the temperature was lower, the light had sufficient chemical activity to produce a strong picture on a similarly prepared plate, exposed for the same time. In the case of the chemically acting rays the intensity, number, and position of the lines on the spectrum had been found to vary with the source of light. The most remarkable illustration of this was the different spectra produced by the electric spark of an induction coil between poles of different metals and projected upon a photographic plate.

The spectrum produced by the spark from silver poles, for example, was found to be three times the length of the whole of the solar spectrum transmitted by quartz. In order to obtain views of this invisible spectrum it was necessary to transmit the rays through a medium more transparent to chemical rays than glass, which, it had been said, was opaque to the higher rays of this kind, and various experiments had been made to ascertain what substance allowed them to pass most freely. The results were shown in the following table of the—

Photograpic Transparency of Solids.

Rock crystal......	74	Sulphate of magnesia..	62
Ice	74	Borax	62
Fluor spar.........	74	Bromide of potassium.	48
Topaz................	65	Thin Glass........	20
Rock salt..........	63	Mica.....................	18
Iceland spar	63	Iodide of potassium....	18
Diamond	62	Nitrate of potash.......	16

The above numbers being founded upon an arbitrary division of the spectrum.

The photographic transparency of liquids differed still more, as would be seen by the following diagram:—

Photographic Transparency of Liquids.

Water...............	74	Wood spirit.............	20
Alcohol.............	63	Acetic acid............ ...	16
Chloroform........	26	Oil of turpentine.......	8
Benzole	21	Bisulphide of carbon...	6

Various gases were also found to interfere with the transmissibility of these rays, as exhibited in the table of the—

Photographic Transparency of Gases.

Hydrogen..........	74	Benzole vapour	85
Nitrogen............	74	Hydrochloric acid......	55
Oxygen	74	Hydrobromic acid......	23
Carbonic acid......	74	Hydriodic acid	15
Olefiant gas........	66	Sulphurous acid.........	14
Marsh gas	63	Sulphuretted hydrogen	14
Coal gas.............	37		

The diamond and rock crystal allow the chemical rays to pass freely, but other substances, in which no difference of transparency can be discovered by the eye, considerably affect the transmission of these rays. Chloride of potassium allowed them to pass less freely; and nitrate of potash, and the nitrates generally, offered still more obstruction.

It was the same with fluids, and also with gases, as would be seen by a reference to the diagrams. It was remarkable, too, that solid bodies when dissolved or melted maintained exactly the same power as when in the solid state. The same was the case when they were converted into vapour, which showed that this power was part of the nature of the substance.

The lecturer then described the phenomenon of fluorescence, and showed that the chemical rays of the spectrum correspond with the rays of fluorescence by taking a photograph in that part of the spectrum which, though otherwise invisible on the screen, lighted up a solution of æsculine. He then showed that all metals give characteristic photographic spectra, some of them bearing a strong family resemblance to each other, as in the cases of iron, cobalt, and nickel, the last metal giving one of the longest spectra observed, and which extended to 190° of the scale. Arsenic, antimony, and tin showed as great differences in the invisible as visible part of the spectrum. The most interesting of the metals to study in this respect was magnesium, which opened a wide field for investigation. There were certain points of resemblance between the spectrum of magnesium and that of the sun, which led to the supposition that this metal existed in the solar atmospheres. The comparison of the spectrum of magnesium with that of the sun led also to some important considerations as to the temperature of the sun. It was known that the higher the temperature the more refrangible were the rays of light emitted by a body. We have no conception of the temperature of the electric spark. The heat of the strongest wind furnace was estimated at 4,500° F., and that of the oxyhydrogen jet was supposed not to exceed 15,000° F., yet with neither of these could the same effects be produced as with the electric spark. The lines of the photographic spectrum of magnesium were not seen in photographs of the solar spectrum, and yet there was no doubt that this metal was present in the solar atmosphere. Kirchoff had discovered that solids when heated gave a continuous spectrum, but that bodies in the form of gas gave rays in definite and limited refrangibility each substance emitting light of definite property. He had also noticed that light from a luminous mass, by passing through ignited vapour which, *per se*, would give bright lines in the spectrum, became furrowed out in dark bands occupying exactly the same position in the spectrum as the bright lines. Now, ignited magnesium vapour emitted green rays which were absolutely identical with the group of fixed lines *b* in the solar spectrum, and it was therefore certain that magnesium was a constituent of the sun. It was, moreover, probable that the heat of the sun was inferior to that of the electric spark, inasmuch as it was insufficient to bring out the highly refrangible lines observed in photographs of the magnesium spectrum.

There were thirteen bodies known on earth which these researches lead us to suppose existed in the solar atmosphere. Nor are they limited merely to the sun. Fraunhöfer had examined the spectra of several stars, and found that although they presented no similarity to that of the sun, nor to each other, yet that some general relationship between them was observable.

Mr. Huggins and the lecturer had recently been investigating this subject, and had obtained very perfect maps of the visible spectra of several stars. They had also obtained a photograph of the spectrum (which was exhibited) of Sirius. This star is130,000,000,000 of miles distant, and the light which produced the photograph must have left it twenty-one years ago.

A photograph of the spectrum of Capella, which is three times further distant than Sirius, had also been obtained, the light to produce which, the lecturer said, must have left that star when the oldest in the room was a little boy. Professor Miller concluded an eloquent address of which the above is a mere outline, by remarking how much these wonderful facts enlarged our ideas of the power of the great Author of the universe, whose will "creates, sustains, and animates the whole."

HAIR AND WOOL—THEIR NATURE AND USES.

The hair, wool, fur, horn, hoof and nails of animals are identical in composition. The surface of all animals is covered with a delicate membrane called the *epidermis*, which contains a great number of little cells. It is this part of the human skin which swells and separates when a blister is applied to it. The epidermis produces hairs on animals, feathers in birds and scales in fish; and it is remarkable that the horns and hoofs of animals are formed of condensed collocations of hairy substances. There are little depressions or cells in the skin which are called hair follicles and are filled with an oily substance. Little blood vessels supply the lower part of these follicles and cause the cells to grow faster at the bottom, and thus the hairs are gradually pushed out and made to grow. Warts and corns are caused by an excessive secretion of these cells. Different animals produce hair of different qualities, for which specific names are employed to denote their character. Wool is simply a species of hair; it is called wool because it has a tendency to curl. We call certain races of mankind "woolly-headed" because their hair is exceedingly crisp and curly. Certain animals also yield wool or crisp curly hair. Wool, however, possesses peculiar qualities not belonging to straight hair. The former can be felted; most of the latter cannot. The wool of the sheep is valuable for making cloth just in proportion to its curling and felting qualities. It is important to know how to judge wool with respect to this property for making cloth. This can be done with the microscope because the outward structure of wool and hair is different. If a human straight hair is placed under the microscope it will be observed that its exterior is composed of scales which overlap one another. On the other hand a piece of wool placed under the microscope presents a serrated surface. The fineness of serratures in wool determines its character for the manufacture of different fabrics. The finest Saxony wool contains 2,720 serratures to the inch, and this wool is used to make super-fine broadcloth. Merino wool contains 2,400 serratures to the inch, and is also well adapted for making fine cloth; but Southdown and Leicester wool contains only from 2,000 to 1,800 serratures to the inch. It appears that the quality of felting depends entirely on these fine serratures becoming interlocked during the felting operation. Woollen fabrics are woven loose, but one kind is converted into cloth texture of close by the felting process, while another is called worsted, because it is made from wool which does not felt well. The felting property in wool is always in proportion to the number of the serratures. The larger wool contains the fewest, the short curly wool contains the greatest number of serratures. The long wools are therefore prepared for making worsted goods; the short wools for fine cloth. Stockings and flannel made of long wool do not "full up" like those formed of short wool, but the latter makes the softest and warmest articles for wearing. Seamless felted garments cannot be made of long coarse wool, which is devoid of the felting property.

Pulled wool is that which is pulled from the pelts of slaughtered sheep and lambs, but most of the wool in market is shorn from the animals in the spring and in some countries semi-annually. Sheep will molt and shed their coats annually, but the molting process is obviated by shearing off the fleeces. Each domestic sheep annually yields its coat to clothe some human being. Man should thus be taught humility by his dependence for warmth upon the animals of a lower creation. All the wool in a fleece is not of the same length and cannot therefore be employed indiscriminately in making cloth. Short wool sheep have some long wool in their fleeces, and long wool sheep have some short wool. Assorters called wool-staplers are employed to pick out the different qualities of wool. In its natural state wool is dirty, and requires to be washed to fit it for carding but it is afterwards sprinkled with oil to adapt it for spinning, When it is dyed in the wool condition for the purpose of making cloth, all the grease is first removed by steeping it for a short period in alkaline lye or in a solution of soap, after which it is washed in water, and then colored. Saxony wool is admitted to be the best in the world for spinning, but Spanish merino is scarcely inferior to it. Australia and South Africa now produce vast quantities from acclimated breeds of the Saxony sheep. The climate of California is peculiarly adapted for the raising of Saxony and merino sheep, and large supplies of wool are now obtained from the Pacific regions. Very fine wool is also raised in some of our Northern and Western States; but sufficient quantities are not raised to manufacture all the woollen and worsted fabrics required in the United States. In the absence of an adequate supply of cotton a far greater quantity of woollen fabrics are required, and wesee no reason why the wool crop and the woollen manufactures of our country cannot and should not be quadrupled within two or three years. We can raise wool of the finest qualities, and cloth of the finest quality can be manufactured in America as well as in Europe. It is not positively necessary that any woollen cloth should be imported. We have heard it asserted that the climate and the waters of the United States are not so suitable for spinning, weaving and dyeing wool as those of Europe. This is sheer nonsense. Very beautiful and good cloth and shawls are now made in some of our manufactories, but not to an extent that meets all the requirements of the people. England is a great woollen cloth manufacturing country, but English sheep do not yield fine wool. Australia, the Cape Colony, Germany and America furnish English manufacturers with their fine wool. America can and should supply itself with all its wool and woollen cloth.—*Scientific American.*

PHOTOGENIC GAS.

According to the newspapers, we find that some recent experiments were made at the offices, in 95, Bishopsgate-street, of Mr. Mongruel's patent cold vapour regenerator, an invention for the production of a brilliant and economic light from ordinary gas or atmospheric air. The Photogenic Light was invented by M. Mongruel in the beginning of 1862, and it is stated to be already adopted in several of the large towns of France, and in many of the largest cafés and establishments of Paris. It was, moreover, reported on by a commission appointed for the purpose by the Société des Sciences Industrielles, Arts, et Belles Lettres of Paris in October last, and the results of their inquiry are thus stated:—1. That there is a guaranteed reduction of 50 per cent. at least in the consumption of gas to give an equal light. 2. Or, with an equal consumption, there is a luminous intensity double or treble that of the primitive light. 3. Whiteness, regularity, and a tranquility of the flame, which softer to the sight, fatigues less in reading or working. 4. Purification of the gas from its pitchy or napthaline atoms, from its ammoniacal vapours, and the sulphurous acids it carries with it from the factory. 5. Consequently, preservation of painting, varnish, gilding, and delicate colours, which in establishments lighted by gas are so promptly attacked by these mordant agents. 6. Complete absence of odour and smoke. 7. Lastly, real advantages for the consumer, to whom the inventor guarantees, all expenses paid, 25 per cent. of positive economy on his habitual expenses for gas lighting. The experiments of Saturday last were conducted and explained by Mr. Thomas in the most satisfactory manner. The first experiment was made upon the ordinary gas in use in that part of the city. This gas, when passed through the generator containing the liquid used by M. Mongruel, acquired a vastly increased illuminating power, while the flame of the jets was purer, softer, and steadier. But though the light was more intense the expenditure of gas, was less, for, tested by a gas-meter and chronometer the consumption given was in the proportion of 6 to 10, which is equivalent to a saving of 40 per cent. The next and the most interesting experiment was made upon atmospheric air, which when passed through the apparatus and liquid, burned with a beautiful clear and steady light. Some idea of the brilliancy of this light may be obtained when it is stated that as measured by a photometer one jet of the ignited air gave more illuminating power than four jets of ordinary gas of equal size. As far, therefore, as the experiments of Saturday were concerned, nothing could be more complete and satisfactory. The capacity of being able to obtain light from the atmosphere must prove of immense advantage in those localities where there are not the means of getting it by the ordinary method hitherto employed; and it is stated that M. Mongruel has had more demands than he can attend to from private individuals for the application of his inven tion in their mansions. Ingenious inventors have been, and are still, occupying themselves with the carburation of gas, since it has long been known that by dissolving carburetted hydrogen gas, the latter requires a treble or quadruple illuminating power. What, however, was wanted, and M. Mongruel appears to have succeeded in inventing, was an apparatus which will produce a constant vapour, always equally rich in carbon, so that the light is at all times the same. In all other apparatus used for the purpose, the generation of the vapours being effected on the mass of the liquid contained therein, the most volatile parts of the liquid naturally first escape, thus impoverishing the remainder, which daily gives less and less light, until the light disappears altogether, while a considerable quantity of the liquid is still left in the apparatus. In M. Mongruel's generator, the mass of the liquid is enclosed hermetically in an upper chamber, whence it descends by a small tube, to form a thin sheet on the bottom of the lower chamber, wherein its vaporisation is effected, and is supplied, drop by drop only as what has preceded it is consumed.—*Lloyd's Mechanics Magazine.*

ROYAL INSTITUTION LECTURES.

Professor Frankland, in his seventh lecture on "Chemical Affinity" (on Thursday, March 5), resumed the consideration of the laws of electrolysis or decomposition, by means of the voltaic battery —viz., 6. The quantity of electricity which passes through the electrolyte is always directly proportional to the quantity of the electrolyte which is decomposed. 7. All compound atoms, if decomposible, require the same quantity of electricity to decompose them. Therefore, if the same electric current be passed through a number of metallic solutions in succession, the metals will be reduced in the ratio of their atomic weights (Faraday.) 8. The quantity of electricity which a compound atom requires to decompose it is equal to the quantity which that atom evolves when it is decomposed in the generating cell of the battery. 9. The quantity of electricity evolved during the chemical union of two atoms is capable of effecting the decomposition of an atom of any compound body susceptible of electrolysis. After illustrating these laws by experiment, the professor exemplified, in the case of oxygen and hydrogen, the extraordinary chemical energy possessed by the constituents of an electrolyte at the moment of their liberation at the electrodes, which occurs also in other cases in the act of separation of the elements of a compound. He next proceeded to point out the relation of Time to chemical action. In many cases, as in the combustion of gun-cotton, chemical action is commenced and completed in an interval of time too short to be measured; but occasionally its commencement and completion are delayed for a considerable time. As instances of these were mentioned the oxidation or rusting of iron; the disintegration of stone by the acids in the air; the opacity which occurs in the mixtures of sulphate of potash and nitrate of strontium, &c. [Such deferred chemical action may result from a species of polarisation, by which heterogeneous vibrations are gradually reduced to vibrations in one direction.] The lecture was concluded with remarks on the so-called influence of vitality on the production of many substances, such as oil, starch, sugar, gum, and their derivatives, which led to the division of chemistry into inorganic and organic. By the discoveries of Wöhler, Berthelot, and others, the distinction between organic and inorganic compounds has been demolished, and more than 1000 organic bodies can now be produced from their inorganic elements (oxygen, hydrogen, nitrogen, carbon, &c), without the agency of vitality; and Dr. Frankland stated that there is no evidence that any peculiar force assists in the production of the chemical changes occuring in living organisms.

Dr. W. Allen Miller, Treasurer, R.S., gave the Friday evening discourse, "On the Photographic Transparency of Bodies, and on the Photographic Spectra of the Elementary Bodies." In the radiation from luminous sources are comprised calorific, luminous, and chemical rays. Dr. Miller's investigations were confined to the last, the action of which he had found it convenient to test by the photographic effect exerted upon a surface of collodion coated with iodide of silver, on which the spectrum of the substance examined was allowed to fall. He was thus enabled to produce and exhibit, by aid of the electric lamp, many photographic transparencies of various media—solids, liquids, and gases, taking as the standard of comparison a diagram showing the relative lengths of the visible solar spectrum and the photographic spectrum of the electric spark between silver points. In the latter the chemical effects were shown to be prolonged to an extent between four and five times the length of the visible portion. After some remarks on the researches of Professor Stokes and others, Dr. Miller proceeded to illustrate the results which he had obtained by his own experiments—viz., 1. Colourless bodies which are equally transparent to the visible rays vary greatly in permeability to the chemical rays; 2. Bodies which are photographically transparent in the solid form are also so in the liquid and gaseous states; 3. Colourless transparent solids, which absorb the photographic rays, do so also with greater or less intensity in the liquid and gaseous states; 4. Pure water is photographically transparent; so that many compounds which cannot be obtained in the solid form sufficiently transparent for experiment may be subjected to trial in solution in water. The mode of experiment was then described, and the results (tabulated in a diagram) adverted to. After due notice of the researches of Kirchhoff and others in what is now termed solar and stellar chemistry, Dr. Miller exhibited a photograph of a spectrum formed by the light of the star "Sirius," a body said by Herschel to be sixty times larger than our sun, and 130 thousand millions of millions of miles distant from us. Yet its light is in a degree influencing the chemical changes which occur upon the earth's surface; and by suitable means these changes may be recorded, estimated, and measured, by a force which emanated from Sirius twenty one years before it was registered by the photographer. A photograph of the spectrum of Capella, a star estimated to be more than three times the distance of Sirius, was also shown. In obtaining these photographs, Dr. Miller was aided by his friend Mr. Huggins, and his excellent astronomical apparatus.

Professor Marshall's eighth lecture (given on the 10th instant) was devoted to an illustrated explanation of the Mechanism of Aerial Locomotion. In birds, the whole anatomical structure was shown to be subservient to the organs of flight. The wings, and the strong muscles connected with them, corresponding to the arms in man, are restricted to locomotion in the air, the head, neck, and bill being strengthened for prehensile purposes. The air is the fulcrum of aerial locomotion; a bird could not fly in a vacuum. The body of the bird is exceedingly strong and light, and, being of a very high temperature (from 120 to 140 degrees Fahrenheit), the air in the sacs surrounding its bony structure becomes specifically lighter than air, whereby the animal is enabled to rise with great facility. By various wonderful arrangements birds are enabled to regulate all their movements, ascending or descending in the air, either very gradually or with immense velocity. Of all birds the little humming-bird is said to be the strongest in flight, in proportion to its size. The latter part of the lecture comprised an account of the locomotive apparatus of aquatic birds, bats, insects, the fossil flying reptiles, the pterodactyles, the archæopteryx, &c.

USEFUL INFORMATION ABOUT BOILERS.

The "Association for the Prevention of Steam Boiler Explosions," in Manchester, England, through its Chief Engineer, Mr. L. E. Fletcher, publishes monthly and annual reports of a most valuable character to all who make and use steam boilers. Its last annual report has been published nearly in full by the *Mechanics' Magazine* and *The Engineer* (London), and from these we condense the following:—

One of the most fruitful sources of fracture in boilers is the unequal expansion and contraction of their different parts on account of the various temperatures, which are caused in many cases, though not in all, by by imperfect circulation of the water. Grooving manifests itself in the double-flued boilers at the tube angle-irons and end plates, more especially at the furnace mouth, and it is more active in proportion as the end plates are rigidly stayed. In no class of boilers is this action so destructive as that in which the furnace tubes are brought so close together that there is not room for the angle iron at either end of the flue to be carried completely round them, and which, therefore, requires to be supplemented with a saddle-plate, which, with its complement of the two partial angle-iron hoops, forms a "spectacle piece." These saddle-pieces are found to wear in grooves so deeply that in some cases the whole thickness of the plate is eaten through. Channeling is also frequent at the transverse seams at the bottom of the shell of internally-fired boilers. Boilers with two furnaces running into a single oval flue, containing a number of vertical water tubes have the advantage of a more rapid circulation of the water; this is calculated to prevent transverse channeling at the ring seams and grooving at the angle irons. Corrosion is found to be going on in all boilers. A fruitful source of this evil is found in the leakage of blow-out pipes, at their attachment to the shell. Boilers are also subject to very rapid exterior corrosion where they come in contact with damp brick work. Internal corrosion arises in many cases from acidity in the water. When this is the case corrosion may be prevented by the use of carbonate of soda. One firm in Manchester, having several 50-horse-power boilers, use half a pound of the carbonate of soda in each per day. This neutralizes the acidity of the water and has been found beneficial. It is added in small doses and may be fed in by the feed pump. Incrustations in boilers are great evils. A partial remedy has been adopted in marine boilers by frequently blowing out at the surface. The scum which rises on the surface of the water is then discharged through a suitable pipe. In most cases the use of a moderate quantity of the carbonate of soda, combined with blowing out the boiler at the surface, will prevent incrustations. Surface condensers, however, afford the most radical prevention of incrustation in all boilers. The condensed steam is pure distilled water, and as it is used over and over again in the boilers of engines which have surface condensers, no incrustations can be formed in them.

During the year 1862, thirty boiler explosions occurred in Great Britain, by which eighty-seven persons lost their lives and eighty-nine were injured. Of these thirty explosions eleven occurred to externally-fired boilers, from failure of the plates that were directly exposed to the action of the fire, three resulted from internal corrosion, three from external corrosion, four were due to improper construction, one to shortness of water, and another to accumulated pressure of steam for want of a safety valve; this was the boiler of a kitchen range. Particulars as to the causes of the other seven explosions were not obtained.

In the Manchester district surface blowing-out in boilers has made considerable progress and the use of the steam jacket for cylinders has been revived. With respect to its utility Mr. Fletcher says;—"The steam jacket has, in combination with the use of highly-heated steam, been the principal element in the attainment of that economy for which the Cornish engine has long since been notorious." Surface blowing-out of the boiler, surface condensation of the steam in condensers, and superheating are due to marine-engineering practice; these changes have developed higher economic results.—*Scientific American.*

USEFUL RECIPES.

To remove Grease Spots from Silk.

To two ounces of spirits of wine add one ounce of French chalk and five ounces of pipe clay, both finely powdered. Make up the mixture into a paste, roll it into pipes, and let it dry. Apply it by rubbing it on the spot of grease, slightly moistened, and then brush it off till the grease is absorbed.

To detect Animal and Vegetable Fibres.

Treat the fabric with bichloride of tin heated to from 130° to 150° Fahr., when the cotton and linen become black, and wool and silk remain unchanged.

To detect mixed Fabrics of Cotton and Wool.

Dip a piece of the suspected cloth in bleaching liquor; after a little the woollen turns yellow and the cotton white, and consequently may be easily distinguished.

Another method.—Take a small piece of the cloth and boil in caustic soda, when the wool will be dissolved and the cotton remain. If the threads have been previously counted, their relative mixture may be thus ascertained.

Cotton with Silk and Wool.

Put a piece of the cloth into chlorine water or bleaching liquor. The cotton is whitened by the liquor, and the silk and woollen become yellow. These changes will be easily distinguished by the use of a small pocket lens.

Another method.—Take a small piece and unravel the threads, and inflame them; the cotton burns away freely, with little or no black charcoal; the woollen and silk shrivel up, leave a black charcoal, and give a strong smell.

To take out Mildew.

Mix soft soap with starch powdered, half as much salt, and the juice of a lemon; lay it on the part on both sides with a painter's brush. Let it lie on the grass day and night till the stain comes out.

Stains caused by Acids.

Wet the part, and lay on it some salt of wormwood. Then rub it without diluting it with more water.

Glues.

Parchment Glue.—Parchment shavings 1 pound; water 6 quarts. Boil until dissolved, then strain and evaporate slowly to the proper consistence. Use a water bath if you want it very light colored.

Japanese Cement, or Rice Glue.—Rice flour; water, sufficient quantity. Mix together cold, then bring the mixture to a boil, stirring it all the time. Observe to boil it in a vessel that will not color it.

Japanners' Gold Size.—Gum ammoniac 1 pound; boiled oil 8 ounces; spirits of turpentine 12 ounces. Melt the gum, then add the oil, and lastly the spirits of turpentine.

Gold Size.—Yellow ochre 1 part; copal varnish 2 parts; linseed oil 3 parts; turpentine 4 parts; boiled oil 5 parts. Mix. The ochre must be in the state of the finest powder, and ground with a little of the oil before mixing.

Glue Liquid.—Glue, water, vinegar, each 2 parts. Dissolve in a water bath, then add alcohol 1 part. An excellent cement.

Transparent Liquid Japan for Metal.—Copal varnish 35 parts; camphor 1 part; boiled oil 2 parts. Mix.

Portable Glue for Draughtsmen, &c.—Glue 5 parts; sugar 2 parts; water 8 parts. Melt it in a water bath, and cast it in moulds. For use, dissolve in warm water.

Waterproof Glue.—1. Glue 1 part; skimmed milk 8 parts. Melt and evaporate in a water bath to the consistence of strong glue.

2. Glue 12 parts; water sufficient to dissolve. Then add yellow resin 3 parts, and when melted add turpentine 4 parts. Mix thoroughly together. This should be done in a water bath.

Gilding.

To Gild or Silver Leather.—Finely powder resin, and dust it over the surface of the leather, then lay on the leaf, and apply (hot) the letters or impression you wish to transfer; lastly, dust off the loose metal with a cloth. The cloths used for this purpose, become, in time, very valuable, and are often sold to the refiners for $5 to $7.

To Gild on Calf or Sheep Skin.—Wet the leather with the white of eggs; when dry rub it with your hand and a little olive oil, then put the gold leaf, and apply the hot iron to it. Whatever the hot iron shall not have touched will go off by brushing.

To Gild Copper, Brass, &c. (*Patent.*)—Fine gold 5 parts; nitric acid (sp. g. 1·45) 21 parts; hydrochloric acid (sp. g. 1·15) 17 parts; pure water 14 parts. Digest with heat in a glass vessel until all the gold is dissolved, and till red or yellow fumes cease to rise. Decant the clear liquid into some convenient vessel, and add water, 500 to 600 parts. Boil for two hours, let it stand to settle, and pour off the clear into a suitable vessel. For use, heat the liquid and suspend the articles (previously well cleaned) by means of a hair or fine wire, until sufficiently coated with gold, then well wash them in pure water.

To Gild Glass or Porcelain.—1. Apply to the part a surface of gold size; when nearly dry lay on the leaf.

2. Gold powder 2 parts; borax 1 part; turpentine to mix. Mix and apply to the surface to be gilded with a camel-hair pencil; when quite dry, heat it in a stove until the borax vitrifies. Burnish. Platina, silver, tin, bronze, &c., may be applied in a similar manner.

To give Iron the color of Copper.—Take 1 oz. of copper-plates, cleansed in the fire; 3 oz. of aqua-fortis; dissolve the copper, and when it is cold use it by washing your iron with it by the help of a feather; it is presently cleansed and smooth, and will be of a copper color; by much using or rubbing it will wear off, but may be renewed by the same process.

A way of gilding with Gold upon Silver.—Beat a ducat thin, and dissolve in it two ounces of aqua-regia; dip clean rags in it, and let them dry; burn the rags, and, with the tinder thereof, rub the silver with a little spittle; be sure first that the silver be cleansed from grease.

Gilders' Wax.—1. Yellow wax 3 pounds; verdigris 1 pound; sulphate of zinc 1 pound; red oxide of iron 2½ pounds. Powder the last three articles very fine.

2. Yellow wax 7 pounds; colcothar 7 pounds; verdigris 3 pounds; borax ½ pound; alum ½ pound.

To dye in Gold Silver Medals, or Laminas, through and through.—Take glauber salt, dissolve it in warm water, so as to form a saturated solution. In this solution put a small proportionate quantity of calx, or magister of gold. Then put and digest in it silver laminas cut small and thin, and let them lie twenty-four hours over a gentle fire. At the end of this term you will find them thoroughly dyed gold color inside and out.

To gild silks, satins, &c.—Nitromuriate of gold, in solution, 1 part; distilled water 3 parts. Mix. Lay out any design with this fluid, and expose it, while wet, to a stream of hydrogen gas; then wash it with clear water.

To make Transparent Silver.—Refined silver one ounce; dissolve it in two ounces of aqua-fortis;

precipitate it with a pugil (a quantity that may be taken up between the thumb and finger) of salt, then strain it through a paper, and the remainder melt in a crucible for about half an hour, and pour it out, and it will be transparent.

Mercurial Plating.—Quicksilver 4 parts; nitric acid 4 parts; finely powdered cream of tartar 2 parts; finely powdered salt of sorrel 1 part. Dissolve the silver in the acid, then add the rest, and stir until dissolved. This imparts a pleasing silvery appearance to articles formed of copper, by merely applying it with the finger.

Grecian Gilding.—Take sal-ammoniac and bichloride of mercury, equal parts, dissolve in nitric acid, and make a solution of gold with this fluid, lay it on the silver, and expose it to a red heat; it will then be gilded.

To Gild or Silver Writing.—Let there be a little gum and lump-sugar in the ink you write with; when dry, breathe on it and apply the leaf.

To Gild Steel.—Apply an etherial solution of gold. This is equally adapted to lettering, as wholly covering the object. It may be applied with a pen, or otherwise.

Miscellaneous.

Mummy Wheat.

The *Presse Scientifique des Deux Mondes* contains a description of a series of experiments made in Egypt by Figari-Bey on the wheat found in the ancient sepulchres of that country. A long dispute occurred a few years ago, as to what truth there might be in the popular belief, according to which this ancient wheat will not only germinate after the lapse of three thousand years, but produce ears of extraordinary size and beauty. The question was left undecided; but Figari-Bey's paper, addressed to the Egyptian Institute at Alexandria, contains some facts which appear much in favour of a negative solution. One kind of wheat which Figari-Bey employed for his experiments had been found in Upper Egypt, at the bottom of a tomb at Medinet-Aboo, by M. Schnepp, secretary to the Egyptian Institute. There were two varieties of it, both pertaining to those still cultivated in Egypt. The form of the grains had not changed; but their colour, both within and without, had become reddish, as if they had been exposed to smoke. The specific weight was also the same—viz., twenty-five grains to a gramme. On being ground they yield a good deal of flour, but are harder than common wheat, and not very friable; the colour of the flour is somewhat lighter than that of the outer envelope. Its taste is bitter and bituminous; and when thrown into the fire, it emits a slight but pungent smell. On being sown in moist ground, under the usual pressure of the atmosphere, and at a temperature of 25 degrees (Reaumur), the grains became soft, and swelled a little during the first four days; on the seventh day their tumefaction became more apparent, with an appearance of maceration and decomposition; and on the ninth day this decomposition was complete. No trace of germination could be discovered during all this time. Figari-Bey obtained similar negative results from grains of wheat found in other sepulchres, and also on barley proceedings from the same source; so that there is every reason to believe that the ears hitherto ostensibly obtained from mummy wheat proceed from grain accidentally contained in the mould into which the former was sown.

New Water-pressure Engine—"Steam Superseded.

"At the Water-works office, in Wolverhampton, England, according to the local chronicle, a hydraulic engine is doing the work of a steam-engine in the most complete and satisfactory manner. It is the invention of Mr. Henry James Lewis, a practical engineer. Its mechanism in appearance is much the same as that of the steam-engine, with the exception that it has two globes or air-vessels upon the cylinder. The action is very simple. The water is supplied to the engine from the main by means of an ordinary pipe, and can be turned on or off by means of a common stopcock at pleasure. When the engine is about to be set to work, the water is allowed to pass into a chest or nozzle, within which is a slide-valve, the same as is used in a steam-engine. The water, having filled the nozzle, rushes through the passage that is not covered by the slide-valve into the cylinder, forcing the piston along with it, at the same time compressing the air in one of the globes or air-vessels until the slide-valve shuts the passage; when the air that is now compressed in the one globe, by giving a certain amount of elasticity to the water acting on the piston, enables the crank to continue its motion. After the valve has covered the one passage, preparatory to opening the other passage for the return stroke of the engine, the same process is repeated. The rectilinear motion is converted into a rotary motion by means of a connecting rod and crank, and applied to the purpose for which it is required by ordinary pulley bands.—*The Builder.*

A Martyr to Science.

It is with real pain that we have to announce to our readers the death of Mr. Lucas Barrett, the distinguished naturalist, who was accidentally drowned whilst investigating the structure of some coral reefs at Port Royal, Jamaica. All who visited the Jamaica Court at the International Exhibition will remember the enthusiasm and painstaking kindness with which this gentleman was ever ready to show and explain the various mineral and geological specimens collected and exhibited by him. Although one of the most active of the Jamaica Commissioners, he still found time to officiate as one of the local secretaries of the British Association, besides keeping a term at Cambridge. Before returning to Jamaica to renew his researches as one of the chief members of the West Indian Geological Survey, he ordered a diving dress and pumping apparatus of the latest and most scientific construction, for the purpose of personally examining the rocks and coral reefs lying in the neighbourhood of most of the West India islands. He first tried this dress at Port Royal, on December 17, in shallow water, and was so well pleased with the result that he determined to give it a trial in deeper water. Two days afterwards he took with him his servants and boat's crew, all of whom were negroes, and descended into the deep water between the reefs. the men in the boat continued to pump without intermission as on the former occasion, but they noticed that he remained longer in the water than usual. Suddenly, to their horror, they saw him floating on the surface at a little distance from the boat. They got to him as quickly as possible, but all was over. The cause of his death will remain a mystery. He was not drowned by the influx of the water, as the diving-dress contained only air. The only explanation to be given is, that the air exit valves became permanently closed in some mysterious manner; but even this seems open to doubt, as the men continued to pump without interruption. Mr. Barrett was only twenty-five years of age when he died; and the enormous amount of valuable work done by him during his brief career, gave promise of his speedily becoming one of the chief ornaments of the science he so ardently loved, and to the too enthusiastic pursuit of which he fell a victim For three years before his engagement on the West Indian survey, he delivered most of the geological lectures for Professor Sedgwick, and was made by him curator of the Woodwardian museum at that university. His collection of *Radiata* in that Museum is one of the finest in the world. His loss to science will be felt severely, not merely on account of his own personal exertions in the cause of truth, but from the enthusiasm he communicated to those who had the privilege of his acquaintance.—*Chemical News.*

Mess Pork.

The following standard rules, known as "Getty's Directions," are those given for putting up prime mess pork, to meet the requirements of the English market. They are also adopted and made imperative in the contracts given out for army supplies by the United States Government. Quality and Weight of Pigs.—The pigs to weigh from 100 to 160 lbs. each, and to be in good condition, strictly corn-fed or hard pork. For the United States army the weight may be extended to 170 lbs. Parts Excluded.—The head is to be excluded, also the fore-leg up to the breast or brisket, the hind-leg, including the hock or gambrel-joint, and the rump, if the hams are not cut up with the sides. What Constitutes a Barrel of Prime Mess.—A barrel of prime mess pork consists of fifty pieces of four pounds each. If the hams are cut up and put in, there shall not be less than twenty-three side-pieces; if without hams, not less than thirty side-pieces. How to Cut and Cure.—After the pig has been split through the back, cut each side longitudinally into two strips; pack the strips into large casks or vats, and fill up with brine, having saltpetre added at the rate of one ounce to three gallons of brine; leave the strips in the brine for eight or ten days to extract the blood, and for the lean meat to take a pink colour. When ready to be packed into barrels, have each strip carefully cleaned, using a knife and a brush if necessary; cut them into four-pound pieces as nearly as may be: Mess (select the pieces) as indicated, and pack neatly and compactly in layers, with sufficient salt to preserve it. Barrels.—The barrel should be twenty-eight inches long, and seventeen and a half inches over the end (when finished), made of seasoned white oak, free from sap, full bound with hickory or white oak hoops, and one iron hoop, one inch wide, on each end next below the chine hoop. Theory of Messing.—Pigs averaging say 145 lbs. will work up in messing about as follows:—When the side, including the ham, is cut up there will be twenty-three or twenty-four pieces of side-meat, eight pieces of ham and saddle, and eighteen or nineteen of shoulder and neck to the barrel; excluding the hams, the number of side-pieces will be increased to thirty-one or thirty-two. In no case should there be more than six pieces of the leg part of the shoulder put into a barrel.—*Grocer.*

Cochineal Superseded.

As everybody knows, the various shades of scarlet and crimson with which textile fabrics are dyed or printed were made from cochineal. Cochineal is an insect taken in Mexico, from the broad leaves of the cactus. Ordinarily it would now command an enormous price. It is worth less even now than it was ten years ago. The cause of this decline in the value of cochineal is because of the discovery of a more beautiful dye, called aniline, produced from coal oil. From this coal oil, by tedious process, is produced this aniline, of which, by the way, a single pound costs eighty dollars. Its diffuseness, we believe, exceeds that of any known substance. A pound of it would impart a perceptible tint to a large pond of water. At a factory, the other day, where silk handkerchiefs are printed, we had an opportunity of observing the incomparable superiority of the new colors to those produced by cochineal. Aniline gives every shade of purple, from the deepest royal to the faint lilac, every variety of blue, from the pale tint of the sky to the deepest ultra-marine, and all the gradations of scarlet and crimson of like beauty.—*American Paper.*

Mechanics' Memoranda.

The following convenient rules for mechanics and others, although not perfect in their fractional parts, are correct enough for all practical purposes:—

To find the area of a triangle; multiply the base by the perpendicular height, and take half the product for the area.

To find the area of a circle; multiply half the circumference by half the diameter, and the product will be the area.

To find the circumference of a circle from the diameter; multiply the diameter by 22, and divide by seven; or to be more exact multiply the diameter by 325, and divide by 183.

To find the contents of a pyramid or cone; find the area of the base, and multiply that area by the perpendicular height, and take one-third of the product for the contents.

To find the weight of wrought iron; find the number of cubic inches in the piece, and multiply 2.016 (the weight of one cubic inch) the product is the weight in pounds.

To find the weight of cast iron; find as above and multiply by 2.607.

To find the weight of copper; find as above and multiply by 3.2118; the product is the weight in pounds.