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[Illustration]

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FOUNDATIONS IN QUICKSAND.

Foundations in quicksand often have to be built in places where least expected, and sometimes the writer has been able to conveniently span the vein with an arch and avoid trouble; but where it cannot be conveniently arched over, it will be necessary to sheath pile for a trench and lay in broad sections of concrete until the space is crossed, the sheath piling being drawn and reset in sections as fast as the trenches are leveled up. The piling is left in permanently if it is not wanted again for use.

Sometimes these bottoms are too soft to be treated in this manner; in that case boxes or caissons are formed, loaded with stone and sunk into place with pig iron until the weight they are to carry is approximated. When settled, the weights are removed and building begins.

Foundations on shifting sand are met with in banks of streams, which swell and become rapids as each winter breaks up. This kind is most troublesome and dangerous to rest upon if not properly treated.

Retaining walls are frequently built season after season, and as regularly become undermined by the scouring of the water. Regular docking with piles and timbers is resorted to, but it is so expensive for small works that it is not often tried.

Foundations are formed often with rock well planted out; and again success has attended the use of bags of sand where rough rock was not convenient or too expensive.

In such cases it is well to try a mattress foundation, which may be formed of brushwood and small saplings with butts from ‰ inch to 2‰ inches in diameter, compressed into bundles from 8 to 12 inches diameter, and from 12 to 16 feet long, and well tied with ropes every four feet. Other bundles, from 4 to 6 inches diameter and 16 feet long, are used as binders, and these bundles are now cross-woven and make a good network, the long parts protruding and making whip ends. One or more sets of netting are used as necessity seems to require. This kind of foundation may be filled in with a concrete of hydraulic cement and sand, and the walls built on them with usual footings, and it is very durable, suiting the purpose as well as anything we have seen or heard of.--_Inland Architect_.

* * * * *

LIFT BRIDGE OVER THE OURCQ CANAL.

This bridge, which was inaugurated in 1868, was constructed under the direction of Mr. Mantion, then engineer-in-chief of the Belt Railway. Fig. 1 shows the bridge raised.

The solution adopted in this case was the only feasible one that presented itself, in view of the slight difference between the level of the railway tracks and the maximum plane of the canal water. This circumstance did not even permit of a thought of an ordinary revolving bridge, since this, on a space of 10 inches being reserved between the level of the water and the bottom of the bridge, and on giving the latter a minimum thickness of 33 inches up to the level of the rails, would have required the introduction into the profile of the railroad of approaches of at least one-quarter inch gradient, that would have interfered with operations at the station close by.

[Illustration: FIG. 1.--LIFT BRIDGE OVER THE OURCQ CANAL.]

Besides, in the case of a revolving bridge, since the bottom of the latter would be but ten inches above the water level, and the rollers would have to be of larger diameter than that, it would have been necessary to suppose the roller channel placed beneath the level of the water, and it would consequently have been necessary to isolate this channel from the canal by a tight wall. The least fissure in the latter would have inundated the channel.

As the Ourcq Canal had no regular period of closing, it was necessary to construct the bridge without hinderance to navigation. The idea of altering the canal’s course could not be thought of, for the proximity of the fortifications and of the bridge over the military road was opposed to it. Moreover, the canal administration insisted upon a free width of 26 feet, which is that of the sluices of the St. Denis Canal, and which would have led to the projection of a revolving bridge of 28 feet actual opening in order to permit of building foundations with caissons in such a way as to leave a passageway of 26 feet during operations.

For these reasons it was decided to construct a metallic bridge that should be lifted by means of counterpoises and balanced after the manner of gasometers.

The free width secured to navigation is 28 feet. The bridge is usually kept raised to a height of 16 feet above the level of the water in order to allow boats to pass (Fig. 2). In this position it is balanced by four counterpoises suspended from the extremities of chains that pass over pulleys. These counterpoises are of cast iron, and weigh, altogether, 44,000 pounds--the weight of the bridge to be balanced, say 11,000 pounds per counterpoise. Moreover, each of the four chains is prolonged beneath the corresponding counterpoise by a chain of the same weight, called a compensating chain.

The pulleys, B and C, that support the suspension chains have projections in their channels which engage with the links and thus prevent the chains from slipping. They are mounted at the extremity of four latticed girders that likewise carry girder pulleys, D. The pulleys that are situated at the side of the bridge are provided laterally with a conical toothing which gears with a pinion connected with the maneuvering apparatus.

The two pinions of the same side of the bridge are keyed to a longitudinal shaft which is set in motion at one point of its length by a system of gearings. The winch upon which is exerted the stress that is to effect the lifting or the descent of the bridge is fixed upon the shaft of the pinion of the said gearing, which is also provided with a flywheel, c. The longitudinal shafts are connected by a transverse one. e, which renders the two motions interdependent. This transverse shaft is provided with collars, against which bear stiff rods that give it the aspect of an elongated spindle, and that permit it to resist twisting stresses.

The windlasses that lift the bridge are actuated by manual power. Two men (or even one) suffice to do the maneuvering.

This entire collection of pulleys and mechanism is established upon two brick foot bridges between which the bridge moves. These arched bridges offer no obstruction to navigation. Moreover, they always allow free passage to foot passengers, whatever be the position of the bridge. They are provided with four vertical apertures to the right of the suspension chains, in order to allow of the passage of the latter. The girders that support the pulleys rest at one extremity upon the upper part of the bridges, and at the other upon solid brick pillars with stone caps.

Finally, in order to render the descent of the bridge easier, there are added to it two water tanks that are filled from the station reservoir when the bridge is in its upper position, and that empty themselves automatically as soon as it reaches the level of the railroad tracks.

A very simple system of fastening has been devised for keeping the bridge in a stationary position when raised. When it reaches the end of its upward travel, four bolts engage with an aperture in the suspension rod and prevent it from descending. These bolts are set in motion by two connecting rods carried by a longitudinal shaft and maneuvered by a lever at the end of the windlass.

At the lower part the bridge rests upon iron plates set into sills. It is guided in its descent longitudinally by iron plates that have an inclination which is reproduced at the extremities of the bridge girders, and transversely by two inclined angle irons into which fit the external edges of the bottoms of the extreme girders.

[Illustration: FIG. 2.--ELEVATION AND PLAN.]

The total weight of the bridge is, as we have said, 44,000 pounds, which is much less than would have been that of a revolving bridge of the same span. The maneuvering of the bridge is performed with the greatest ease and requires about two minutes.

This system has been in operation at the market station of La Vilette since the year 1868, and has required but insignificant repairs. We think the adoption of it might be recommended for all cases in which a slight difference between the level of a railroad and that of a water course would not permit of the establishment of a revolving bridge.--_Le Genie Civil_.

*   *   *   *   *

ST. PETERSBURG A SEAPORT.

The Emperor and Empress of Russia, on Wednesday, May 27. 1885, the second anniversary of their coronation at Moscow, opened the Maritime Canal, in the Bay of Cronstadt, the shallow upper extremity of the Gulf of Finland, by which great work the city of St. Petersburg is made a seaport as much as London. St. Petersburg, indeed, stands almost on the sea shore, at the very mouth of the Neva, though behind several low islands which crowd the head of the Gulf; and though this is an inland sea without saltness or tides, it is closed by ice in winter. Seventeen miles to the west is the island of Cronstadt, a great fortress, with naval dockyards and arsenals for the imperial fleet, and with a spacious harbor for ships of commerce. The navigable entrance channel up the Bay of Cronstadt to the mouth of the Neva lies under the south side of Cronstadt, and is commanded by its batteries. As the bay eastward has a depth not exceeding 12 ft., and the depth of the Neva at its bar is but

9 ft., all large vessels have been obliged hitherto to discharge their cargoes at Cronstadt, to be there transferred to lighters and barges which brought the goods up to the capital. "The delay and expense of this process," says Mr. William Simpson, our special artist, "will be understood by stating that a cargo might be brought from England by a steamer in a week, but it would take three weeks at least to transport the same cargo from Cronstadt to St. Petersburg. Of course, much of this time was lost by custom house formalities. Sometimes it has taken even longer than is here stated, which made the delivery of goods at St. Petersburg a matter of great uncertainty, thus rendering time contracts almost an impossibility. This state of things had continued from the time of Peter the Great, and his great scheme had never been fully realized. The increase of commerce and shipping had long made this a crying evil; but even with all these difficulties, the trade here has been rapidly growing. A scheme to bring the shipping direct to the capital had thus become almost a necessity. As Manchester wishes to bring the ocean traffic to her doors without the intervention of Liverpool, so St. Petersburg desired to have its steamers sailing up to the city, delivering and loading their cargoes direct at the stores and warehouses in her streets. If Glasgow had not improved the Clyde, and had up to the present day to bring up all goods carried by her ocean going steamers from Port Glasgow--a place constructed for that purpose last century, and which is twenty miles from Glasgow--she would have been handicapped exactly as St. Petersburg has been till now in the commercial race.

"For some years the subject was discussed at St. Petersburg, and more than one scheme was proposed; at last the project of General N. Pooteeloff was adopted. According to this plan, a canal has been cut through the shallow bottom of the Gulf of Finland, all the way from Cronstadt to St. Petersburg. The line of this canal is from northwest to southeast; it may be said to run very nearly parallel to the coast line on the south side of the Gulf, and about three miles distant from it. This line brings the canal to the southwest end of St. Petersburg, where there are a number of islands, which have formed themselves, in the course of ages, where the Bolshaya, or Great Neva, flows into the Gulf. It is on these islands that the new port is to be formed. It is a very large harbor, and capable of almost any amount of extension. It will be in connection with the whole railway system of Russia. One part of the scheme is that of a new canal, on the south side of the city, to connect the maritime canal, as well as the new harbor, with the Neva, so that the large barges may pass, by a short route, to the river on the east, and thus avoid the bridges and traffic of the city.

"The whole length of the canal is about eighteen miles. The longer portion of it is an open channel, which is made 350 feet wide at bottom. Its course will be marked by large iron floating buoys; these it is proposed to light with gas by a new self-acting process which has been very successful in other parts of the world; by this means the canal will be navigable by night as well as by day. The original plan was to have made the canal 20 feet deep, but this has been increased to 22 feet. The Gulf of Finland gradually deepens toward Cronstadt, so that the dredging was less at the western end. This part was all done by dredgers, and the earth brought up was removed to a safe distance by means of steam hopper barges. The contract for this part of the work was sublet to an American firm--Morris and Cummings, of New York. The eastern portion of the work on the canal is by far the most important, and about six miles of it is protected by large and strong embankments on each side. These embankments were formed by the output of the dredgers, and are all faced with granite bowlders brought from Finland; at their outer termination the work is of a more durable kind, the facing is made of squared blocks of granite, so that it may stand the heavy surf which at times is raised by a west wind in the Gulf. These embankments, as already stated, extend over a space of nearly six miles, and represent a mass of work to which there is no counterpart in the Suez Canal; nor does the plan of the new Manchester Canal present anything equivalent to it. The width of this canal also far exceeds any of those notable undertakings. The open channel is, as stated above, 350 ft. wide; within the embankments the full depth of 22 ft. extends to 280 ft., and the surface between the embankments is 700 ft. This is nearly twice the size of the Suez Canal at the surface, which is 100 meters, or about 320 ft., while it is only about 75 ft. at the bottom; the Amsterdam Canal is 78 ft. wide. The new Manchester Canal is to be 100 ft. of full depth, and it boasts of this superiority over the great work of Lesseps. The figures given above will show how far short it comes of the dimensions of the St. Petersburg Canal. The Manchester Canal is to be 24 ft. in depth; in that it has the advantage of 2 ft. more than the St. Petersburg Canal; but with the ample width this one possesses, this, or even a greater depth, can be given if it should be found necessary. Most probably this will have ultimately to be done, for ocean going steamers are rapidly increasing in size since the St. Petersburg Canal was planned, and in a very few years the larger class of steamers might have to deliver their cargoes at Cronstadt, as before, if the waterway to St. Petersburg be not adapted to their growing dimensions.

[Illustration: THE ST. PETERSBURG AND CRONSTADT MARITIME CANAL, OPENED BY THE EMPEROR OF RUSSIA, ON WEDNESDAY, MAY 27, 1885.]

"The dredging between the embankments of the canal was done by an improved process, which may interest those connected with such works. It may be remembered that the Suez Canal was mostly made by dredging, and that the dredgers had attached to them what the French called 'long couloirs' or spouts, into which water was pumped, and by this means the stuff brought up by the dredgers was carried to the sides of the canal, and there deposited. The great width of the St. Petersburg Canal was too much for the long couloirs, hence some other plan had to be found. The plan adopted was that invented by Mr. James Burt, and which had been used with the greatest success on the New Amsterdam Canal. Instead of the couloir, floating pipes, made of wood, are in this system employed; the earth or mud brought up has a copious stream of water poured on it, which mixes in the process of descending, and the whole becomes a thick liquid. This, by means of a centrifugal pump, is propelled through the floating pipes to any point required, where it can be deposited. The couloir can only run the output a comparatively short distance, while this system can send it a quarter of a mile, or even further, if necessary. Its power is not limited to the level surface of the water.

I saw on my visit to the canal one of the dredgers at work, and the floating pipes lay on the water like a veritable sea-serpent, extending to a long distance where the stuff had to be carried. At that point the pipe emerged from the water, and what looked very much like a vertebra or two of the serpent crossed the embankment, went down the other side, and there the muddy deposit was pouring out in a steady flow. Mr. Burt pointed out to me one part of the works where his pump had sent the stuff nearly half a mile away, and over undulating ground. This system will not suit all soils. Hard clay, for instance, will not mix with the water; but where the matter brought up is soft and easily diluted, this plan possesses many advantages, and its success here affords ample evidence of its merits.

"About five miles below St. Petersburg, a basin had been already finished, with landing quays, sheds, and offices; and there is an embankment connecting it with the railways of St. Petersburg, all ready for ships to arrive. When the ships of all nations sail up to the capital, then the ideas of Peter the Great, when he laid the foundations of St. Petersburg, will be realized. St. Petersburg will be no longer an inland port. It will, with its ample harbor and numerous canals among its streets, become the Venice of the North. Its era of commercial greatness is now about to commence. The ceremony of letting the waters of the canal into the new docks was performed by the Emperor in October, 1883. The Empress and heir apparent, with a large number of the Court, were present on the occasion. The works on the canal, costing about a million and a half sterling, were begun in 1876, and have been carried out under the direction of a committee appointed by the Government, presided over by his Excellency, N. Sarloff. The resident engineer is M. Phofiesky; and the contractors are Messrs. Maximovitch and Boreysha."

We heartily congratulate the Russian government and the Russian nation upon the accomplishment of this great and useful work of peace. It will certainly benefit English trade. The value of British imports from the northern ports of Russia for the year 1883 was £13,799,033; British exports, £6,459,993; while from the southern ports of Russia our trade was: British imports, £7,177,149; British exports, £1,169,890--making a total British commerce with European Russia of £20,976,182 imports from Russia and £7,629,883 exports to Russia. It cannot be to the interest of nations which are such large customers of each other to go to war about a few miles of Afguhan frontier. The London _Chamber of Commerce Journal_, ably edited by Mr. Kenric B. Murray, Secretary to the Chamber, has in its May number an article upon this subject well deserving of perusal. It points out that in case of war most of the British export trade to Russia would go through Germany, and might possibly never again return under British control. In spite of Russian protective duties, this trade has been well maintained, even while the British import of Russian commodities, wheat, flax, hemp, tallow, and timber, was declining 40 per cent. from 1883 to 1884. The St. Petersburg Maritime Canal will evidently give much improved facilities to the direct export of English goods to Russia. Without reference to our own manufactures, it should be observed that the Russian cotton mills, including those of Poland, consume yearly 264 million pounds of cotton, most of which comes through England. The importation of English coal to Russia has afforded a noteworthy instance of the disadvantage hitherto occasioned by the want of direct navigation to St. Petersburg; the freight of a ton of coal from Newcastle to Cronstadt was six shillings and sixpence, but from Cronstadt to St. Petersburg it cost two shillings more. It is often said, in a tone of alarm and reproach, that Russia is very eager to get to the sea. The more Russia gets to the sea everywhere, the better it will be for British trade with Russia; and friendly intercourse with an empire containing nearly a hundred millions of people is not to be lightly rejected.--_Illustrated London News_.

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THE NEW FRENCH DISPATCH BOAT MILAN.

The Milan, a new dispatch boat, has recently been making trial trips at Brest. It was constructed at Saint Nazaire, by the "Societe des Ateliers et Chantiers de la Loire," and is the fastest man-of-war afloat. It has registered 17 knots with ordinary pressure, and with increase of pressure can make 18 knots, but to attain such high speed a very powerful engine is necessary. In fact, a vessel 303 ft. long, 33 ft. wide, and drawing 12 ft. of water, requires an engine which can develop 4,000 H.P.

[Illustration: THE NEW FRENCH DISPATCH BOAT MILAN.]

The hull of the Milan is of steel, and is distinguished for its extreme lightness. The vessel has two screws, actuated by four engines arranged two by two on each shaft.

The armament consists of five three inch cannons, eight revolvers, and four tubes for throwing torpedoes.

The Milan can carry 300 tons of coal, an insufficient quantity for a long cruise, but this vessel, which is a dispatch boat in every acceptation of the word, was constructed for a definite purpose. It is the first of a series of very rapid cruisers to be constructed in France, and yet many English packets can attain a speed at least equal to that of the Milan. We need war vessels which can attain twenty knots, to be master of the sea.--_L'Illustration_.

*   *   *   *   *

THE LAUNCHING AND DOCKING OF SHIPS SIDEWISE.

The slips of the shipyards at Alt-Hofen (Hungary) belonging to the

Imperial and Royal Navigation Company of the Danube are so arranged that the vessels belonging to its fleet can be hauled up high and dry or be launched sidewise. They comprise three distinct groups, which are adapted, according to needs, for the construction or repair of steamers, twenty of which can be put into the yard at a time. The operation, which is facilitated by the current of the Danube, consists in receiving the ships upon frames beneath the water and at the extremity of inclined planes running at right angles with them. After the ship has been made secure by means of wedges, the frame is drawn up by chains that wind round fixed windlasses. These apparatus are established upon a horizontal surface 25.5 feet above low-water mark so as to give the necessary slope, and at which terminate the tracks. They may, moreover, be removed after the ships have been taken off, and be put down again for launching. For 136 feet of their length the lower part of the sliding ways is permanent, and fixed first upon rubble masonry and then upon the earth.

Fig. 1 gives a general view of the arrangement. The eight sliding ways of the central part are usually reserved for the largest vessels. The two extreme ones comprise, one of them 7, and the other 6, tracks only, and are maneuvered by means of the same windlasses as the others. A track, FF, is laid parallel with the river, in order to facilitate, through lorries, the loading and unloading of the traction chains. These latter are ¾ inch in diameter, while those that pass around the hulls are 1 inch.

The motive power is furnished by a 10 H.P. steam engine, which serves at the same time for actuating the machine tools employed in construction or repairs. The shaft is situated at the head of the ways, and sets in motion four double-gear windlasses of the type shown in Fig. 2. The ratio of the wheels is as 9 to 1. The speed at which the ships move forward is from 10 to 13 feet per minute. Traction is effected continuously and without shock. After the cables have been passed around the hull, and fastened, they are attached to four pairs of blocks each comprising three pulleys. The lower one of these is carried by rollers that run over a special track laid for this purpose on the inclined plane.

[Illustration: FIG. 1.--WAYS OF LAUNCHING VESSELS SIDEWISE.]

The three successive positions that a boat takes are shown in Fig. 1. In the first it has just passed on to the frame, and is waiting to be hauled up on the ways; in the second it is being hauled up; and in the third the frame has been removed and the boat is shoved up on framework, so that it can be examined and receive whatever repairs may be necessary. This arrangement, which is from plans by Mr. Murray Jackson, suffices to launch 16 or 18 new boats annually, and for the repair of sixty steamers and lighters. These latter are usually 180 feet in length, 24 feet in width, and 8 feet in depth, and their displacement, when empty, is 120 tons. The dimensions of the largest steamers vary between 205 and 244 feet in length, and 25 and 26 feet in width. They are 10 feet in depth, and, when empty, displace from 440 to 460 tons. The Austrian government has two monitors repaired from time to time in the yards of the company. The short and wide forms of these impose a heavier load per running foot upon the ways than ordinary boats do, but nevertheless no difficulty has ever been experienced, either in hauling them out or putting them back into the water.--_Le Genie Civil_.

[Illustration: FIG. 2.--DETAILS OF WINDLASS.]

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IMPROVED HIGH-SPEED ENGINE.

This engine, exhibited at South Kensington by Fielding and Platt, of Gloucester, consists virtually of a universal joint connecting two shafts whose axes form an obtuse angle of about 157 degrees. It has four cylinders, two being mounted on a chair coupling on each shaft. The word cylinder is used in a conventional sense only, since the cavities acting as such are circular, whose axes, instead of being straight lines, are arcs of circles struck from the center at which the axes of the shafts would, if continued, intersect. The four pistons are carried upon the gimbal ring, which connects, by means of pivots, the two chair couplings.

[Illustration: THE FIELDING HIGH SPEED ENGINE.]

Fig. 10 shows clearly the parts constituting the coupling, cylinders, and pistons of a compound engine. CC are the high-pressure cylinders; DD the low pressure; EEEE the four parts forming the gimbal ring, to which are fixed in pairs the high and low pressure pistons, GG and FF; HHHH are the chair arms formed with the cylinders carrying pivots, IIII, which latter fit into the bearings, JJJJ, in the gimbal ring. Figs. 1, 2, 3, 4 show these parts connected and at different points of the shaft’s rotation. The direction of rotation is shown by the arrow. In Fig. 1 the lower high-pressure cylinder, C, is just about taking steam, the upper one just closing the exhaust; the low-pressure pistons are at half stroke, that in sight exhausting, the opposite one, which cannot be seen in this view, taking steam.

In Fig 2 the shaft has turned through one-eighth of a revolution; in Fig. 3, a quarter turn; Fig. 4, three-eighths of a turn. Another eighth turn brings two parts into position represented by Fig. 1, except the second pair of cylinders now replace the first pair. The bearings, KL, support the two shafts and act as stationary valves, against which faces formed on the cylinders revolve; steam and exhaust ports are provided in the faces of K and L, and two ports in the revolving faces, one to each cylinder. The point at which steam is cut off is determined by the length of the admission ports in K and L. The exhaust port is made of such a length that steam may escape from the cylinders during the whole of the return stroke of pistons.

Fig. 5 shows the complete engine. It will be seen that the engine is entirely incased in a box frame, with, however, a lid for ready access to the parts for examination, one great advantage being that the engine can be worked with the cover removed, thus enabling any leakage past the pistons or valve faces to be at once detected. The casing also serves to retain a certain amount of lubricant.

The lubrication is effected by means of a triple sight-feed lubricator, one feeder delivering to steam inlet, and two serving the main shaft bearings.

Figs, 6 and 7 are an end elevation and plan of the same engine. There is nothing in the other details calling for special notice.

Figs. 8 and 9 show the method of machining the cylinders and pistons, the whole of which can be done by ordinary lathes, which is evidently a great advantage in the event of reboring, etc., being required in the colonies or other countries where special tools are inaccessible.

Figs. 11 and 12 are sections which explain themselves.--_The Engineer_.

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THE NATIONAL TRANSIT CO'S PIPE LINES FOR THE TRANSPORTATION OF PETROLEUM TO THE SEABOARD.

While Englishmen and Americans have been alike interested in the late project for forcing water by a pipe line over the mountainous region lying between Suakim and Berber in the far-off Soudan, few men of either nation have any proper conception of the vast expenditure of capital, natural and engineering difficulties overcome, and the bold and successful enterprise which has brought into existence far greater pipe lines in our own Atlantic States. We refer to the lines of the National Transit Company, which have for a purpose the economic transportation of crude petroleum from Western Pennsylvania to the sea coast at New York, Philadelphia, and Baltimore, and to the Lakes at Cleveland and Buffalo.

To properly commence our sketch of this truly gigantic enterprise, we must go back to the discovery of petroleum in the existing oil regions of Pennsylvania and adjacent States. Its presence as an oily scum on the surface of ponds and streams had long been known, and among the Indians this "rock-oil" was highly appreciated as a vehicle for mixing their wax paint, and for anointing their bodies; in later years it was gathered in a rude way by soaking it up in blankets, and sold at a high price for medicinal purposes only, under the name of Seneca rock oil, Genesee oil, Indian oil, etc.

But the date of its discovery as an important factor in the useful arts and as a source of enormous national wealth was about 1854. In the year named a certain Mr. George H. Bissell of New Orleans accidentally met with a sample of the "Seneca Oil," and being convinced that it had a value far beyond that usually accorded it, associated himself with some friends and leased for 99 years some of the best oil springs near Titusville, Pa. This lease cost the company $5,000, although only a few years before a cow had been considered a full equivalent in value for the same land. The original prospectors began operations by digging collecting ditches, and then pumping off the oil which gathered upon the surface of the water. But not long after this first crude attempt at oil gathering, the Pennsylvania Rock Oil Co. was organized, with Prof. B. Silliman of Yale College as its president, and a more intelligent method was introduced into the development of the oil-producing formation. In 1858, Col. Drake of New Haven was employed by the Pennsylvania Co. to sink an artesian well; and, after considerable preparatory work, on August 28, 1859, the first oil vein was tapped at a depth of 69‰ feet below the surface; the flow was at first 10 barrels per day, but in the following September this increased to 40 barrels daily.

[Illustration: MAP SHOWING THE NATIONAL TRANSIT CO.'S PIPE LINES.]

The popular excitement and the fortunes made and lost in the years following the sinking of the initial well are a matter of history, with which we have here nothing to do. It is sufficient to say that a multitude of adventurers were drawn by the "oil-craze" into this late wilderness, and the sinking of wells extended with unprecedented rapidity over the region near Titusville and from there into more distant fields.

By June 1, 1862, 495 wells had been put down near Titusville, and the daily output of oil was nearly 6,000 barrels, selling at the wells at from $4.00 to $6.00 per barrel. But the tapping of this vast subterranean storehouse of oleaginous wealth continued, until the estimated annual production was swelled from 82,000 barrels in 1859 to 24,385,966 barrels in 1883; in the latter year 2,949 wells were put down, many of them, however, being simply dry holes.[1] The total output of oil in the Pennsylvania regions, between 1859 and 1883, is estimated at about 234,800,000 barrels--enough oil to fill a tank about 10,000 feet square, nearly two miles to a side, to a depth of over 13‰ feet.

[Footnote 1: The total number of wells in the Pennsylvania oil regions cannot be given. In the years 1876-1884, inclusive, 28,619 wells were sunk; this is an average of 3,179 per year. During the same period 2,507 dry holes were drilled at an average cost of $1,500 each.]

As long as oil could be sold at the wells at from $4.00 to $10.00 a barrel, the cost of transportation was an item hardly worthy of consideration, and railroad companies multiplied and waged a bitter war with each other in their scramble after the traffic. But as the production increased with rapid strides, the market price of oil fell with a corresponding rapidity, until the quotations for 1884 show figures as low as 50 to 60 cents per barrel for the crude product at Oil City.

In December, 1865, the freight charge per barrel for a carload of oil from Titusville to New York, and the return of the empty barrels, was $3.50.[1] To this figure was added the cost of transportation by pipe-line from Pithole to Titusville, $1.00; cost of barreling, 25 cents; freight to Corry, Pa., 80 cents; making the total cost of a barrel of crude oil in New York, $5.55. In January, 1866, the barrel of oil in New York cost $10.40, including in this figure, however, the Government tax of $1.00 and the price of the barrel, $3.25.

[Footnote 1: It is stated that in 1862 the cost of sending one barrel of oil to New York was $7.45. Steamboats charged $2.00 per barrel from Oil City to Pittsburg, and the hauling from Oil Creek to Meadville cost $2.25 per barrel.]

The question of reducing these enormous transportation charges was first broached, apparently, in 1864, when a writer in the _North American_, of Philadelphia, outlined a scheme for laying a pipe-line down the Allegheny River to Pittsburg. This project was violently assailed by both the transportation companies and the people of the oil region, who feared that its success would interfere with their then great prosperity. But short pipe-lines, connecting the wells with storage tanks and shipping points, grew apace and prepared the way for the vast network of the present day, which covers this region and throws out arms to the ocean and the lakes.

Among the very first, if not the first, pipe lines laid was one put down between the Sherman well and the railway terminus on the Miller farm. It was about 3 miles long, and designed by a Mr. Hutchinson; he had an exaggerated idea of the pressure to be exercised, and at intervals of 50 to 100 feet he set up air chambers 10 inches in diameter. The weak point in this line, however, proved to be the joints; the pipes were of cast iron, and the joint-leakage was so great that little, if any, oil ever reached the end of the line, and the scheme was abandoned in despair.

In connection with this question of oil transportation, a sketch of the various methods, other than pipelines, adopted in Pennsylvania may not be out of place. We are mainly indebted to Mr. S.F. Peckham, in his article on "Petroleum and its Products" in the U. S. Census Report of 1880, for the information relating to tank-cars immediately following:

Originally the oil was carried in 40 and 42 gallon barrels, made of oak and hooped with iron; early in 1866, or possibly in 1865, tank-cars were introduced. These were at first ordinary flat-cars upon which were placed two wooden tanks, shaped like tubs, each holding about 2,000 gallons.

On the rivers, bulk barges were also, after a time, introduced on the Ohio and Allegheny; at first these were rude affairs, and often of inadequate strength; but as now built they are 130 x 22 x 16 feet, in their general dimensions, and divided into eight compartments, with water-tight bulkheads; they hold about 2,200 barrels.

In 1871 iron-tank cars superseded those of wood, with tanks of varying sizes, ranging from 3,856 to 5,000 gallons each. These tanks were cylinders, 24 feet 6 inches long, and 66 inches in diameter, and weighed about 4,500 lb. The heads are made of 5/46 in. flange iron, the bottom of ‰ in., and the upper half of the shell of 3/16 in. tank iron.

In October, 1865, the Oil Transportation Co. completed and tested a pipe-line 32,000 feet long; three pumps were used upon it, two at Pithole and one at Little Pithole. July 1, 1876, the pipe-line owners held a meeting at Parkers to organize a pipe-line company to extend to the seaboard under the charter of the Pennsylvania Transportation Co., but the scheme was never carried out. In January, 1878, the Producers' Union organized for a similar seaboard line, and laid pipes, but they never reached the sea, stopping their line at Tamanend, Pa. The lines of the National Transit Co., illustrated in our map, were completed in 1880-81, and this company, to which the United Pipe Lines have also been transferred, is said to have $15,000,000 invested in plant for the transport of oil to tide water.

The National Transit Co. was organized under what was called the Pennsylvania Co. act, about four years ago, and succeeded to the properties of the American Transit Co., a corporation operating under the laws of Pennsylvania. Since its organization the first named company has constructed and now owns the following systems:

The line from Olean, N.Y., to Bayonne, N.J., and to Brooklyn, N.Y., of which a full page profile is given, showing the various pumping stations and the undulations over its route of about 300 miles. The Pennsylvania line, 280 miles long, from Colegrove, Pa., to Philadelphia. The Baltimore line, 70 miles long, from Millway, Pa., to Baltimore. The Cleveland line, 100 miles long, from Hilliards, Pa., to Cleveland, O. The Buffalo line, 70 miles long, from Four Mile, Cattaraugus County, N.Y., to Buffalo, and the line from Carbon Center, Butler County, Pa., to Pittsburg, 60 miles in length. This amounts to a total of 880 miles of main pipe-line alone, ranging from 4 inches to 6 inches in diameter; or, adding the duplicate pipes on the Olean New York line, we have a round total of 1,330 miles, not including loops and shorter branches and the immense network of the pipes in the oil regions proper.

A general description of the longest line will practically suffice for all, as they differ only in diameter of pipe used and power of the pumping plant. As shown on the map and profile, this long line starts at Olean, near the southern boundary of New York State, and proceeds by the route indicated to tide water at Bayonne, N.J., and by a branch under the North and East rivers and across the upper end of New York city to the Long Island refineries. This last named pipe is of unusual strength, and passes through Central Park; few of the thousands who daily frequent the latter spot being aware of the yellow stream of crude petroleum that is constantly flowing beneath their feet. The following table gives the various pumping stations on this Olean New York line, and some data relating to distances between stations and elevations overcome:

			Greatest

Pumping Stations.	Miles between Stations.	Elevation above Tide. Ft.	Summit between Stations. Ft.
Olean	--	1,490	--
Wellsville	28.20	1,510	2,490
Cameron	27.91	1,042	2,530
West Junction	29.70	911	1,917
Catatonk	27.37	869	1,768
Osborne	27.99	1,092	1,539
Hancock	29.86	922	1,873
Cochecton	26.22	748	1,854
Swartwout	28.94	475	1,478
Newfoundland	29.00	768	1,405
Saddle River	28.77	35	398

On this line two six-inch pipes are laid the entire length, and a third six-inch pipe runs between Wellsville and Cameron, and about half way between each of the other stations, "looped" around them. The pipe used for the transportation of oil is especially manufactured to withstand the great strain to which it will be subjected, the most of it being made by the Chester Pipe and Tube Works, of Chester, Pa., the Allison Manufacturing Co., of Philadelphia and the Penna. Tube Works, of Pittsburg, Pa. It is a lap-welded, wrought-iron pipe of superior material, and made with exceeding care and thoroughly tested at the works. The pipe is made in lengths of 18 feet, and these pieces are connected by threaded ends and extra strong sleeves. The pipe-thread and sleeves used on the ordinary steam and water pipe are not strong enough for the duty demanded of the oil-pipe. The socket for a 4-inch steam or water pipe is from 2‰ to to 2¾inches long, and is tapped with 8 standard threads to the inch, straight or parallel to the axis of the pipe; with this straight tap only three or four threads come in contact with the socket threads, or in any way assist in holding the pipes together. In the oil-pipe, the pipe ends and sockets are cut on a taper of ¾inch to 1 foot, for a 4-inch pipe, and the socket used is thicker than the steam and water socket, is 3¾inches long, and has entrance for 1 5/8 inches of thread on each pipe end tapped with 9 standard threads to the inch. In this taper socket you have iron to iron the whole length of the thread, and the joint is perfect and equal by test to the full strength of the pipe. Up to 1877 the largest pipe used on the oil lines was 4-inch, with the usual steam thread, but the joints leaked under the pressure, 1,200 pounds to the square inch being the maximum the 8-thread pipe would stand. This trouble has been remedied by the 9-thread, taper-cut pipe of the present day, which is tested at the mill to 1,500 pounds pressure, while the average duty required is 1,200 pounds; as the iron used in the manufacture of this line-pipe will average a tensile test strain of 55,000 pounds per square inch, the safety factor is thus about one-sixth.

[Illustration: PROFILE SHOWING NATIONAL TRANSIT CO.'S PIPE-LINE, FROM OLEAN TO SADDLE RIVER.]

The line-pipe is laid between the stations in the ordinary manner, excepting that great care is exercised in perfecting the joints. No expansion joints or other special appliances of like nature are used on the line as far as we can learn; the variations in temperature being compensated for, in exposed locations, by laying the pipe in long horizontal curves. The usual depth below the surface is about 3 feet, though in some portions of the route the pipe lies for miles exposed directly upon the surface. As the oil pumped is crude oil, and this as it comes from the wells carries with it a considerable proportion of brine, freezing in the pipes is not to be apprehended. The oil, however, does thicken in very cold weather, and the temperature has a considerable influence on the delivery.

A very ingenious patented device is used for cleaning out the pipes, and by it the delivery is said to have been increased in certain localities 50 per cent. This is a stem about 2‰ feet long, having at its front end a diaphragm made of wings which can fold on each other, and thus enable it to pass an obstruction it cannot remove; this machine carries a set of steel scrapers, somewhat like those used in cleaning boilers. The device is put into the pipe, and propelled by the pressure transmitted from the pumps from one station to another; relays of men follow the scraper by the noise it makes as it goes through the pipe, one party taking up the pursuit as the other is exhausted. They must never let it get out of their hearing, for if it stops unnoticed, its location can only again be established by cutting the pipe.

The pumping stations are substantial structures of brick, roofed with iron. The boiler house is removed some distance from the engine house for greater safety from fire; the building, about 40 by 50 feet, contains from six to seven tubular boilers, each 5 by 14 feet, and containing 80 three-inch tubes. The pump house is a similar brick structure about 40 by 60 feet, and contains the battery of pumping engines to be described later. At each station are two iron tanks, 90 feet in diameter and 30 feet high; into these tanks the oil is delivered from the preceding station, and from them the oil is pumped into the tanks at the next station beyond. The pipe-system at each station is simple, and by means of the "loop-lines" before mentioned the oil can be pumped directly around any station if occasion would require it.

The pumps used on all these lines are the Worthington compound, condensing, pressure pumping engines. The general characteristics of these pumps are, independent plungers with exterior packing, valve-boxes subdivided into separate small chambers capable of resisting very heavy strains, and leather-faced metallic valves with low lift and large surfaces. These engines vary in power from 200 to 800 horse-power, according to duty required. They are in continuous use, day and night, and are required to deliver about 15,000 barrels of crude oil per 24 hours, under a pressure equivalent to an elevation of 3,500 feet.

We have lately examined the latest pumping engine plant, and the largest yet built for this service, by the firm of H.R. Worthington; it is to be used at the Osborne Hollow Pumping Station. As patents are yet pending on certain new features in this engine, we must defer a full description of it for a later issue of our journal.

The Pennsylvania line has a single 6-inch pipe 280 miles long, with six pumping stations as shown in the map, and groups of shorter lines, with a loop extending from the main line to Milton, Pa., a shipping point for loading on cars. At Millway, Pa., a 5-inch pipe leaves the Pennsylvania line and runs to Baltimore, a distance of 70 miles, and is operated from the first named station alone, there being no intermediate pumping station.[1] The Cleveland pipe, 100 miles long, is 5 inches in diameter, and has upon it four pumping stations; it carries oil to the very extensive refineries of the company at the terminal on Lake Erie. The Buffalo line is 4 inches in diameter and 70 miles long; it has a pumping station at Four-Mile and at Ashford (omitted on the map). The Pittsburg line is 4 inches in diameter and 60 miles long; it has pumping stations at Carbon Center and at Freeport.

[Footnote 1: Millway is about 400 feet above tide-water at Baltimore, but the line passes over a very undulating country in its passage to the last named point. We regret that we have no profile on this 70 mile line operated by a single pumping plant.--_Ed. Engineering News_.]

A very necessary and remarkably complete adjunct to the numerous pipe lines of this company is an independent telegraph system extending to every point on its widely diverging lines. The storage capacity of the National Transit Co.'s system is placed at 1,500,000 barrels, and this tankage is being constantly increased to meet the demands of the producers.[1]

[Footnote 1: As showing the extent of the sea-coast transportation of petroleum, we should mention that the statistics for 1884 show a total of crude equivalent exported from the United States in that year, equaling 16,661,086 barrels, of 51 gallons each. This is a daily average of 42,780 barrels.]

The company is officially organized as follows: C.A. Griscom, President; Benjamin Brewster, Vice President; John Bushnell, Secretary; Daniel O'Day, General Manager; J.H. Snow, General Superintendent. Mr. Snow was the practical constructor of the entire system, and the general perfection of the work is mainly due to his personal experience, energy, and careful supervision. His engineering assistants were Theodore M. Towe and C.J. Hepburn on the New York line and J.B. Barbour on the Pennsylvania lines.

The enterprise has been so far a great engineering success, and the oil delivery is stated on good authority to be within 2 per cent. of the theoretical capacity of the pipes. From a commercial standpoint, the ultimate future of the undertaking will be determined by the lasting qualities of wrought iron pipe buried in the ground and subjected to enormous strain; time alone can determine this question.

In preparing this article we are indebted for information to the firm of H.R. Worthington, to General Manager O'Day, of the National Transit

Co., to the editor of the _Derrick_ of Oil City, Pa., and to numerous engineering friends.--_Engineering News_.

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THE FUEL OF THE FUTURE.

By GEORGE WARDMAN.

The practical application of natural gas, as an article of fuel, to the purpose of manufacturing glass, iron, and steel, promises to work a revolution in the industrial interests of America--promises to work a revolution; for notwithstanding the fact that, in many of the largest iron, steel, and glass factories in Pittsburg and its vicinity, natural gas has already been substituted for coal, the managers of some such works are shy of the new fuel, mainly for two reasons: 1. They doubt the continuity and regularity of its supply. 2. They do not deem the difference between the price of natural gas and coal sufficient as yet to justify the expenditure involved in the furnace changes necessary to the substitution of the one for the other. These two objections will doubtless disappear with additional experience in the production and regulation of the gas supply, and with enlarged competition among the companies engaging in its transmission from the wells to the works. At present the use of natural gas as a substitute for coal in the manufacture of glass, iron, and steel is in its infancy.

Natural gas is as ancient as the universe. It was known to man in prehistoric times, we must suppose, for the very earliest historical reference to the Magi of Asia records them as worshiping the eternal fires which then blazed, and still blaze, in the fissures of the mountain heights overlooking the Caspian Sea. Those records appertain to a period at least 600 years before the birth of Christ; but the Magi must have lived and worshiped long anterior to that time.

Zoroaster, reputed founder of the Parsee sect, is placed contemporary with the prophet Daniel, from 2,500 to 600 B.C.; and, although Daniel has been doubted, and Zoroaster may never have seen the light, the fissures of the Caucasus have been flaming since the earliest authentic records.

The Parsees (Persians) did not originally worship fire. They believed in two great powers--the Spirit of Light, or Good, and the Spirit of Darkness, or Evil. Subsequent to Zoroaster, when the Persian empire rose to its greatest power and importance, overspreading the west to the shores of the Caspian and beyond, the tribes of the Caucasus suffered political subjugation; but the creed of the Magi, founded upon the eternal flame-altars of the mountains, proved sufficiently vigorous to transform the Parseeism of the conquerors to the fire worship of the conquered.

About the beginning of the seventh century of the Christian era, the Grecian Emperor Heraclius overturned the fire altars of the Magi at Baku, the chief city on the Caspian, but the fire worshipers were not expelled from the Caucasus until the Mohammedans subjugated the Persian Empire, when they were driven into the Rangoon, on the Irrawaddy, in India, one of the most noted petroleum producing districts of the world.

Petroleum and natural gas are so intimately related that one would hardly dare to say whether the gas proceeds from petroleum or the petroleum is deposited from the gas. It is, however, safe to assume that they are the products of one material, the lighter element separating from the heavier under certain degrees of temperature and pressure. Thus petroleum may separate from the gas as asphaltum separates from petroleum. But some speculative minds consider natural gas to be a product of anthracite coal. The fact that the great supply-field of natural gas in Western Pennsylvania, New York, West Virginia, and Eastern Ohio is a bituminous and not an anthracite region does not of itself confute that theory, as the argument for it is, that the gas may be tapped at a remote distance from the source of supply; and, whereas anthracite is not a gas-coal, while bituminous is, we are told to suppose that the gas which once may have been a component part of the anthracite was long ago expelled by Nature, and has since been held in vast reservoirs with slight waste, awaiting the use of man. That is one theory; and upon that supposition it is suggested that anthracite may exist below the bituminous beds of the region lying between the Alleghany Mountains and the Great Lakes. Another theory is, that natural gas is a product of the sea-weed deposited in the Devonian stratum. But, leaving modern theories on the origin of natural gas and petroleum, we may suppose the natural gas jets now burning in the fissures of the Caucasus to have started up in flames about the time when, according to the Old Testament, Noah descended from Mount Ararat, or very soon thereafter. In the language of modern science it would be safe to say that those flames sprang up when the Caucasus range was raised from beneath the surface of the universal sea. The believer in biblical chronology may say that those fires have been burning for four thousand years--the geologist may say for four millions.

We know that Alexander the Great penetrated to the Caspian; and in Plutarch we read: "Hence [Arbela] he marched through the province Babylon [Media?], which immediately submitted to him, and in Ecbatana [?] was much surprised at the sight of the place where fire issues in a continuous stream, like a spring of water, out of a cleft in the earth, and the stream of naphtha, which not far from this spot flows out so abundantly as to form a large lake. This naphtha, in other respects resembling bitumen, is so subject to take fire that, before it touches the flame, it will kindle at the very light that surrounds it, and often inflames the intermediate air also. The barbarians, to show the power and nature of it, sprinkled the street that led to the king’s lodgings with little drops of it, and, when it was almost night, stood at the farther end with torches, which being applied to the moistened places, the first taking fire, instantly, as quick as a man could think of it, it caught from one end to another in such manner that the whole street was one continued flame. Among those who used to wait upon the king, and find occasion to amuse him, when he anointed and washed himself, there was one Athenophanus, an Athenian, who desired him to make an experiment of the naphtha upon Stephanus, who stood by in the bathing place, a youth with a ridiculously ugly face, whose talent was singing well. 'For,' said he, 'if it take hold of him, and is not put out, it must undeniably be allowed to be of the most invincible strength.' The youth, as it happened, readily consented to undergo the trial, and as soon as he was anointed and rubbed with it, his whole body was broke out into such a flame, and was so seized by the fire, that Alexander was in the greatest perplexity and alarm for him, and not without reason; for nothing could have prevented him from being consumed by it if, by good chance, there had not been people at hand with a great many vessels of water for the service of the bath, with all which they had much ado to extinguish the fire; and his body was so burned all over that he was not cured of it a good while after. And thus it was not without some plausibility that they endeavor to reconcile the fable to truth, who say this was the drug in the tragedies with which Medea anointed the crown and veils which she gave to Creon's daughter."

An interesting reference to the fire-worshipers of the Caucasus is contained in the "History of Zobeide," a tale of the wonderful Arabian Nights Entertainment. It runs thus:

"I bought a ship at Balsora, and freighted it; my sisters chose to go with me, and we set sail with a fair wind. Some weeks after, we cast anchor in a harbor which presented itself, with intent to water the ship. As I was tired with having been so long on board, I landed with the first boat, and walked up into the country. I soon came in sight of a great town. When I arrived there, I was much surprised to see vast numbers of people in different postures, but all immovable. The merchants were in their shops, the soldiery on guard; every one seemed engaged in his proper avocation, yet all were become as stone.... I heard the voice of a man reading Al Koran.... Being curious to know why he was the only living creature in the town,... he proceeded to tell me that the city was the metropolis of a kingdom now governed by his father; that the former king and all his subjects were Magi, worshipers of fire and of Nardoun. the ancient king of the giants who rebelled against God. 'Though I was born,' continued he, 'of idolatrous parents, it was my good fortune to have a woman governess who was a strict observer of the Mohammedan religion. She taught me Arabic from Al Koran; by her I was instructed in the true religion, which I would never afterward renounce. About three years ago a thundering voice was heard distinctly throughout the city, saying, "Inhabitants, abandon the worship of Nardoun and of fire, and worship the only true God, who showeth mercy!" This voice was heard three years successively, but no one regarded it. At the end of the last year all the inhabitants were in an instant turned to stone. I alone was preserved.'"

In the foregoing tale we doubtless have reference to the destruction of Baku, on the Caspian (though to sail from Balsora to Baku is impossible), and the driving away into India, by the Arabs under Caliph Omar, of all who refused to renounce fire-worship and adopt the creed of the Koran. The turning of the refractory inhabitants into stone is probably the Arabian storyteller's figurative manner of referring to the finding of dead bodies in a mummified condition.

It is known that the Egyptians made use of bitumen, in some form, in the preservation of their dead, a fact with which the Arabians were familiar. As the Magi held the four elements of earth, air, fire, and water to be sacred, they feared to either bury, burn, sink, or expose to air the corrupting bodies of their deceased. Therefore, it was their practice to envelop the corpse in a coating of wax or bitumen, so as to hermetically seal it from immediate contact with either of the four sacred elements. Hence the idea of all the bodies of the Magi left at Baku being turned to stone, while only the true believer in Mohammed remained in the flesh.

Marco Polo, the famous traveler of the thirteenth century, makes reference to the burning jets of the Caucasus, and those fires are known to the Russians as continuing in existence since the army of Peter the Great wrested the regions about the Caspian from the modern Persians. The record of those flaming jets of natural gas is thus brought down in an unbroken chain of evidence from remote antiquity to the present day, and they are still burning.

Numerous Greek and Latin writers testify to the known existence of petroleum about the shores of the Mediterranean two thousand years ago. More modern citations may, however, be read with equal interest. In the "Journal of Sir Philip Skippon's Travels in France," in 1663, we find the following curious entries:

"We stayed in Grenoble till August 1st, and one day rode out, and, after twice fording the river Drac (which makes a great wash) at a league's distance, went over to Pont de Clef, a large arch across that river, where we paid one sol a man; a league further we passed through a large village called Vif, and about a league thence by S. Bathomew, another village, and Chasteau Bernard, where we saw a flame breaking out of the side of a bank, which is vulgarly called La Fountaine qui Brule; it is by a small rivulet, and sometimes breaks out in other places; just before our coming some other strangers had fried eggs here. The soil hereabouts is full of a black stone, like our coal, which, perhaps, is the continual fuel of the fire.... Near Peroul, about a league from Montpelier, we saw a boiling fountain (as they call it), that is, the water did heave up and bubble as if it boiled. This phenomenon in the water was caused by a vapor ascending out of the earth through the water, as was manifest, for if that one did but dig anywhere near the place, and pour water upon the place new digged, one should observe in it the like bubbling, the vapor arising not only in that place where the fountain was, but all thereabout; the like vapor ascending out of the earth and causing such ebullition in water it passes through hath been observed in Mr. Hawkley's ground, about a mile from the town of Wigan, in Lancashire, which vapor, by the application of a lighted candle, paper; or the like, catches fire and flames vigorously. Whether or not this vapor at Peroul would in like manner catch fire and burn I cannot say, it coming not in our minds to make the experiment.... At Gabian, about a day's journey from Montpelier, in the way to Beziers, is a fountain of petroleum. It burns like oil, is of a pungent scent, and a blackish color. It distills out of several places of the rock all the year long, but most in the summer time. They gather it up with ladles and put it in a barrel set on end, which hath a spigot just at the bottom. When they have put in a good quantity, they open the spigot to let out the water, and when the oil begins to come presently stop it. They pay for the farm of this fountain about fifty crowns per annum. We were told by one Monsieur Beaushoste, a chymist in Montpelier, that petroleum was the very same with oil of jet, and not to be distinguished from it by color, taste, smell, consistency, virtues, or any other accident, as he had by experience found upon the coast of the Mediterranean Sea, in several places, as at Berre, near Martague, in Provence; at Messina, in Sicily, etc."

In Harris' "Voyages," published in 1764, an article on the empire of Persia thus refers to petroleum:

"In several parts of Persia we meet with naphtha, both white and black; it is used in painting and varnish, and sometimes in physic, and there is an oil extracted from it which is applied to several uses. The most famous springs of naphtha are in the neighborhood of Baku, which furnish vast quantities, and there are also upward of thirty springs about Shamasky, both in the province of Schirwan. The Persians use it as oil for their lamps and in making fireworks, of which they are extremely fond, and in which they are great proficients."

Petroleum has long been known to exist also in the northern part of Italy, the cities of Parma and Genoa having been for many years lighted with it.

In the province of Szechuen, China, natural gas is obtained from beds of rock-salt at a depth of fifteen to sixteen hundred feet. Being brought to the surface, it is conveyed in bamboo tubes and used for lighting as well as for evaporating water in the manufacture of salt. It is asserted that the Chinese used this natural gas for illuminating purposes long before gas-lighting was known to the Europeans. Remembering the unprogressive character of Chinese arts and industries, there is ground for the belief that they may have been using this natural gas as an illuminant these hundreds of years.

In the United States the existence of petroleum was known to the Pilgrim Fathers, who doubtless obtained their first information of it from the Indians, from whom, in New York and western Pennsylvania, it was called Seneka oil. It was otherwise known as "British" oil and oil of naphtha, and was considered "a sovereign remedy for an inward bruise."

The record of natural gas in this country is not so complete as that of petroleum, but we learn that an important gas spring was known in West Bloomfleld, N.Y., seventy years ago. In 1864 a well was sunk to a depth of three hundred feet upon that vein, from which a sufficient supply of gas was obtained to illuminate and heat the city of Rochester (twenty-five miles distant), it was supposed. But the pipes which were laid for that purpose, being of wood, were unfitted to withstand the pressure, in consequence of which the scheme was abandoned; but gas from that well is now in use as an illuminant and as fuel both in the town of West Bloomfield and at Honeoye Falls. The village of Fredonia, N.Y., has been using natural gas in lighting the streets for thirty years or there about. On Big Sewickley Creek, in Westmoreland County, Pa., natural gas was used for evaporating water in the manufacture of salt thirty years ago, and gas is still issuing at the same place. Natural gas has been in use in several localities in eastern Ohio for twenty-five years, and the wells are flowing as vigorously as when first known. It has also been in use in West Virginia for a quarter of a century, as well as in the petroleum region of western Pennsylvania, where it has long been utilized in generating steam for drilling oil wells.

In 1826 the _American Journal of Science_ contained a letter from Dr. S.P. Hildreth, who, in writing of the products of the Muskingum (Ohio) Valley, said: "They have sunk two wells, which are now more than four hundred feet in depth; one of them affords a very strong and pure salt water, but not in great quantity; the other discharges such vast quantities of petroleum, or, as it is vulgarly called, 'Seneka oil,' and besides is so subject to such tremendous explosions of gas, as to force out all the water and afford nothing but gas for several days, that they make little or no salt."

The value of the foregoing references is to be found in the testimony they offer as to the duration of the supply of natural gas. Whether we look to the eternal flaming fissures of the Caucasus, or to New York, Pennsylvania, and Ohio, there is much to encourage the belief that the flow of natural gas may be, like the production of petroleum, increased rather than diminished by the draughts made upon it. Petroleum, instead of diminishing in quantity by the millions of barrels drawn from western Pennsylvania in the last quarter of a century, seems to increase, greater wells being known in 1884 than in any previous year, and prices having fallen from two dollars per bottle for "Seneka oil" to sixty cents per barrel for the same article under the name of crude petroleum. Hence we may assume that, as new pipe-lines are laid, the supply of natural gas available for use in the great manufacturing district of Pittsburg and vicinity will be increased, and the price of this fuel diminished in a corresponding ratio.

Natural gas is now supplied in Pittsburg at a small discount on the actual cost of coal used last year in the large manufacturing establishments, an additional saving being made in dispensing with firemen and avoidance of hauling ashes from the boiler-room. It is supplied, for domestic purposes, at twenty cents per thousand cubic feet, which is not cheaper than coal in Pittsburg, but it is a thousand per cent cleaner, and in that respect it promises to prove a great blessing, not only to those who can afford to use it, but to the community at large, in the hope held out that the smoke and soot nuisance may be abated in part, if not wholly subdued, and that gleams of sunshine there may become less phenomenal in the future than they are at the present time. Twenty cents per thousand feet is too high a price to bring gas into general use for domestic purposes in a city where coal is cheap. Ten cents would be too much, and no doubt five cents per thousand would pay a profit. The fact is, the dealers in natural gas appear to be somewhat doubtful of the continuity of supply, and anxious to get back the cost of wells and pipes in one year, which, if successful, would be an enormous return on the investment.

There are objections to the use of natural gas by mill operators--that it costs too much, and that the continuity of the supply is uncertain; by heads of families, that it is odorless, and, in case of leakage from the pipes, may fill a room and be ready to explode without giving the fragrant warning offered by common gas. Both of these objections will probably disappear under the experience that time must furnish. More wells and tributary lines will lessen the cost and tend to regulate the pressure for manufacturers. Cut-offs and escape pipes outside of the house will reduce the risk of explosions within. The danger in the house may also be lessened by providing healthful ventilation in all apartments wherein gas shall be consumed.

This subject of, the ventilation of rooms in which common gas is ordinarily used is beginning to attract attention. It is stated, upon scientific authority, that a jet of common gas, equivalent to twelve sperm candles, consumes 5.45 cubic feet of oxygen per hour, producing 3.21 feet of carbonic acid gas, vitiating, according to Dr. Tidy's "Handbook of Chemistry," 348.25 cubic feet of air. In every five cubic feet of pure air in a room there is one cubic foot of oxygen and four of nitrogen. Without oxygen human life, as well as light, would become extinct. It is asserted that one common gas-jet consumes as much oxygen as five persons.

Carbonic acid gas is the element which, in deep mines and vaults, causes almost instant insensibility and suffocation to persons subjected to its influences, and instantly extinguishes the flame of any light lowered into it. The normal quantity of this gas contained in the air we breathe is 0.04; one per cent, of it causes distress in breathing; two per cent, is dangerous; four per cent, extinguishes life, and four per cent of it is contained in air expelled from the lungs. According to Dr. Tidy's table, each ordinary jet of common gas contributes to the air of a room sixteen by ten feet on the sides and nine feet high, containing 1,440 cubic feet of air, twenty-two per cent, of carbonic acid gas, which, continued for twenty-four hours without ventilation, would reach the fatal four per cent.

Prof. Huxley gives, as a result of chemical analyses, the following table of ratio of carbonic-acid gas in the atmosphere at the points named:

On the Thames, at London	0.0343
In the streets of London	0.0380
Top of Ben Nevis	0.0327
Dress circle of Haymarket theater (11:30 P.M.)	0.0757
Chancery Court (seven feet from the ground)	0.1930
From working mines (average of 339 samples)	0.7853
Largest amount in a Cornish mine	2.0500

In addition to the consumption of oxygen and production of carbonic acid by the use of common gas, the gas itself, owing to defectiveness of the burner, is projected into the air. Now, considering the deleterious nature of all illuminating gases, the reasons for perfect ventilation of rooms in which natural gas is used for heating and culinary purposes are self-evident, not alone as a protection against explosions, but for the health of the occupants of the house, remembering that a larger supply of oxygen is said to be necessary for the perfect combustion of natural than of common gas.

Carbonic oxide, formed by the consumption of carbon, with an insufficient supply of air, is the fatal poison of the charcoal furnace, not infrequently resorted to, in close rooms, as a means of suicide. The less sufficient the air toward perfect combustion, the smaller the quantity of carbonic acid and the greater the amount of carbonic oxide. That is to say, at the time of ignition the chief product of combustion is carbonic oxide, and, unless sufficient air be added to convert the oxide to carbonic acid, a decidedly dangerous product is given off into the room. Yet, by means of a flue to carry off the poisonous gases from burning jets, the combustion of gas, creating a current, is made an aid to ventilation. Unfortunately, this important fact, if commonly known, is not much heeded by heads of families or builders of houses. But in any large community where gas comes into general use as an article of fuel, this fact will gradually become recognized and respected.

The property of indicating the presence of very minute quantities of gas in a room is claimed for an instrument recently described by C. Von Jahn in the _Revue Industrielle_. This is a porous cup, inverted and closed by a perforated rubber stopper. Through the perforation in the stopper the interior of the cup is connected with a pressure gauge containing colored water. It is claimed that the diffusion of gas through the earthenware raises the level of the water in the gauge so delicately that the presence of one-half of one per cent, of gas may be detected by it. Other instruments of a slightly different character are credited by their inventors with most sensitive power of indicating gas-leakages, but their practical efficiency remains to be demonstrated. An automatic cut-off for use outside of houses in which natural gas is consumed has been invented, but this writer knows nothing of either its mode of action or its effectiveness.

The great economic question, however, connected with the use of natural gas is, how will it affect the industrial interests of the country? There are grounds for the belief that a sufficient supply of natural gas may be found in the vicinity of Pittsburg to reduce the cost of fuel to such a degree as to make competition in the manufacture of iron, steel, and glass, in any part of the country where coal must be used, out of the question. Such a condition of affairs would probably result in driving the great manufacturing concerns of the country into the region where natural gas is to obtained. That may be anywhere from the western slope of the Alleghanies to Lake Erie or to Lake Michigan. And, if the cost of producing iron, steel, and glass can be so cheapened by the new fuel, the tariff question may undergo some important modification in politics. For, if the reduction in the cost of fuel should ever become an offset to the lower rate of wages in Europe, the manufacturers of Pennsylvania, who have long been the chief support of the protective policy of the country, may lose their present interest in that question, and leave the tariff to shift for itself elsewhere. It should be remembered that natural gas is not, as yet, much cheaper than coal in Pittsburg. But it may safely be assumed that it will cheapen, as petroleum has done, by a development of the territory in which it is known to exist in enormous quantities. It is quite possible that, instead of buying gas, many factories will bore for it with success, or remove convenient to its natural sources, so that a gas well may ultimately become an essential part of the "plant" of a mill or factory. Even now coal cannot compete with gas in the manufacture of window glass, for, the gas being free from sulphur and other impurities contained in coal, produces a superior quality of glass; so that in this branch of industry the question of superiority seems already settled.

Having said thus much of an industry now in its infancy but promising great growth, I submit tables of analyses of common and of the natural or marsh gas, the latter from a paper recently prepared by a committee of the Engineers' Society of Western Pennsylvania, and for the use of which I am indebted to that association:

COMMON GAS.

Hydrogen	46.0
Light carbureted hydrogen (marsh gas)	39.5
Condensible hydrocarbon	3.8
Carbonic oxide	7.5
" acid	0.6
Aqueous vapor	2.0
Oxygen	0.1
Nitrogen	0.5

	100.0

Natural gas is now conveyed to Pittsburg through four lines of 5-5/8 inch pipe and one line of eight inch pipe. A line of ten inch pipe is also being laid. The pressure of the gas at the wells is from 150 to 230 pounds to the square inch. As the wells are on one side eighteen and on the other about twenty-five miles distant, and as the consumption is variable, the pressure at the city cannot be given. Greater pressure might be obtained at the wells, but this would increase the liability to leakage and bursting of pipes. For the prevention of such casualties safety valves are provided at the wells, permitting the escape of all superfluous gas. The enormous force of this gas may be appreciated from a comparison of, say, 200 pounds pressure at the wells with a two ounce pressure of common gas for ordinary lighting. The amount of natural gas now furnished for use in Pittsburg is supposed to be something like 25,000,000 cubic feet per day; the ten inch pipe now laying is estimated to increase the supply to 40,000,000 feet. The amount of manufactured gas used for lighting the same city probably falls below 3,000,000 feet.

About fifty mills and factories of various kinds in Pittsburg now use natural gas. It is used for domestic purposes in two hundred houses. Its superiority over coal in the manufacture of window glass is unquestioned. That it is not used in all the glass houses of Pittsburg is due to the fact that its advantages were not fully known when the furnaces were fired last summer, and it costs a large sum to permit the furnaces to cool off after being heated for melting. When the fires cool down, and before they are started up again, the furnaces now using coal will doubtless all be changed so as to admit natural gas. The superiority of French over American glass is said to be due to the fact that the French use wood and the Americans coal in their furnaces, wood being free from sulphur, phosphorus, etc. The substitution of gas for coal, while not increasing the cost, improves the quality of American glass, making it as nearly perfect as possible.

While the gas is not used as yet in any smelting furnace nor in the Bessemer converters, it is preferred in open hearth and crucible steel furnaces, and is said to be vastly superior to coal for puddling. The charge of a puddling furnace, consisting of 500 pounds of pig-metal and eighty pounds of "fix," produces with coal fuel 490 to 500 pounds of iron. With gas for fuel, it is claimed that the same charge will yield 520 to 530 pounds of iron. In an iron mill of thirty furnaces, running eight heats each for twenty-four hours, this would make a difference in favor of the gas of, say, 8 x 30 x 25 = 6,000 pounds of iron per day. This is an important item of itself, leaving out the cost of firing with coal and hauling ashes.

For generating steam in large establishments, one man will attend a battery of twelve or twenty boilers, using gas as fuel, keep the pressure uniform, and have the fire room clean as a parlor. For burning brick and earthenware, gas offers the double advantage of freedom from smoke and a uniform heat. The use of gas in public bakeries promises the abolition of the ash-box and its accumulation of miscellaneous filth, which is said to often impregnate the "sponge" with impurities.

In short, the advantages of natural gas as a fuel are so obvious to those who have given it a trial, that the prediction is made that, should the supply fail, many who are now using it will never return to the consumption of crude coal in factories, but, if necessary, convert it or petroleum into gas at their own works.

It seems, indeed, that until we shall have acquired the wisdom enabling us to conserve and concentrate the heat of the sun, gas must be the fuel of the future.--_Popular Science Monthly_.

TABLE OF ANALYSIS OF NATURAL GAS--FROM VARIOUS SOURCES.

CONSTITUENTS	[2.]	[3.]	[6.]	[7.]	[8.]	[9.]
Hydrogen	....	....	6.10	13.50	22.50	4.79

Marsh Gas	82.41	96.50	75.44	80.11	60.27	89.65
Ethane	....	....	18.12	5.72	6.80	4.39
Propane	....	....	trace.	....	....	trace.
Carbonic acid	10.11	....	0.34	0.66	2.28	0.35
Carbonic oxide	....	0.50	trace.	trace.	trace.	0.26
Nitrogen	4.31	....	....	....	7.32	....
Oxygen	0.23	2.00	....	....	0.83	....
"Illuminating hydrocarbons."	2.94	1.00	....	....	....	0.56
	100.00	100.00	100.00	99.99	100.00	100.00
Specific gravity	0.693	0.692	0.6148	0.5119		0.5580

CONSTITUENTS	[10.]	[12.]	[14.]	[15.]	[16.]	[17.]
Hydrogen	....	19.56	....	0.98	....	....
Marsh Gas	96.34	78.24	47.37	93.09	80.69	95.42
Ethane	....	....	....	....	4.75	....
Propane	....	....	....	....	....	....
Carbonic acid	3.64	....	3.10	2.18	6.44	0.60
Carbonic oxide		....	....	....	....	....
Nitrogen		....	49.39	0.49	8.12	3.98
Oxygen		2.20	0.17	....	....	....
"Illuminating hydrocarbons."	[10.]	....	....	3.26	....	....
		100.00	100.03	100.00	100.00	100.00
Specific gravity	0.5923	0.56				

Petroleum is composed of about 85 per cent of carbon and 15 per cent of nitrogen.

Locations:

1. Petrolia, Canada.
2. West Bloomfield, N.Y.
3. Olean, N.Y.
4. Fredonis, N.Y.
5. Pioneer Run, Venango Co., Pa.
6. Burn’s Well, near St. Joe., Butler Co., Pa.
7. Harvey Well, Butler Co., Pa.
8. Cherry Tree, Indiana Co., Pa.
9. Leechburg, Pa.
10. Creighton, Pa.
11. Penn Fuel Co.’s Well, Murraysville, Pa.
12. Fuel Gas Co.’s Well, Murraysville.
13. Roger’s Gulch, Wirt Co., W. Va.
14. Gas from Marsh Ground
15. Baku, on the Caspian Sea.
16. Gas occluded in Wigan cannel-coal.
17. Blower in coal-mine. South Wales.

Notes:

1. Chiefly marsh-gas with ethane and some carbonic acid.
4. A mixture of marsh-gas, ethane and butane.
5. Chiefly propane, with small quantities of carbonic acid and
nitrogen.
10. Trace of heavy hydrocarbons.
11. Marsh-gas, with a little carbonic acid.
13. Chiefly marsh-gas, with small quantities of nitrogen and
 15.86 per cent
carbonic acid.

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1. FouquØ, "Comptes Rendus," lxvii, p. 1045.
2. H. Wurtz, "Am. Jour. Arts and Sci." (2), xlix, p. 336.
3. Robert Young.
4. FouquØ, "Comptes Rendus," lxvii. p. 1045.
5. FouquØ, "Comptes Rendus," lxvii. p. 1045.
6. S.P. Sadler, "Report L, 2d Geol. Sur. Pa.," p. 153.
7. S.P. Sadler, "Report L, 3d Geol. Sur. Pa.," p. 152.
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10. F.C. Phillips.
11. Robert Young.
12. Rogers.
13. FouquØ, "Comptes Rendus," lxvii, p. 1045.
14. Bischof’s Chemical Geology," I, p. 730.
15. Bischof’s Chemical Geology," I, p. 730.
16. J.W. Thomas, London, "Chemical Society’s Journal," 1876, p. 793.
17. Same, 1875, p. 793.

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CLOSING LEAKAGES FOR PACKING.

By L. C. LEVOIR.

The mineral asbestos is but a very poor packing material in steam-boilers. Moreover, it acts as a strong grinding material on all moving parts.

For some years I have tested the applicability of artificial precipitates to close the holes in boilers, cylinder-covers, and stuffing boxes. I took, generally with the best success, alternate layers of hemp-cotton, thread, and absorbent paper, all well saturated with the chlorides of calcium and magnesium. The next layers of the same fiber are moistened with silicate of soda. By pressure the fluids are mixed and the pores are closed. A stuffing box filled with this mixture has worked three years without grinding the piston-rod.

In the same manner I close the screw-thread hole in gas tubes used for conducting steam. I moisten the thread in the sockets with oleic acid from the candle-works, and dust over it a mixture of 1 part of minium, 2 parts of quick-lime, and 1 part of linseed powder (without the oil). When the tube is screwed in the socket, the powder mixes with the oleic acid. The water coming in at first makes the linseed powder viscid. Later the steam forming the oleate of lime and the oleate of lead, on its way to the outer air, presses it in the holes and closes them perfectly.

After a year in use the tubes can be unscrewed with ease, and the screw threads are perfectly smooth.

With this kind of packing only one exception must be made--that is, it is only tight under pressure; condensation or vacuum must be thoroughly avoided.--_Chem. News_.

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LUMINOUS PAINT.

In answer to various inquiries concerning the manufacture of this article, we give herewith the process of William Henry Balmain, the original discoverer of luminous paint, and also other processes. These particulars are derived from the letters patent granted in this country to the parties named.

Balmain’s invention was patented in England in 1877, and in this country in 1882. It is styled as Improvements in Painting, Varnishing, and Whitewashing, of which the following is a specification:

The said invention consists in a luminous paint, the body of which is a phosphorescent compound, or is composed in part of such a compound, and the vehicle of which is such as is used as the vehicle in ordinary paint compounds, viz., one which becomes dry by evaporation or oxidation.

The objector article to which such paint or varnish or wash is applied is itself rendered visible in the darkest place, and more or less capable of imparting light to other objects, so as to render them visible also. The phosphorescent substance found most suitable for the purpose is a compound obtained by simply heating together a mixture of lime and sulphur, or carbonate of lime and sulphur, or some of the various substances containing in themselves both lime and sulphur--such, for example, as alabaster, gypsum, and the like--with carbon or other agent to remove a portion of the oxygen contained in them, or by heating lime or carbonate of lime in a gas or vapor containing sulphur.

The vehicle to be used for the luminous paint must be one which will dry by evaporation or oxidation, in order that the paint may not become soft or fluid by heat or be liable to be easily rubbed off by accident or use from the articles to which it has been applied. It may be any of the vehicles commonly used in oil-painting or any of those commonly used in what is known as "distemper" painting or whitewashing, according to the place or purpose in or for which the paint is to be used.

It is found the best results are obtained by mixing the phosphorescent substance with a colorless varnish made with mastic or other resinous body and turpentine or spirit, making the paint as thick as convenient to apply with a brush, and with as much turpentine or spirit as can be added without impairing the required thickness. Good results may, however, be obtained with drying oils, spirit varnishes, gums, pastes, sizes, and gelatine solutions of every description, the choice being varied to meet the object in view or the nature of the article in hand.

The mode of applying the paint, varnish, or wash will also depend upon the circumstances of the case. For example, it may be applied by a brush, as in ordinary painting, or by dipping or steeping the article in the paint, varnish, or wash; or a block or type may be used to advantage, as in calico-printing and the like. For outdoor work, or wherever the surface illuminated is exposed to the vicissitudes of weather or to injury from mechanical contingencies, it is desirable to cover it with glass, or, if the article will admit of it, to glaze it over with a flux, as in enameling, or as in ordinary pottery, and this may be accomplished without injury to the effect, even when the flux or glaze requires a red heat for fusion.

Among other applications of the said invention which may be enumerated, it is particularly advantageous for rendering visible clock or watch faces and other indicators--such, for example, as compasses and the scales of barometers or thermometers--during the night or in dark places during the night time. In applying the invention to these and other like purposes there may be used either phosphorescent grounds with dark figures or dark grounds and phosphorescent figures or letters, preferring the former. In like manner there may be produced figures and letters for use on house-doors and ends of streets, wherever it is not convenient or economical to have external source of light, signposts, and signals, and names or marks to show entries to avenues or gates, and the like.

The invention is also applicable to the illumination of railway carriages by painting with phosphorescent paint a portion of the interior, thus obviating the necessity for the expense and inconvenience of the use of lamps in passing through tunnels. It may also be applied externally as warning-lights at the front and end of trains passing through tunnels, and in other similar cases, also to ordinary carriages, either internally or externally. As a night-light in a bed-room or in a room habitually dark, the application has been found quite effectual, a very small proportion of the surface rendered phosphorescent affording sufficient light for moving about the room, or for fixing upon and selecting an article in the midst of a number of complicated scientific instruments or other objects.

The invention may also be applied to private and public buildings in cases where it would be economical and advantageous to maintain for a short time a waning or twilight, so as to obviate the necessity for lighting earlier the gas or other artificial light. It may also be used in powder-mills and stores of powder, and in other cases where combustion or heat would be a constant source of danger, and generally for all purposes of artificial light where it is applicable.

In order to produce and maintain the phosphorescent light, full sunshine is not necessary, but, on the contrary, is undesirable. The illumination is best started by leaving the article or surface exposed for a short time to ordinary daylight or even artificial light, which need not be strong in order to make the illumination continue for many hours, even twenty hours, without, the necessity of renewed exposure.

The advantages of the invention consist in obtaining for the purposes of daily life a light which is maintained at no cost whatever, is free from the defects and contingent dangers arising from combustion or heat, and can be applied in many cases where all other sources of light would be inconvenient or incapable of application.

Heretofore phosphorus has been mixed with earthy oxides, carbonates, and sulphates, and with oxides and carbonates of metal, as tin, zinc, magnesia, antimony, and chlorides of the same, also crystallized acids and salts and mineral substances, and same have been inclosed and exhibited in closely-stopped bottles as a phosphorus; but such union I do not claim; but what I claim is:

A luminous paint, the body of which is a phosphorescent substance, or composed in part of such substance, the vehicle of which is such as is ordinarily used in paints, viz., one which will become dry by oxidation or evaporation, substantially as herein described.

A. Krause, of Buffalo, N.Y., obtained a patent for improvement in phosphorescent substances dated December 30, 1879. The patentee says: This invention relates to a substance which, by exposure to direct or indirect sun-light, or to artificial light, is so affected or brought into such a peculiar condition that it will emit rays of light or become luminous in the dark.

It is a well-known fact that various bodies and compositions of matter, more especially compositions containing sulphur in combination with earthy salts, possess the property of emitting rays of light in the dark after having been exposed to sun-light. All of these bodies and compositions of matter are, however, not well adapted for practical purposes, because the light emitted by them is either too feeble to be of any practicable utility, or because the luminous condition is not of sufficient duration, or because the substances are decomposed by exposure to the atmosphere.

Among the materials which have been employed with the best results for producing these luminous compositions are sea-shells, especially oyster-shells. I have found by practical experiments that only the inner surface of these shells is of considerable value in the production of luminous compositions, while the body of the shell, although substantially of the same chemical composition, does not, to any appreciable extent, aid in producing the desired result. It follows from this observation that the smallest shells, which contain the largest surface as compared with their cubic contents, will be best adapted for this purpose.

I have found that chalk, which is composed of the shells of microscopic animals, possesses the desired property in the highest degree; and my invention consists, therefore, of a luminous substance composed of such chalk, sulphur, and bismuth, as will be hereinafter fully set forth.

In preparing my improved composition I take cleaned or precipitated chalk, and subject it to the process of calcination in a suitable crucible over a clear coal or charcoal fire for three or four hours, or thereabout. I then add to the calcined chalk about one-third of its weight of sulphur, and heat the mixture for from forty-five to ninety minutes, or thereabout. A small quantity of bismuth, in the proportion of about one per cent, or less of the mixture, is added together with the sulphur.

The metal may be introduced in the metallic form in the shape of fillings, or in the form of a carbonate, sulphuret, sulphate, or sulphide, or oxide, as may be most convenient.

The substance produced in this manner possesses the property of emitting light in the dark in a very high degree. An exposure to light of very short duration, sometimes but for a moment, will cause the substance to become luminous and to remain in this luminous condition, under favorable circumstances, for upward of twenty-four hours.

The intensity of the light emitted by this composition after exposure is considerable, and largely greater than the light produced by any of the substances heretofore known.

The hereinbefore described substance may be ground with oil and used like ordinary paint; or it may be ground with any suitable varnish or be mixed in the manner of water colors; or it may be employed in any other suitable and well-known manner in which paints are employed.

My improved luminous substance is adapted for a great variety of uses--for instance, for painting business and other signs, guide boards, clock and watch dials, for making the numbers on houses and railway cars, and for painting all surfaces which are exposed periodically to direct or indirect light and desired to be easily seen during the night.

When applied with oil or varnish, my improved luminous substance can be exposed to the weather in the same manner as ordinary paint without suffering any diminution of its luminous property. I claim as my invention the herein described luminous substance, consisting of calcined chalk, sulphur, and bismuth, substantially as set forth.

Merrill B. Sherwood, Jr., of Buffalo, N. Y., obtained a patent for a phosphorescent composition, dated August 9, 1881.

The author says: My invention relates to an improvement in phosphorescent illuminants.

I have taken advantage of the peculiar property which obtains in many bodies of absorbing light during the day and emitting it during the night time.

The object of my invention is the preparation by a prescribed formula, to be hereinafter given, of a composition embodying one of the well-known phosphorescent substances above referred to, which will be applicable to many practical uses.

With this end in view my invention consists in a phosphorescent composition in which the chief illuminating element is monosulphide of calcium.

The composition obtained by the formula may be used either in a powdered condition by dusting it over articles previously coated, in whole or in part, with an adhesive substance, or it may be intimately mixed with paints, inks, or varnishes, serving as vehicles for its application, and in this way be applied to bodies to render them luminous.

The formula for obtaining the composition is as follows: To one hundred parts of unslaked lime, that obtained from calcined oyster shells producing the best results, add five parts of carbonate of magnesia and five parts of ground silex. Introduce these elements into a graphite or fire-clay crucible containing forty parts of sulphur and twenty-five parts of charcoal, raise the whole mass nearly or quite to a white heat, remove from the fire, allow it to cool slowly, and, when it is cold or sufficiently lowered in temperature to be conveniently handled, remove it from the crucible and grind it. The method of reducing the composition will depend upon the mode of its use. If it is to be applied as a loose powder by the dusting process, it should be simply ground dry; but if it is to be mixed with paint or other similar substance, it should be ground with linseed or other suitable oil. In heating the elements aforesaid, certain chemical combinations will have taken place, and monosulphide of calcium, combined with carbonate of lime, magnesia, and silex, will be the result of such ignition.

If, in the firing of the elements, as above set forth, all of the charcoal does not unite with the other elements, such uncombined portion should be removed from the fused mass before it is ground.

If it is designed to mix the composition with paints, those composed of zinc-white and baryta should be chosen in preference to those composed of white lead and colored by vegetable matter, as chemical action will take place between the composition and paint last mentioned, and its color will be destroyed or changed by the gradual action of the sulphureted hydrogen produced. However, by the addition of a weak solution of gum in alcohol or other suitable sizing to the composition, it may be used with paints containing elements sensitive to sulphureted hydrogen without danger of decomposing them and destroying their color.

In many, and possibly in a majority of cases, the illuminating composition applied as a dry powder will give the most satisfactory results, in view of the tendency to chemical action between the paint and composition when intimately mixed; in view of the fact that by the addition to paint of any color of a sufficient quantity of the composition to render the product luminous, the original color of the paint will be modified or destroyed; and, also, in view of the fact that the illuminating composition is so greatly in excess of the paint, the proportions in which they are united being substantially ten parts of the former to one of the latter, it will be difficult to impart a particular color to the product of the union without detracting from its luminosity. On the other hand, the union of dry powder with a body already painted by the simple force of adhesion does not establish a sufficiently intimate relation between it and the paint to cause chemical action, the application of a light coat of powder does not materially change the color of the article to which it is applied; and, further, by the use of the powder in an uncombined state its greatest illuminating effects are obtained. Again, if the appearance in the daytime of the article which it is desired to have appear luminous at night is not material, it may be left unpainted and simply sized to retain the powder.

In printing it is probable that the composition will be employed almost exclusively in the form of dry powder, as printing-ink, normally pasty, becomes too thick to be well handled when it is combined with powder in sufficient quantity to render the printed surface luminous. However, the printed surface of a freshly printed sheet may be rendered luminous by dusting the sheet with powder, which will adhere to all of the inked and may be easily shaken from the unmoistened surfaces thereof.

I am aware that monosulphide of calcium and magnesia have before been used together in phosphorescent compounds. What I claim is a phosphorescent composition consisting of monosulphide of calcium, combined with carbonate of lime, magnesia, and silex, substantially as described.

Orlando Thowless, of Newark, N.J., obtained a patent for a process of manufacturing phosphorescent substances dated November 8, 1881. The inventor says: The object of my invention is to manufacture phosphorescent materials of intense luminosity at low cost and little loss of materials.

I first take clam shells and, after cleaning, place them in a solution composed of about one part of commercial nitric acid and three parts of water, in which the shells are allowed to remain about twenty minutes. The shells are then to be well rinsed in water, placed in a crucible, and heated to a red heat for about four hours. They are then removed and placed, while still red-hot, in a saturated solution of sea salt, from which they are immediately removed and dried. After this treatment and exposure to light the shells will have a blood-red luminous appearance in the dark. The shells thus prepared are used with sulphur and the phosphide and sulphide of calcium to produce a phosphorescent composition, as follows: One hundred parts, by weight, of the shells, prepared as above, are intimately mixed with twenty parts, by weight, of sulphur. This mixture is placed in a crucible or retort and heated to a white heat for four or five hours, when it is to be removed and forty parts more of sulphur, one and one-half parts of calcium phosphide, and one-half part of chemically pure sulphide of calcium added. The mixture is then heated for about ninety minutes to an extreme white heat. When cold, and after exposure to light, this mixture will become luminous. Instead of these two ignitions, the same object may be in a measure accomplished by the addition of the full amount of sulphur with the phosphide and sulphide of calcium and raising it to a white heat but once. The calcium phosphide is prepared by igniting phosphorus in connection with newly slaked lime made chemically pure by calcination. The condition of the shells when the sulphur is added is not material; but the heat renders them porous and without moisture, so that they will absorb the salt to as great an extent as possible. Where calcined shells are mixed with solid salt, the absorbing power of the shells is greatly diminished by the necessary exposure, and there will be a lack of uniformity in the saturation. On the contrary, by plunging the red-hot shells in the saline solution the greatest uniformity is attained.

Instead of using clam shells as the base of my improved composition, I may use other forms of sea shells--such as oyster shells, etc.

I claim as new:

1. The herein described process of manufacturing phosphorescent

materials, which consists in heating sea shells red-hot, treating them while heated with a bath of brine, then, after removal from the bath, mixing sulphur and phosphide and sulphide of calcium therewith, and finally subjecting the mixture to a white heat, substantially as and for the purpose described.

2. The described process, which consists in placing clean and red-hot clam shells in a saturated solution of sea salt, and then drying them, for the purpose specified.

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BOXWOOD AND ITS SUBSTITUTES.

[Footnote: Prize essay written for the International Forestry Exhibition, Edinburgh.]

By JOHN R. JACKSON. A.L.S., Curator of the Museums, Royal Gardens, Ken.

The importance of the discovery of a hard, compact, and even grained wood, having all the characteristics of boxwood, and for which it would form an efficient substitute, cannot be overestimated; and if such a discovery should be one of the results of the present Forestry Exhibition, one of its aims will have been fulfilled.

For several years past the gradual diminution in the supplies of boxwood, and the deterioration in its quality, have occupied the attention of hardwood merchants, of engravers, and of scientific men.

Of merchants, because of the difficulties in obtaining supplies to meet the ever increasing demand; of engravers, because of the higher prices asked for the wood, and the difficulty of securing wood of good size and firm texture, so that the artistic excellence of the engraving might be maintained; and of the man of science, who was specially interested in the preservation of the indigenous boxwood forests, and in the utilization of other woods, natives, it might be, of far distant countries, whose adaptation would open not only a new source of revenue, but would also be the means of relieving the strain upon existing boxwood forests.

While by far the most important use of boxwood is for engraving purposes, it must be borne in mind that the wood is also applied to numerous other uses, such, for instance, as weaving shuttles, for mathematical instruments, turnery purposes, carving, and for various ornamental articles, as well as for inlaying in cabinet work. The question, therefore, of finding suitable substitutes for boxwood divides itself into two branches, first, directly for engraving purposes, and, secondly, to supply its place for the other uses to which it is now put. This, to a certain extent, might set free some of the boxwood so used, and leave it available for the higher purposes of art. At the same time, it must not be forgotten that much of the wood used for general purposes is unsuited for engraving, and can only therefore be used by the turner or cabinet maker. Nevertheless, the application of woods other than box for purposes for which that wood is now used would tend to lessen the demand for box, and thus might have an effect in lowering the price.

So far back as 1875 a real uneasiness began to be felt as to the future supplies of box. In the _Gardeners' Chronicle_ for September 25, of that year, page 398, it is said that the boxwood forests of Mingrelia in the Caucasian range were almost exhausted. Old forests, long abandoned, were even then explored in search of trees that might have escaped the notice of former proprietors, and wood that was rejected by them was, in 1875, eagerly purchased at high prices for England. The export of wood was at that time prohibited from Abhasia and all the government forests in the Caucasus. A report, dated at about the same period from Trebizond, points out that the Porte had prohibited the cutting of boxwood in the crown forests. (_Gardeners' Chronicle_, Aug. 19, 1876, p. 239.) Later on, the British Consul at Tiflis says: "_Bona fide_ Caucasian boxwood may be said to be commercially non-existent, almost every marketable tree having been exported." (_Gardeners' Chronicle_, Dec. 6, 1879, p. 726.)

The characters of boxwood are so marked and so distinct from those of most other woods that some extracts from a report of Messrs. J. Gardner & Sons, of London and Liverpool, addressed to the Inspector-General of Forests in India, bearing on this subject, will not be without value; indeed, its more general circulation than its reprint in Mr. J.S. Gamble's "Manual of Indian Timbers" will, it is hoped, be the means of directing attention to this very important matter, and by pointing out the characters that make boxwood so valuable, may be the means of directing observation to the detection of similar characters in other woods. Messrs. Gardner say:

"The most suitable texture of wood will be found growing upon the sides of mountains. If grown in the plains the growth is usually too quick, and consequently the grain is too coarse, the wood of best texture being of slow growth, and very fine in the grain.

"It should be cut down in the winter, and, if possible, stored at once in airy wooden sheds well protected from sun and rain, and not to have too much air through the sides of the sheds, more especially for the wood under four inches diameter.

"The boxwood also must not be piled upon the ground, but be well skidded under, so as to be kept quite free from the effects of any damp from the soil.

"After the trees are cut down, the longer they are exposed the more danger is there afterward of the wood splitting more than is absolutely necessary during the necessary seasoning before shipment to this country.

"If shipped green, there is great danger of the wood sweating and becoming mildewed during transit, which causes the wood afterward to dry light and of a defective color, and in fact rendering it of little value for commercial purposes.

"There is no occasion to strip the bark off or to put cowdung or anything else upon the ends of the pieces to prevent their splitting.

"Boxwood is the nearest approach to ivory of any wood known, and will, therefore, probably gradually increase in value, as it, as well as ivory, becomes scarcer. It is now used very considerably in manufacturing concerns, but on account of its gradual advance in price during the past few years, cheaper woods are in some instances being substituted.

"Small wood under four inches is used principally by flax spinners for rollers, and by turners for various purposes, rollers for rink skates, etc., etc., and if free from splits, is of equal value with the larger wood. It is imported here as small as one a half inches in diameter, but the most useful sizes are from 2‰ to 3‰ inches, and would therefore, we suppose, be from fifteen to thirty or forty years in growing, while larger wood would require fifty years and upward at least, perhaps we ought to say one hundred years and upward. It is used principally for shuttles, for weaving silk, linen, and cotton, and also for rule making and wood engraving. _Punch, The Illustrated London News, The Graphic_, and all the first class pictorial papers use large quantities of boxwood."

In 1880, Messrs. Churchill and Sim reported favorably on some consignments of Indian boxwood, concluding with the remarks that if the wood could be regularly placed on the market at a moderate figure, there was no reason why a trade should not be developed in it. Notwithstanding these prospects, which seemed promising in 1877 and 1880, little or nothing has been accually done up to the present time in bringing Indian boxwood into general use, in consequence, as Mr. Gamble shows, of the cost of transit through India. The necessity, therefore, of the discovery of some wood akin to box is even more important now than ever it was.

BOXWOOD SUBSTITUTES.

First among the substitutes that have been proposed to replace boxwood may be mentioned an invention of Mr. Edward Badoureau, referred to in the _Gardeners' Chronicle_, March 23, 1878, p. 374, under the title of artificial boxwood. It is stated to consist of some soft wood which has been subject to heavy pressure. It is stated that some English engravers have given their opinion on this prepared wood as follows:

It has not the power of resistance of boxwood, so that it would be imposible to make use of it, except in the shape of an electro obtained from it, as it is too soft to sustain the pressure of a machine, and would be easily worn out. In reply to these opinions, Mr. Badoureau wrote: "My wood resists the wear and tear of the press as well as boxwood, and I can show engravings of English and French artists which have been obtained direct from the wood, and are as perfect as they are possible to be; several of them have been drawn by Mr. Gustave Dore."

Mr. Badoureau further says that "while as an engraver he has so high an opinion of the qualities of compressed wood as a substitute for boxwood, as the inventor of the new process he considered that it possesses numerous advantages both for artistic and industrial purposes." In short, he says, "My wood is to other wood what steel is to iron."

The following woods are those which have, from time to time, been proposed or experimented upon as substitutes for boxwood, for engraving purposes. They are arranged according to their scientific classification in the natural orders to which they belong:

Natural Order Pittosporeæ.

1. _Pittosporum undulatum_. Vent.--A tree growing in favorable situations to a height of forty or even sixty feet, and is a native of New South Wales and Victoria. It furnishes a light, even grained wood, which attracted some attention at the International Exhibition in 1862; blocks were prepared from it, and submitted to Prof. De la Motte, of King’s College, who reported as follows:

"I consider this wood well adapted to certain kinds of wood engraving. It is not equal to Turkey box, but it is superior to that generally used for posters, and I have no doubt that it would answer for the rollers of mangles and wringing machines." Mr. W.G. Smith, in a report in the _Gardeners’ Chronicle_ for July 26, 1873, p. 1017, on some foreign woods which I submitted to him for trial, says that the wood of _Pittosporum undulatum_ is suitable only for bold outlines; compared with box, it is soft and tough, and requires more force to cut than box. The toughness of the wood causes the tools to drag back, so that great care is required in cutting to prevent the lines clipping. The average diameter of the wood is from 18 to 30 inches.

2. _Pittosporum bicolor_, Hook.--A closely allied species, sometimes forty feet high, native of New South Wales and Tasmania. This wood is stated to be decidedly superior to the last named.

3. _Bursaria spinosa_, Cav.--A tree about forty feet high, native of North, South, and West Australia, Queensland, New South Wales, Victoria, and Tasmania, in which island it is known as boxwood. It has been reported upon as being equal to common or inferior box, and with further trials might be found suitable for common subjects; it has the disadvantage, however, of blunting the edges and points of the tools.

Natural Order Meliaceæ.

4. _Swietenia mahagoni_, L. (mahogany).--A large timber tree of

Honduras, Cuba, Central America, and Mexico. It is one of the most valuable of furniture woods, but for engraving purposes it is but of little value, nevertheless it has been used for large, coarse subjects. Spanish mahogany is the kind which has been so used.

Natural Order Ilicineæ.

Ilex opaca, L. (North American holly).--It is a widely diffused tree, the wood of which is said to closely resemble English holly, being white in color, and hard, with a fine grain, so that it is used for a great number of purposes by turners, engineers, cabinet makers, and philosophical instrument makers. For engraving purposes it is not equal to the dog-wood of America (_Cornus florida_); it yields, however, more readily to the graver's tools.

Natural Order Celastrineæ.

6. _Elæodendron australe_, Vent.--A tree twenty to twenty-five feet high, native of Queensland and New South Wales. The wood is used in the colony for turning and cabinet work, and Mr. W.G. Smith reports that for engraving purposes it seems suitable only for rough work, as diagrams, posters, etc.

7. _Euonymus sieboldianus_, Blume.--A Chinese tree, where the wood, which is known as pai'cha, is used for carving and engraving. Attention was first drawn to this wood by Mr. Jean von Volxem, in the _Gardeners' Chronicle_ for April 20, 1878. In the Kew Report for 1878, p. 41, the following extract of a letter from Mr. W.M. Cooper, Her Majesty's Consul at Ningpo, is given: "The wood in universal use for book blocks, wood engravings, seals, etc., is that of the pear tree, of which large quantities are grown in Shantung, and Shan-se, especially. Pai'cha is sometimes used as an indifferent substitute. Pai'cha is a very fine white wood of fine fiber, without apparent grains, and cuts easily; is well suited for carved frames, cabinets, caskets, etc., for which large quantities are manufactured here for export. The tree itself resembles somewhat the _Stillingia_, but has a rougher bark, larger and thinner leaves, which are serrated at the edge, more delicate twigs, and is deciduous." In 1879, a block of this wood was received at the Kew Museum, from Mr. Cooper, a specimen of which was submitted to Mr. Robson J. Scott, of Whitefriars Street, to whom I am much indebted for reports on various occasions, and upon this wood Mr. Scott reported as follows: "The most striking quality I have observed in this wood is its capacity for retaining water, and the facility with which it surrenders it. This section (one prepared and sent to the Kew Museum), which represents one-tenth of the original piece, weighed 3 lb. 4‰ ounces. At the end of twenty one days it had lost 1 lb. 6¾ ounces in an unheated chamber. At the end of another fourteen days, in a much elevated temperature, it only lost … ounce. In its present state of reduced bulk its weight is 1 lb. 10 ounces. It is not at all likely to supersede box, but it may be fit for coarser work than that for which box is necessary." Later on, namely in the Kew Report for 1880, p. 51, Mr. R.D. Keene, an engraver,

to whom Mr. Scott submitted specimens of the wood for trial, writes: "I like the wood very much, and prefer it to box in some instances; it is freer to work, and consequently quicker, and its being uniform in color and quality is a great advantage; we often have great difficulty in box in having to work from a hard piece into a soft. I think it a very useful wood, especially for solid bold work. I question if you could get so extreme a fine black line as on box, but am sure there would be a large demand for it at a moderate price." Referring to this letter, Mr. Scott remarks that the writer does not intend it to be understood that pai'cha is qualified to supersede box, but for inferior subjects for which coarse brittle box is used. Mr. Scott further says that of the woods he has tried he prefers pear and hawthorn to pai'cha.

Natural Order Sapindaceæ.

8. _Acer saccharinum_, L. (sugar or bird's eye maple).--A North American tree, forming extensive forests in Canada, New Brunswick, and Nova Scotia. The wood is well known as a cabinet or furniture wood. It has been tried for engraving, but it does not seem to have attracted much notice. Mr. Scott says it is sufficiently good, so far as the grain is concerned. From this it would seem not to promise favorably.

Natural Order LeguminoseæSub-order Papilionaceæ.

9. _Brya ebenus_, [Delta]. DC.--A small tree of Jamaica, where the wood is known as green ebony, and is used for making various small articles. It is imported into this country under the name of cocus wood, and is used with us for making flutes and other wind instruments. Mr. Worthington Smith considers that the wood equals bad box for engraving purposes.

Natural Order Rosaceæ.

10. _Pyrus communis_, L. (common pear).--A tree averaging from 20 to 40 feet high. Found in a wild state, and very extensively cultivated as a fruit tree. The wood is of a light brown color, and somewhat resembles limewood in grain. It is, however, harder and tougher. It is considered a good wood for carving, because it can be cut with or across the grain with equal facility. It stands well when well seasoned, and is used for engraved blocks for calico printers, paper stainers, and for various other purposes. Pear-wood has been tried for engraving purposes, but with no great success. Mr. Scott's opinion of its relative value is referred to under pai'cha wood _(Euonymus sieboldianus)_.

11. _Amelanchier canadensis_. L. (shade tree or service tree of America).--A shrub or small tree found throughout Canada, Newfoundland, and Virginia. Of this wood, Porcher says, in his "Resources of the Southern Fields and Forests": "Upon examining with a sharp instrument the specimens of various southern woods deposited in the museum of the Elliott Society, ... I was struck with the singular weight, density, and

fineness of this wood. I think I can confidently recommend it as one of the best to be experimented upon by the wood engraver."

12. _Cratoegus oxyacantha_, L. (hawthorn).--A well-known shrub or small tree in forests and hedges in this country. The wood is very dense and close grained. Of this wood, Mr. Scott reports that it is by far the best wood after box that he has had the opportunity of testing.

Natural Order Myrtaceæ.

13. _Eugenia procera_, Poir.--A tree 20 to 30 feet high, native of Jamaica, Antigua, Martinique, and Santa Cruz. A badly seasoned sample of this wood was submitted to Mr. R.H. Keene, who reported that "it is suited for bold, solid newspaper work."

Natural Order Cornaceæ.

14. _Cornus florida_, L. (North American dogwood).--A deciduous tree, about 30 feet high, common in the woods in various parts of North America. The wood is hard, heavy, and very fine grained. It is used in America for making the handles of light tools, as mallets, plane stocks, harrow teeth, cogwheels, etc. It has also been used in America for engraving.

In a letter from Prof. Sargent, Director of the Arnold Arboretum, Brookline, Massachusetts, quoted in the Kew Report for 1882, p. 35, he says: "I have been now, for a long time, examining our native woods in the hope of finding something to take the place of boxwood for engraving, but so far I am sorry to say with no very brilliant success. The best work here is entirely done from boxwood, and some _Cornus florida_ is used for less expensive engraving. This wood answers fairly well for coarse work, but it is a difficult wood to manage, splitting, or rather 'checking,' very badly in drying." This, however, he states in a later letter, "can be overcome by sawing the logs through the center as soon as cut. It can be obtained in large quantities." Mr. R.H. Keene, the engraver before referred to, reports that the wood is very rough, and suitable for bold work.

Natural Order Ericaceæ.

15. _Rhododendron maximum_, L. (mountain laurel of North America).--Of this wood it is stated in Porcher's "Resources of the Southern Fields and Forests," p. 419, that upon the authority of a well-known engraver at Nashville, Tennessee, the wood is equaled only by the best boxwood. This species of _Rhododendron_ "abounds on every mountain from Mason and Dixon's line to North Georgia that has a rocky branch." Specimens of this wood submitted to Mr. Scott were so badly selected and seasoned that it was almost impossible to give it a trial. In consideration of its hardness and apparent good qualities, further experiments should be made with it.

16. _Rhododendron californicum_.--Likewise a North American species, the wood of which is similar to the last named. Specimens were sent to Kew by Professor Sargent for report in 1882, but were so badly seasoned that no satisfactory opinion could be obtained regarding it.

17. _Kalmia latifolia_, L. (calico bush or ivy bush of North America).--The wood is hard and dense, and is much used in America for mechanical purposes. It has been recommended as a substitute for boxwood for engraving, and trials should, therefore, be made with it.

Natural Order Epacrideæ.

18. _Monotoca elliptica_, R. Br.--A tall shrub or tree 20 or 30 feet high, native of Queensland, New South Wales, Victoria, and Tasmania. The wood has been experimented upon in this country, and though to all appearances it is an excellent wood, yet Mr. Worthington Smith reported upon it as having a bad surface, and readily breaking away so that the cuts require much retouching after engraving.

Natural Order Ebenaceæ.

19. _Diospyros texana_.--A North American tree, of the wood of which Professor Sargent speaks favorably. "It is, however," he says, "in Texas, at least, rather small, scarcely six inches in diameter, and not very common. In northern Mexico it is said to grow much larger, and could probably be obtained with some trouble in sufficient quantities to become an article of commerce." Of this wood Mr. Scott says: "It is sufficiently good as regards the grain, but the specimen sent for trial was much too small for practical purposes." Mr. R.H. Keene, the engraver, says it "is nearly equal to the best box."

20. _Diospyros virginiana_, L. (the persimmon of America).--A good-sized tree, widely diffused, and common in some districts. The wood is of a very dark color, hard, and of a fairly close grain. It has been used in America for engraving, but so far as I am aware has not been tried in this country. It has, however, been lately introduced for making shuttles.

21. _Dyospyros ebenum_, Koenig (ebony).--A wood so well known as to need no description. It has been tried for engraving by Mr. Worthington Smith, who considers it nearly as good as box.

Natural Order Apocyneæ.

22. _Hunteria zeylanica_, Gard.--A small tree, common in the warmer parts of Ceylon. This is a very hard and compact wood, and is used for engraving purposes in Ceylon, where it is said, by residents, to come nearer to box than any other wood known. On this wood Mr. Worthington Smith gave a very favorable opinion, but it is doubtful whether it would

ever be brought from Ceylon in sufficient quantities to meet a demand.

Natural Order Bignoniaceæ.

23. _Tecoma pentaphylla_, Dl.--A moderate-sized tree, native of the West Indies and Brazil. The wood is compact, very fine, and even grained, and much resembles box in general appearance. Blocks for engraving have been prepared from it by Mr. R.J. Scott, who reported upon it as follows: "It is the only likely successor to box that I have yet seen, but it is not embraced as a deliverer should be, but its time may not be far off."

Natural Order Corylaceæ.

24. _Carpinus betulus_, L. (hornbeam).--A tree from 20 to 70 feet high, with a trunk sometimes 10 feet in girth, indigenous in the southern counties of England. The wood is very tough, heavy, and close grained. It is largely used in France for handles for agricultural and mining implements, and of late years has been much used in this country for lasts. The wood of large growth is apt to became shaky, and it is consequently not used as a building wood. It is said to have been used as a substitute for box in engraving, but with what success does not appear.

25. _Ostrya virginica_, Willd (ironwood, or American hornbeam).--A moderate-sized tree, widely spread over North America. The wood is light-colored, and extremely hard and heavy; hence the name of ironwood. It is used in America by turners, as well as for mill cogs, etc., and has been suggested as a substitute for boxwood for engraving, though no actual trials, so far as I am aware, have been made with it.

Besides the foregoing list of woods, there are others that have been occasionally used for posters and the coarser kinds of engraving, such, for instance, as lime, sycamore, yew, beech, and even pine; and in America, _Vaccinium arboreum_ and _Azalea nudiflora_. Of these, however, but little is known as to their value.

It will be noticed that in those woods that have passed through the engraver's hands, some which promised best, so far as their texture or grain is concerned, have been tried upon very imperfect or badly seasoned samples.

The subject is one of so much importance, as was pointed out at the commencement of this paper, that a thoroughly organized series of experiments should be undertaken upon carefully seasoned and properly prepared woods, not only of those mentioned in the preceding list, but also of any others that may suggest themselves, as being suitable, It must, moreover, always be borne in mind that the questions of price, and the considerations of supply and demand, must, to a great extent, regulate the adaptation of any particular wood.

With regard to those woods referred to as being tried by Mr. Worthington

Smith, he remarks in his report that any of them would be useful for some classes of work, if they could be imported, prepared, and sold for a farthing, or less than a halfpenny, per square inch.

Specimens of all the woods here enumerated are contained in the Kew Museum.

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COMPOSITE PORTRAITS.

Not long since we gave a figure from a drawing by Mr. Grallieni, which, looked at from a distance, seemed to be a death's head, but which, when examined more closely, was seen to represent two children caressing a dog. Since then we have had occasion to publish some landscapes of Kircher and his imitators, which, looked at sideways, exhibited human profiles. This sort of amusement has exercised the skill of artists of all times, and engravings, and even paintings, of double aspect are very numerous. Chance has recently put into our hands a very curious work of this kind, which is due to a skillful artist named Gaillot. It is an album of quite ancient lithographs, which was published at Berlin by Senefelder. The author, under the title of "Arts and Trades," has drawn some very amusing faces that are formed through the tools and objects used in the profession represented. We reproduce a few specimens of these essentially original compositions of Gaillot. The green grocer is formed of a melon for the head, of an artichoke and its stem for the forehead and nose, of a pannier for the bust, etc. The hunter is made up of a gun, of a powder horn, and of a hunting horn, etc.; and so on for the other professions. This is an amusing exercise in drawing that we have thought worthy of reproducing. Any one who is skillful with his pencil might exercise himself in imagining other compositions of the same kind.--_La Nature_.

[Illustration: COMPOSITE PORTRAITS.--OCCUPATIONS. 1. Green-grocer. 2. Hunter. 3. Artist. 4. Cobbler. 5. Chemist 6. Cooper.]

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HAND-CRAFT AND REDE-CRAFT.--A PLEA FOR THE FIRST NAMED.

[Footnote: Read before the Worcester Free Industrial Institute, June 25, 1885.]

By DANIEL C. GILMAN, President of the Johns Hopkins University, Baltimore.

I cannot think of a theme more fit for this hour and place than handy-craft. I begin by saying "handy-craft," for that is the form of the word now in vogue, that which we are wonted to see in print and hear in speech; but I like rather the old form, "hand-craft," which was used by our sires so long ago as the Anglo-Saxon days. Both words mean the same thing, the power of the hand to seize, hold, shape, match, carve, paint, dig, bake, make, or weave. Neither form is in fashion, as we know very well, for people choose nowadays such Latin words as "technical ability," "manual labor," "industrial pursuits," "dexterity," "professional artisanship," "manufacture," "decorative art," and "technological occupations," not one of which is half as good as the plain, old, strong term "hand-craft."

An aid to hand-craft is rede-craft--the power to read, to reason, and to think; or, as it is said in the book of Common Prayer, "to read, mark, learn, and inwardly digest." By rede craft we find out what other men have done; we get our book learning, we are made heirs to thoughts that breathe and words that burn, we enter into the life, the acts, the arts, the loves, the lore of the wise, the witty, the cunning, and the worthy of all ages and all places; we learn, as says the peasant poet of Scotland,

"The song whose thunderous chime
  Eternal echoes render--
The mournful Tuscan's haunted rhyme,
  And Milton's starry splendor!"

I do not pit rede-craft against hand-craft. Quite otherwise, I call them not foes (as some would), but friends. They are brothers, partners, consorts, who can work together, as right hand and left hand, as science and art, as theory and practice. Rede-craft may call for books and hand-craft for tools, but it is by the help of both books and tools that mankind moves on. Indeed, we shall not err wide of the mark if we say that a book is a tool, for it is the instrument which we make use of in certain cases when we wish to find out what other men have thought and done. Perhaps you will not be as ready to admit that a tool is a book. But take for example the plow. Compare the form in use to-day on a first-rate farm with that which is pictured on ancient stones long hid in Egypt--ages old. See how the idea of the plow has grown, and bear in mind that its graceful curves, it fitness for a special soil, or for a special crop, its labor-saving shape, came not by chance, but by thought. Indeed, a plow is made up from the thoughts and toils of generations of plowmen. Look at a Collins ax; it is also the record of man's thought. Lay it side by side with the hatchet of Uncas or Miantonomoh, or with an ax of the age of bronze, and think how many minds have worked on the head and on the helve, how much skill has been spent in getting the metal, in making it hard, in shaping the edge, in fixing the weight, in forming the handle. From simple tools, turn to complex; to the printing press, the sewing machine, the locomotive, the telegraph, the ocean steamer; all are full of ideas. All are the offspring of hand-craft and rede craft, of skill and thought, of practice put on record, of science and art.

Now, the welfare of each one of us, the welfare of our land, the welfare of our race, rests on this union. You may almost take the measure of a man's brain, if you can find out what he sees with his eyes and what he does with hands; you may judge of a country, or of a city, if you know what it makes.

I do not know that we need ask which is best, hand-craft or rede-craft. Certainly "the eye cannot say to the hand, I have no need of thee." At times, hand-craft becomes rede-craft, for when the eye is blind the hand takes its place, and the finger learns to read, running over the printed page to find out what is written, as quickly as the eye.

In these days, there are too many who look down on hand-craft. They think only of the tasks of a drudge or a char-boy. They do not know the pleasure there is in working, and especially in making. They have never learned to guide the fingers by the brain. They like to hear, or see, or own, or eat, what others have made, but they do not like to put their own hands to work. If you doubt what I say, put a notice in the paper asking for a clerk, and you will have a, hundred answers for every one that will come when you ask for a workman. So it comes to pass that young men grow up whose hands have not been trained to any kind of skill; they wish, therefore, to be buyers and sellers, traders, dealers, and so the market is overstocked with clerks, book-keepers, salesmen, and small shop-keepers, while it is understocked in all the higher walks of hand-craft. Some men can only get on by force of arms, lifting, pounding, heaving, or by power of sitting at counter or a desk and "clerking it."

Machinery works against hand-craft. In many branches of labor, the hand now has but little to do, and that little is always the same, so that labor becomes tiresome and the workman dull. Machines can be made to cut statuary, to weave beautiful tapestry, to fashion needles, to grind out music, to make long calculations; alas! the machine has also been brought into politics. Of course, a land cannot thrive without machinery; it is that mechanical giant, the steam engine, which carries the corn, the cotton, and the sugar from our rich valleys to the hungry of other lands, and brings back to us the product of their looms. Nevertheless, he who lives by the machine alone lives but half a life; while he who uses his hand to contrive and to adorn drives dullness from his path. A true artist and a true artisan are one. Hand-craft, the power to shape, to curve, to beautify, to create, gives pleasure and dignity to labor.

In other times and in other lands, hand-craft has had more honor than it has had with us. Let me give some examples. Not long ago, I went to one of the shrines of education, the Sorbonne in Paris. Two paintings adorn the chapel walls, not of saints or martyrs, nor of apostles or prophets, perhaps I should say of both saints and prophets, _Labor_ and _Humilitas_, Industry and Modesty.

The touch of Phidias was his own, and so inimitable that a few months ago, an American, scanning, with his practiced eye, the galleries of the

Louvre, recognized a fragment of the work of Phidias, long separated from the Parthenon frieze which Lord Elgin sent to London. The sculptor's touch could not be mistaken. It was as truly his own as his signature, his autograph. Ruskin, in a lecture on the relation of Art to Morals, calls attention to a note which Durer made on some drawings sent him by Raphael: "These figures Raphael drew and sent to Albert Durer in Nurnberg, to show him his hand, '_sein hand zu weisen_.'" Ruskin compares this phrase with other contests of hand-craft, Apelles and Protogenes showing their skill by drawing a line; Giotto in striking a circle.

In the household of the Kings of Prussia, there is a custom, if not a law, that every boy shall learn a trade. I believe this is a fact, though I have no certain proof of it. The Emperor Wilhelm is said to be a glazier, the Crown Prince a compositor, and on the Emperor's birthday not long ago his majesty received an engraving by Prince Henry and a, book bound by Prince Waldemar, two younger sons of the Crown Prince. Let me refer to sacred writ; the prophet Isaiah, telling of the golden days which are to come, when the voice of weeping shall be no more heard in the land, nor the voice of crying, when the child shall die an hundred years old, and men shall eat of the fruit of the vineyards they have planted, adds this striking promise, as the culm of all hope, that the elect of the Lord shall long enjoy the work of their hands.

Now, in view of what has been said, my first point is this: We who have to deal with the young, we all who love our fellow-men, we all who desire that our times, our city, our country, should be thrifty, happy, and content, must each in his place and way give high honor to labor. We, especially, who are teachers and parents, should see to it that the young get "hand-craft" while they are getting "rede-craft." How can this be done?

Mothers begin right in the nursery, teaching little fingers to play before the tongue can lisp a sentence. Alas! this natural training has often been stopped at school. Hitherto, until quite lately, in schools both low and high, rede-craft has had the place of honor, hand-craft has had no chance. But a change is coming. In the highest of all schools, universities, for example, work rooms, labor places, "laboratories," are now thought to be as useful as book rooms, reading rooms, libraries.

What mean those buildings which you have seen spring up within a few years past in all the college greens of New England? They are libraries and laboratories. They show that rede-craft and hand-craft are alike held in honor, and that a liberal education means skill in getting and skill in using knowledge; that knowledge comes from searching books and searching nature; that the brain and the hand are in close league. So too, in the lowest school, as far as possible from the university, the kindergarten has won its place and the blocks, and straws, and bands, the chalk, the clay, the scissors, are in use to make young fingers deft. Between the highest and the lowest schools there is a like call for hand-craft. Seeing this need, the authorities in our public schools have begun to project special schools for such training, and are looking for guidance far and near. At this intermediate stage, for boy and girls who are between the age of the kindergarten and the age of the college or the shop, for youth between eight and sixteen, there is much to be done; people are hardly aware how much is needed to secure fit training for the rising generation.

It seems sometimes as if one of the most needed forms of hand-craft would become a lost art, even good handwriting. We cannot give much credit to schools if they send out many who are skilled in algebra, or in Latin, but who cannot write a page of English so that it can be read without effort.

Drawing is another kind of hand-craft, quite too much neglected. I think it should be laid down as a law of the road to knowledge, that everybody must learn to draw as well as to write. The pencil maybe mastered just as readily as the pen. It is a simpler tool. The child draws before he writes, and savages begin their language with pictures; but, we wiseacres of this age of books let our young folks drop their slate pencils and their Fabers, and practice with their Gillotts and their Esterbrooks. Let us say, in every school and in every house, the child must not only learn to read and write, he must learn to draw. We cannot afford to let our young folks grow up without this power. A new French book is just now much talked about, with this droll title, "The Life of a Wise Man, by an Ignoramus." It is the story of the great Pasteur, whose discoveries in respect to life have made him world renowned. I turned to the book, eager to find out the key to such success, and I found the old story--"the child was father of the man." This philosopher, whose eye is so skilled in observing nature, and whose hand is so apt in experiments, is the boy grown up whose pictures were so good that the villagers thought him at thirteen an artist of rank.

Girls should learn the first lesson of hand-craft with the needle; boys may (and they will always prize the knowledge), but girls must. It is wise that our schools are going back to old fashioned ways, and saying that girls must be taught to sew.

Boys should practice their hands upon the knife. John Bull used to laugh at Brother Jonathan for whittling, and Mr. Punch always drew the Yankee with a blade in his fingers; but they found out long ago in Great Britain that whittling in this land led to something, a Boston notion, a wooden clock, a yacht America, a labor-saving machine, a cargo of wooden-ware, a shop full of knick-knacks, an age of inventions. Boys need not be kept back to the hand-craft of the knife. For in-doors there are the type case and printing press, the paint box, the tool box, the lathe; and for out doors, the trowel, the spade, the grafting knife. It matters not how many of the minor arts the youth acquires. The more the merrier. Let each one gain the most he can in all such ways; for arts like these bring no harm in their train; quite otherwise, they lure good fortune to their company.

Play, as well as work, may bring out hand-craft. The gun, the bat, the rein, the rod, the oar, all manly sports, are good training for the hand. Walking insures fresh air, but it does not train the body or mind like games and sports which are played out of doors. A man of great fame as an explorer and as a student of nature (he who discovered, in the West, bones of horses with two, three, and four toes, and who found the remains of birds with teeth) once told me that his success was largely due to the sports of his youth. His boyish love of fishing gave him his manly skill in exploration.

I speak as if hand-craft was to be learned by sport. So it may. It may also be learned by labor. Day by day for weeks I have been watching from my study window a stately inn rise from the cellar just across the road. A bricklayer has been there employed whose touch is like the stroke of an artist. He handled each brick as if it were porcelain, balanced it carefully in his hand, measured with his eye just the amount of mortar which it needed, and dropped the block into its bed, without staining its edge, without varying from the plumb line, by a stroke of hand-craft as true as the sculptor's. Toil gave him skill.

The second point I make is this: If you really value hand-craft, buy that which shows hand-craft, encourage those who are engaged in hand-craft, help on with your voice and with your pocket, those who bring taste and skill and art into the works of their hand. If your means are so small that you only buy what you need for your daily wants, you cannot have much choice, you must buy that which is cheapest; but hardly any one within the sound of my voice is so restricted as that; almost if not quite every one buys something every year for his pleasure, a curtain, a rug, a wall paper, a chair, or a table not certainly needed, a vase, a clock, a, mantel ornament, a piece of jewelry, a portrait, an etching, a picture. Now whenever you make such a purchase, to please your taste, to make your parlor or your chamber more attractive, choose that which shows good handiwork. Such a choice will last. You will not tire of it as you will of that which has but a commonplace form or pattern.

I come now to a third point. That which has just been said applies chiefly to things whose price is fixed by beauty. But handicraft gives us many works not pleasing to the eye, yet of the highest skill--a Jacquard loom, a Corliss engine, a Hoe printing press, a Winchester rifle, an Edison dynamo, a Bell telephone. Ruskin may scout the work of machinery, and up to a certain point may take us with him. Let us allow that works of art marked by the artist's own touch--the gates of Paradise by Ghiberti, a shield by Cellini, a statue by Michael Angelo, are better than all reproductions and imitations, better than plaster casts by Eichler, electrotypes by Barbedienne, or chromos by Prang. But even Ruskin cannot suppress the fact that machinery brings to every thrifty cottage in New England comforts and adornments which, in the days of Queen Bess, were not known outside of the palace. Be mindful, then, that handicraft makes machines which are wonders of productive force--weaving tissues such as Penelope never saw, of woolen, cotton, linen, and silk, to carpet our floors, cover our tables, cushion our chairs, and clothe our bodies; machines of which Vulcan never dreamed, to point a needle, bore a rifle, cut a watch wheel, or rule a series of lines, measuring forty thousand to an inch, with sureness which the unaided hand can never equal. Machinery is a triumph of handicraft as truly as sculpture and architecture. The fingers which can plan and build a steamship or a suspension bridge, which can make the Quinebaug and the Blackstone turn spindles by the hundred thousand, which can turn a rag heap into spotless paper, and make myriads of useful and artful articles from rough metal, are fingers which this age alone has evolved. The craft which makes useful things cheap can make cheap things beautiful. The Japanese will teach us how to form and finish, if we do not first teach them how to slight and sham.

A fourth point is this. If hand-craft is of such worth, boys and girls must be trained in it. This, I am well aware is no new thought. Forty years ago schools of applied science were added to Harvard and Yale colleges; twenty years ago Congress gave enough land-scrip to aid in founding at least one such school in every state; men of wealth, like many whom you have known and whom you honor, have given large sums for like ends. Now the people at large are waking up. They see their needs; they have the means to supply what they want. Is there the will? Know they the way? Far and near the cry is heard for a different training from that now given in the public schools. Many are trying to find it. Almost every large town has its experiment--and many smaller places have theirs. Nobody seems to know just what is best. Even the words which express the want are vague. Bright and thoughtful people differ as to what might, can, and should be done. A society has been formed in New York to bring together the needed data. The Slater trustees, charged with the care of a large fund for the training of freedmen, have said that manual training must be given in all the schools they aid. The town of Toledo in Ohio opened, some time since, a school of practical training for boys, which worked so well that another has lately been opened for girls. St. Louis is doing famously. Philadelphia has several experiments in progress. Baltimore has made a start. In New York there are many noteworthy movements--half a dozen at least full of life and hope. Boston was never behindhand in knowledge, and in the new education is very alert, the efforts of a single lady deserving praise of high degree. These are but signs of the times.

Some things may be set down as fixed; for example, most of those who have thought on this theme will agree on the points I am about to name, though they may or may not like the names which I venture to propose:

1. Kindergarten work should be taught in the nurseries and infant schools of rich and poor.

2. Drawing should be taught in schools of every grade, till the hand uses the pencil as readily as the pen.

3. Every girl at school if not at home should learn to sew.

4. Every boy should learn the use of tools, the gardener’s or the carpenter’s, or both.

5. Well planned exercises, fitted to strengthen the various bodily organs, arms, fingers, wrists, lungs, etc., are good. Driving, swimming, rowing, and other manly sports should be favored.

What precedes is at the basis of good work.

In addition:

6. With good teachers, quite young children may learn the minor decorative arts, carving, leather stamping, brass beating and the like, as is shown in the Leland classes of Philadelphia.

7. In towns, boys who begin to earn a living when they enter their teens may be taught in evening schools to practice the craft of carpentry, bricklaying, plastering, plumbing, gas fitting, etc., as is shown successfully in the Auchmuty schools of New York. Trade schools they are called; schools of practice for workmen would be a better name.

8. Boys who can carry their studies through the later teens may learn, while at the high school or technical school or college, to work in wood and metals with precision, as I have lately seen in the College of the City of New York, at Cornell University, and elsewhere-colleges or high schools with work-shops and practice classes. If they can take the time to fit themselves to be foremen and leaders in machine shops and factories, they may be trained in theoretical and practical mechanics, as in the Worcester Industrial Institute and in a score of other places; but the youth must have talent as well as time to win the race in these hard paths. These are schools for foremen, or, if we may use a foreign word like Kindergarten, they are Meisterschaft schools.

9. Youths who wish to enter the highest departments of engineering must follow advanced courses of mathematics and physics, and must learn to apply this knowledge. The better colleges and universities afford abundant opportunities for such training, but their scientific laboratories are fitted only for those who love long study as well as hard. These are schools for engineers.

10. Girls are most likely to excel in the lighter arts--to design (for furniture or fabrics), to embroider, to carve, to engrave, to etch, to model, to paint. Here also success depends largely upon that which was inborn, though girls of moderate talent in art, by patience, may become skilled in many kinds of art work. Schools for this instruction are schools of art (elementary, decorative, professional, etc.).

If there be those in this hall who think that hand-craft is adverse to rede-craft, let me ask them to study the lives of men of mark. Isaac Newton began his life as a farm-boy who carried truck to a market town; Spinoza, the philosopher of Amsterdam, ground lenses for his livelihood; Watt, the inventor of the steam engine, was mechanic to the University of Glasgow; Porson, the great professor of Greek, was trained as a weaver; George Washington was a land surveyor; Benjamin Franklin a printer.

Before I close let me draw a lesson from the history of our land. Some of you doubtless bear in mind that before the late war men used to say, "Cotton is king;" and why so? Because the trades which hung on this crop were so many and so strong that they ruled all others. The rise or fall of a penny in the price of cotton at Liverpool affected planters in the South, spinners in the North, seamen on the ocean, bankers and money-changers everywhere. Now wheat and petroleum share the sovereignty; but then cotton was king. Who enthroned this harmless plant? Two masters of hand-craft, one of whom was born a few miles east of this place in Westborough; the other was a native of England who spent most of his days a few miles south of this city. Within five years--not quite a century ago--these two men were putting in forms which could be seen, ideas which brought our countrymen large measures of both weal and woe. In 1790, Samuel Slater, once an apprentice to Strutt and Arkwright, built the mill at Pawtucket which taught Americans the art of cotton-spinning; and before 1795, Eli Whitney had invented the gin which easily cleansed the cotton boll of its seeds, and so made marketable the great crop we have spoken of. Many men have made more noise in the world than Slater and Whitney; few if any can be named whose peaceable hand-craft has done so much to give this country its front place in the markets of the globe.

Let me come nearer home, and as I take my seat let me name a son of this very town who loved hand-craft and rede-craft, and worthily aided both--Isaiah Thomas, the patriot printer, editor, and publisher, historian of the printer's craft in this land, and founder of the far famed antiquarian library, eldest in that group of institutions which gave to Worcester its rank in the world of letters, as its many products give it standing in the world of industry and art.

Mindful of three such worthies, it is not strange that Salisbury, Washburn, Boylston, and many more have built up this high school of handicraft; it will be no wonder if others like minded build on the foundations which have been so fitly laid.

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MAKING SEA WATER POTABLE.

[Footnote: Read lately before the Manchester Literary and Philosophical Society]

By THOMAS KAY, President of the Stockport Natural History Society.

The author called attention to the absence of research in this direction, and how man, endowed to overcome every physical disability which encompassed him on land, was powerless to live on the wide ocean, although it is teeming with life.

The water for experiment was taken from the English Channel, about fifty miles southwest of the Eddystone Lighthouse, and it was found to correspond closely with the analysis of the Atlantic published by Roscoe, viz.: Total solids 35.976, of which the total chlorides, are

32.730, representing 19.868 of chlorine.

The waters of the Irish Sea and the English Channel nearer to the German Ocean, from their neighborhood to great rivers, are weaker than the above.

Schweitzer's analysis of the waters of the English Channel, near Brighton, was taken as representing the composition of the sea, and is here given:

Sodium chloride	27.059
Potassium "	0.766
Magnesium "	3.666
" bromide	0.029
" sulphate	2.296
Calcium "	1.406
" carbonate	0.033
Iodine and ammoniacal salts	traces
Water	964.795
	1000.000

The chlorides in the--

Irish Sea are about	30 per mille.
English Channel are about	31 "
Beyond the Eddystone are	32 "

As the requirement for a potable sea water does not arise except in mid-ocean, the proportion of 32 per mille must be taken as the basis of calculation.

This represents as near 20 per mille of chlorine as possible.

From the analysis shown it will be perceived that the chlorides of sodium and magnesium are in great preponderance.

It is to the former of these that the baneful effects of sea water when drunk are to be ascribed, for chloride of sodium or common salt produces thirst probably by its styptic action on the salivary glands, and scurvy by its deleterious action on the blood when taken in excess.

Sodium chloride being the principal noxious element in sea water, and soda in combination with a vegetable or organic acid, such as citric acid, tartaric acid, or malic acid, being innocuous, the conclusion is that the element of evil to be avoided is _chlorine_.

After describing various experiments, and calling attention to the power of earthy matters in abstracting salts from solutions by which he hoped the process would be perfected, an imperial pint of water from beyond the Eddystone was shown mixed with 960 grains of citrate of silver and 4 grains of the free citric acid.

Each part of the chlorides requires three parts by weight of the silver citrate to throw down the chlorine, thus:

$$3NaCl + Ag_{3}C_{6}H_{5}O_{7} = Na3.C_{6}H_{5}O_{7}+3AgCl.$$

The silver chloride formed a dense insoluble precipitate, and the supernatant fluid was decanted and filtered through a rubber tube and handed round as a beverage.

It contained in each fluid ounce by calculation about:

18	grains of citrate of soda.		
1-1/2	"	"	magnesia.
1/2	"	"	potash.
1	"	sulphate of magnesia.	
1/2	"	"	lime.
1/5	"	citric acid.	

with less than half a grain of undecomposed chlorides.

To analyze this liquid therapeutically, it may be broadly stated that salts of potash are _diuretic_, salts of magnesia _aperient_, and salts of soda _neutral_, except in excessive doses, or in combination with acids of varying medicinal action; thus, soda in nitric acid, nitrate of soda, is a _diuretic_, following the law of nitrates as nitrate of potash, a most powerful diuretic, nitrous ether, etc.; while soda in combination with sulphuric acid as sulphate of soda is _aperient_, following the law of sulphates, which increase aperient action, as in sulphate of magnesia, etc.

Thus it would seem that soda holds the scales evenly between potash and magnesia in this medical sense, and that it is weighed, so to speak, on either side by the kind of mineral acid with which it may be combined.

With non-poisonous vegetable acids, and these slightly in excess, there is not such an effect produced.

Sodium is an important constituent of the human body, and citric acid, from its carbon, almost a food. Although no one would advocate saline drinks in excess, yet, under especial circumstances, the solution of it in the form of citrate can hardly be hurtful when used to moisten the throat and tongue, for it will never be used under circumstances where it can be taken in large quantities.

In the converted sea water the bulk of the solids is composed of inert citrate of soda. There is a little citrate of potash, which is a feeble diuretic; a little citrate and sulphate of magnesia, a slight aperient, corrected, however, by the constipatory half grain of sulphate of lime; so that the whole practically is inoperative.

The combination of these salts in nature’s proportions would seem to indicate that they must be the best for administration in those ailments to which their use would be beneficial.

Citrate of silver is an almost insoluble salt, and requires to be kept from the light, air, and organic matter, it being very easily decomposed.

A stoppered bottle covered with India-rubber was exhibited as indicating a suitable preserver of the salt, as it affords protection against light, air, and breakage. As one ounce of silver citrate will convert half a pint of sea water into a drinkable fluid, and a man can keep alive upon it a day, then seven ounces of it will keep him a week, and so on, it may not unreasonably be hoped, in proportion.

It is proposed to pack the silver citrate in hermetically sealed rubber covered bottles or tubes, to be inserted under the canisters or thwarts of the life-boats in ocean-going vessels, and this can be done at a simple interest on the first outlay, without any loss by depreciation, as it will always be worth its cost, and be invaluable in case of need.

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THE ACIDS OF WOOL OIL.

All wools contain a certain amount of animal oil or grease, which permeates every portion of the fleece. The proportion of oil varies with the breed of sheep. A difference in climate and soil materially affects the yield of oil. This is shown by analyses made of different kinds of wool, both foreign and domestic. Spanish wool was found to have but eight per cent. grease; Australian wool fifteen per cent.; while in some fleeces of Pennsylvania wool as high as forty per cent. was obtained. To extract the oil from the wool, a fleece was put in a tall cylinder and naphtha poured on it. The naphtha on being allowed to drain through slowly dissolved out the grease. This naphtha solution was distilled; the naphtha passing off while grease remained--a dark oil having high specific gravity and remaining nearly solid at the ordinary temperature. I am indebted to Mrs. Richards for this method of extracting the oil. The process is quick and inexpensive, and is applicable to the treatment of large quantities of wool.

The object of these experiments was to find the readiest method of separating wool oil into its bases and acids, and further to identify the various fatty acids. A solution of the oil in naphtha was cooled to 15° C. This caused a separation of the oil into two portions: a white solid fat and a fluid dark oil. The first on examination proved to be a mixture of palmitic and stearic acids existing uncombined in the wool oil. The original wool oil was saponified by boiling with alcoholic potash.

The soap formed was separated into two portions by shaking with ether and water. On standing, the solution separated into two layers, the upper or murial solution containing the bases, the lower or aqueous solution containing the acids. This method of separation is very slow. In one case it worked very well, but as a rule appeared to be almost impracticable. Benzol and naphtha were tried, instead of ether, but the results were less satisfactory. On suggestion of Prof. Ordway, potassium chloride was added to the soap solution partially separated by ether and water. This caused an immediate and complete separation. By the use of potassium chloride it was found possible to effect a separation with benzol and water, also with naphtha and water.

Another means of separation was tried by precipitating the calcium salts, from a solution of the potash soap. From the portion of the calcium salts insoluble in alcohol, a fatty acid was obtained with a melting point and composition almost identical with the melting point and composition of palmitic acid. The aqueous portion of the separation effected by water and ether was examined for the fatty acid. The lead salts of the fatty acids were digested with ether, which dissolved out the lead oleate. From this oleic acid was obtained. This was further purified by forming the Boreum salt of oleic acid. The lead salts not soluble in ether were decomposed by acid. The fatty acids set free were saponified by carbonate of potassium. A fractional precipitation was effected by adding lead acetate in successive portions; each portion sufficient to precipitate one-fourth of all the acids present.

The acid obtained from the first fractionation had the melting point at 75°-76°, indicating an acid either in carbon then stearic or palmitic acids.

The acids obtained from the third fractionation had a melting point of 53°-54° C. This acid in composition and general properties was very similar to that obtained by freezing the naphtha solution of the oil, and is probably a mixture of stearic and palmitic acids. These acids, being in combination with the bases of the oil, would be set free only on saponifying the oil and subsequently decomposing with acid.

In conclusion, I should say that but a small proportion of the fatty acids exist in the wool oil uncombined; that the proportion of oleic acid is small, and can only be obtained in an oxidized condition; that the main portion of the fatty acids is composed of stearic and palmitic acids in nearly equal proportions; that the existence of a fatty acid, containing a higher per cent. of carbon than those mentioned, is not fully established.--_N.W. Shedd, M.I.T._

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A NEW ABSORBENT FOR OXYGEN.

OTTO, BARON V.D. PFORDTEN.--The author makes use of a solution of chromous chloride, which he prepares as follows:

He first heats chromic acid with concentrated hydrochloric acid, so as to obtain a strong green solution of chromic chloride free from chlorine. This is then reduced with zinc and hydrochloric acid. The blue chromous chloride solution thus obtained is poured into a saturated solution of sodium acetate in an atmosphere of carbonic acid. A red precipitate of chromous acetate is formed, which is washed by decantation in water containing carbonic acid. This salt is relatively stable, and can be preserved for an indefinite time in a moist condition in stoppered bottles filled with carbonic acid.

In this process the following precautions are to be observed:

Spongy flocks always separate from the zinc used in the reduction, which float about in the acid liquid for a long time and give off minute gas bubbles. If poured into the solution of sodium acetate, they would contaminate the precipitate; and when dissolved in hydrochloric acid, would occasion a slight escape of hydrogen. The solution of chromous chloride must therefore be freed from the zinc by filtration in the absence of air. For this purpose the reduction is carried on in a flask fitted up like a washing bottle. The long tube is bent down outside the flask, and is here provided with a small bulb tube containing glass wool or asbestos. The hydrogen gas liberated during reduction is at first let escape through this tube; afterward its outer end is closed, and it is pressed down into the liquid. The hydrogen must now pass through the shorter tube (the mouthpiece of the washing bottle), which has an India rubber valve. When the reduction is complete, the blue liquid is driven up in the long tube by introducing carbonic acid through the short tube, so that it filters through the asbestos into the solution of sodium acetate into which the reopened end of the long tube dips. When washing out the red precipitate, at first a little acetic acid is added to dissolve any basic zinc carbonate which has been deposited. In this manner a chromous acetate is obtained perfectly free from zinc.

For the absorption of oxygen the compound just described is decomposed with hydrochloric acid in the following simple washing apparatus: Upon a shelf there are fixed side by side two ordinary preparation glasses, closed with caoutchouc stoppers, each having three perforations. Each two apertures receive the glass tubes used in gas washing bottles, while the third holds a dropping funnel. It is filled with dilute hydrochloric acid, and after the expulsion of the air by a current of gas, plentiful quantities of chromous acetate are passed into the bottles. When the current of gas has been passed in for some time, the hydrochloric acid is let enter, which dissolves the chromous acetate, and thus, in the absence of air, produces a solution of blue chromous chloride. It is advisable to use an excess of chromous acetate or an insufficient quantity of hydrochloric acid, so that there may be no free hydrochloric acid in the liquid. To keep back any free acetic acid which might be swept over by the current of gas, there is introduced after the washing apparatus another washing bottle with sodium carbonate. Also solid potassium carbonate may be used instead of calcium chloride for drying the gas. If the two apertures of the washing apparatus are fitted with small pinch cocks, it is ready for use, and merely requires to be connected with the gas apparatus in action in order to free the gas generated from oxygen. As but little chromous salt is decomposed by the oxygen such a washing apparatus may serve for many experiments.

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GAIFFE'S NEW MEDICAL GALVANOMETER.

In this apparatus, which contains but one needle, and has no directing magnet, proportionability between the intensities and deflections is obtained by means of a special form given the frame upon which the wire is wound.

We give herewith a figure of the curve that Mr. Gaiffe has fixed upon after numerous experiments. Upon examination it will be seen that the needle approaches the current in measure as the directing action of the earth increases; and experiment proves that the two actions counterbalance each other, and render the deflections very sensibly proportional to the intensities up to an angle of from 65 to 75 degrees.

[Illustration]

Another important fact has likewise been ascertained, and that is that, under such circumstances, the magnetic intensity of the needle may change without the indications ceasing to have the same exactness up to 65 degrees. As well known, Mr. Desains has demonstrated that this occurs likewise in sinus or tangent galvanometers; but these have helices that are very large in proportion to the needle. In medical galvanometers the proportions are no longer the same, and the needle is always very near the directing helix. If this latter is square, or even elliptical, it is found that, beyond an angle of 15 degrees, there are differences of 4 or 5 degrees in the indications given with the same intensity of current by the same needle, according to the latter's intensity of magnetism. This inconvenience is quite grave, for it often happens that a needle changes magnetic intensity, either under the influence of too strong currents sent into the apparatus, or of other magnets in its vicinity, or as a consequence of the bad quality of the steel, etc. It was therefore urgently required that this should be remedied, and from this point of view the new mode of winding the wire is an important improvement introduced into medical galvanometers.--_La Lumiere Electrique_.

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THE SUSPENSION OF LIFE.

Every one knows that life exists in a latent state in the seeds of plants, and may be preserved therein, so to speak, indefinitely. In 1853, Ridolfi deposited in the Egyptian Museum of Florence a sheaf of wheat that he had obtained from seeds found in a mummy case dating back about 3,000 years. This aptitude of revivification is found to a high degree in animalcules of low order. The air which we breathe is loaded with impalpable dust that awaits, for ages perhaps, proper conditions of heat and moisture to give it an ephemeral life that it will lose and acquire by turns.

In 1707, Spallanzani found it possible, eleven times in succession, to suspend the life of rotifers submitted to desiccation, and to call it back again by moistening this organic dust with water. A few years ago Doyere brought to life some tardigrades that had been dried at a temperature of 150° and kept four weeks in a vacuum. If we ascend the scale of beings, we find analogous phenomena produced by diverse causes. Flies that have been imported in casks of Madeira have been resuscitated in Europe, and chrysalids have been kept in this state for years. Cockchafers drowned, and then dried in the sun, have been revived after a lapse of twenty-four hours, two days, and even five days, after submersion. Frogs, salamanders, and spiders poisoned by curare or nicotine, have returned to life after several days of apparent death.

Cold produces some extraordinary effects. Spallanzani kept several frogs in the center of a lump of ice for two years, and, although they became dry, rigid, almost friable, and gave no external appearance of being alive, it was only necessary to expose them to a gradual and moderate heat to put an end to the lethargic state in which they lay.

Pikes and salamanders have at different epochs been revived before the eyes of Maupertuis and Constant Dumeril (members of the Academy of Sciences) after being frozen stiff. Auguste Dumeril, son of Constant, and who was the reporter of the committee relative to the Blois toad in 1851, published a curious memoir the following year in which he narrates how he interrupted life through congelation of the liquids and solids of the organism. Some frogs, whose internal temperature had been reduced to -2° in an atmosphere of -12°, returned to life before his eyes, and he observed their tissues regain their usual elasticity and their heart pass from absolute immobility to its normal motion.

There is therefore no reason for doubting the assertions of travelers who tell us that the inhabitants of North America and Russia transport fish that are frozen stiff, and bring them to life again by dipping them into water of ordinary temperature ten or fifteen days afterward. But I think too much reliance should not be put in the process devised by the great English physiologist, Hunter, for prolonging the life of man indefinitely by successive freezings. It has been allowed to no one but a romancer, Mr. Edmond About, to be present at this curious operation.

Among the mammifera we find appearances of death in their winter sleep; but these are incomplete, since the temperature of hibernating animals remains greater by one degree than that of the surrounding air, and the motions of the heart and respiration are simply retarded. Dr. Preyer has observed that a hamster sometimes goes five minutes without breathing appreciably after a fortnight's sleep.

In man himself a suspension of life, or at least phenomena that seem inseparable therefrom, has been observed many times. In the _Journal des Savants_ for 1741 we read that a Col. Russel, having witnessed the death of his wife, whom he tenderly loved, did not wish her buried, and threatened to kill any one who should attempt to remove the body before he witnessed its decomposition himself. Eight days passed by without the woman giving the slightest sign of life, "when, at a moment when he was holding her hand and shedding tears over her, the church bell began to ring, and, to his indescribable surprise, his wife sat up and said, 'It is the last stroke, we shall be too late.' She recovered."

At a session of the Academy of Sciences, Oct. 17, 1864, Mr. Blaudet communicated a report upon a young woman of thirty summers who, being subject to nervous attacks, fell, after her crises, into a sort of lethargic sleep which lasted several weeks and sometimes several months. One of her sleeps, especially, lasted from the beginning of the year 1862 until March, 1863.

Dr. Paul Levasseur relates that, in a certain English family, lethargy seemed to have become hereditary. The first case was exhibited in an old lady who remained for fifteen days in an immovable and insensible state, and who afterward, on regaining her consciousness, lived for quite a long time. Warned by this fact, the family preserved a young man for several weeks who appeared to be dead, but who came to life again.

Dr. Pfendler, in an inaugural thesis (Paris, 1833), minutely describes a case of apparent death of which he himself was a witness. A young girl of Vienna at the age of 15 was attacked by a nervous affection that brought on violent crises followed by lethargic states which lasted three or four days. After a time she became so exhausted that the first physicians of the city declared that there was no more hope. It was not long, in fact, before she was observed to rise in her bed and fall back as if struck with death. "For four hours she appeared to me," says Dr. Pfendler, "completely inanimate. With Messrs. Franck and Schaeffer, I made every possible effort to rekindle the spark of life. Neither mirror, nor burned feather, nor ammonia, nor pricking succeeded in giving us a sign of sensibility. Galvanism was tried without the patient showing any contractility. Mr. Franck believed her to be dead, but nevertheless advised me to leave her on the bed. For twenty-eight hours no change supervened, although it was thought that a little putrefaction was observed. The death bell was sounded, the friends of the girl had dressed her in white and had crowned her with flowers, and all was arranged for her burial. Desiring to convince myself of the course of the putrefaction, I visited the body again, and found that no further advance had been made than before. What was my astonishment when I believed that I saw a slight respiratory motion. I looked again, and saw that I was not mistaken. I at once used friction and irritants, and in an hour and a half the respiration increased. The patient opened her eyes, and, struck with the funereal paraphernalia around her, returned to consciousness, and said, 'I am too young to die.'" All this was followed by a ten hours' sleep. Convalescence proceeded rapidly, and the girl became free from all her nervous troubles. During her crisis she heard everything. She quoted some Latin words that Mr. Franck had used. Her most fearful agony had been to hear the preparations for her burial without being able to get rid of her torpor. Medical dictionaries are full of anecdotes of this nature, but I shall cite but two more.

On the 10th of November, 1812, during the fatal retreat from Russia, Commandant Tascher, desiring to bring back to France the body of his general, who had been killed by a bullet, and who had been buried since the day before, disinterred him, and, upon putting him into a landau, and noticing that he was still breathing, brought him to life again by dint of care. A long time afterward this same general was one of the pall bearers at the funeral obsequies of the aide-de-camp who had buried him. In 1826 a young priest returned to life at the moment the bishop of the diocese was pronouncing the _De Profundis_ over his body. Forty years afterward, this priest, who had become Cardinal Donnett, preached a feeling sermon upon the danger of premature burial.

I trust I have now sufficiently prepared the mind of the reader for an examination of the phenomena of the voluntary suspension of life that I shall now treat of.

The body of an animal may be compared to a machine that converts the food that it receives into motion. It receives nothing, it will produce nothing; but there is no reason why it should get out of order if it is not deteriorated by external agents. The legendary rustic who wanted to accustom his ass to go without food was therefore theoretically wrong only because he at the same time wanted the animal to work. The whole difficulty consists in breaking with old habits. To return to the comparison that we just made, we shall run the risk of exploding the boiler of a steam engine if we heat it or cool it abruptly, but we can run it very slowly and for a very long time with but very little fuel. We may even preserve a little fire under the ashes, and this, although it may not be capable of setting the parts running, will suffice later on to revivify the fireplace after it has been charged anew with fuel.

We have recently had the example of Dr. Tanner, who went forty days without any other nourishment than water. Not very long ago Liedovine de Schiedam, who had been bedridden for twenty years, affirmed that she had taken no food for eight of them. It is said that Saint Catharine of Sienna gradually accustomed herself to do without food, and that she lived twenty years in total abstinence. We know of several examples of prolonged sleep during which the sleeper naturally took no nourishment. In his Magic Disquisitions, Delvis cites the case of a countryman who slept for an entire autumn and winter. Pfendler relates that a certain young and hysterical woman fell twice into a deep slumber which each time lasted six months. In 1883 an _enceinte_ woman was found asleep on a bench in the Grand Armee Avenue. She was taken to the Beaujon Hospital, where she was delivered a few days after while still asleep, and it was not till the end of three months that she could be awakened from her lethargy. At this very moment, at Tremeille, a woman named Marguerite Bouyenvalle is sleeping a sleep that has lasted nearly a year, during which the only food that she has had is a few drops of soup daily.

What is more remarkable, Dr. Fournier says in his Dictionary of Medical Sciences that he knew of a distinguished writer at Paris, who sometimes went for months at a time without taking anything but emollient drinks, while at the same time living along like other people.

Respiration is certainly more necessary to life than food is; but it is not absolutely indispensable, as we have seen in the cases of apparent death cited in our previous article. It is possible, through exercise, for a person to accustom himself, up to a certain point, to abstinence from air as he can from food. Those who dive for pearls, corals, or sponges succeed in remaining from two to three minutes under water. Miss Lurline, who exhibited in Paris in 1882, remained two and a half minutes beneath the water of her aquarium without breathing. In his treatise De la Nature, Henri de Rochas, physician to Louis XIII., gives six minutes as the maximum length of time that can elapse between successive inspirations of air. It is probable that this figure was based upon an observation of hibernating animals.

In his Encyclopedic Dictionary, Dr. Dechambre relates the history of a Hindoo who hid himself in the waters of the Ganges where women were bathing, seized one of them by the legs, drowned her, and then removed her jewels. Her disappearance was attributed to crocodiles. One woman who succeeded in escaping him denounced the assassin, who was seized and hanged in 1817.

A well known case, is that of Col. Townshend, who possessed the remarkable faculty of stopping at will not only his respiration, but also the beating of his heart. He performed the experiment one day in the presence of Surgeon Gosch, who cared for him in his old age, two physicians, and his apothecary, Mr. Shrine. In their presence, says Gosch, the Colonel lay upon his back, Dr. Cheyne watched his pulse, Dr. Baynard put his hand upon his heart, and Mr. Shrine held a mirror to his mouth. After a few seconds no pulse, movement of the heart, or respiration could be observed. At the end of half an hour, as the spectators were beginning to get frightened, they observed the functions progressively resuming their course, and the Colonel came back to life.

The fakirs of India habituate themselves to abstinence from air, either by introducing into the nostrils strings that come out through the mouth, or by dwelling in subterranean cells that air and light never enter except through narrow crevices that are sometimes filled with clay. Here they remain seated in profound silence, for hours at a time, without any other motion than that of the fingers as the latter slowly take beads from a chaplet, the mind absorbed by the mental pronunciation of OM (the holy triune name), which they must repeat incessantly while endeavoring to breathe as little as possible. They gradually lengthen the intervals between their inspirations and expirations, until, in three or four months, they succeed in making them an hour and a half. This is not the ideal, for one of their sacred books says, in speaking of a saint: "At the fourth month he no longer takes any food but air, and that only every twelve days, and, master of his respiration he embraces God in his thought. At the fifth he stands as still as a pole; he no longer sees anything but Baghavat, and God touches his cheek to bring him out of his ecstasy."

It will be conceived that by submitting themselves to such gymnastics from infancy, certain men, already predisposed by atavism or a peculiar conformation, might succeed in doing things that would seem impossible to the common run of mortals. Do we not daily see acrobats remaining head downward for a length of time that would suffice to kill 99 per cent, of their spectators through congestion if they were to place themselves in the same posture? Can the savage who laboriously learns to spell, letter by letter, comprehend how many people get the general sense of an entire page at a single glance?

There is no reason, then, _a priori_, for assigning to the domain of legerdemain the astonishing facts that are told us by a large number of witnesses, worthy of credence, regarding a young fakir who, forty years ago, was accustomed to allow himself to be buried, and resuscitated several months afterward.

An English officer, Mr. Osborne, gives the following account of one of these operations, which took place in 1838 at the camp of King Randjet Singh:

"After a few preparations, which lasted some days, and that it would prove repugnant to enumerate, the fakir declared himself ready to undergo the ordeal. The Maharajah, the Sikhs chiefs, and Gen. Ventura, assembled near a masonry tomb that had been constructed expressly to receive him. Before their eyes, the fakir closed with wax all the apertures in his body (except his mouth) that could give entrance to air. Then, having taken off the clothing that he had on, he was enveloped in a canvas sack, and, according to his wish, his tongue was turned back in such a way as to close the entrance to his windpipe. Immediately after this he fell into a sort of trance. The bag that held him was closed and a seal was put upon it by the Maharajah. The bag was then put into a wooden box, which was fastened by a padlock, sealed, and let down into the tomb. A large quantity of earth was thrown into the hole and rammed down, and then barley was sown on the surface and sentinels placed around with orders to watch day and night.

"Despite all such precautions, the Maharajah had his doubts; so he came twice in the space of ten months (the time during which the fakir was buried), and had the tomb opened in his presence. The fakir was in the bag into which he had been put, cold and inanimate. The ten months having expired, he was disinterred, Gen. Ventura and Capt. Ward saw the padlock removed, the seals broken, and the box taken from the tomb. The fakir was taken out, and no pulsation either at the heart or pulse indicated the presence of life. As a first measure for reviving him, a person introduced a finger gently into his mouth and placed his tongue in its natural position. The top of his head was the only place where there was any perceptible heat. By slowly pouring warm water over his body, signs of life were gradually obtained, and after about two hours of care the patient got up and began to walk.

"This truly extraordinary man says that during his burial he has delightful dreams, but that the moment of awakening is always very painful to him. Before returning to a consciousness of his existence he experiences vertigoes. His nails and hair cease to grow. His only fear is that he may be harmed by worms and insects, and it is to protect himself from these that he has the box suspended in the center of the tomb."

This sketch was published in the _Magasin Pittoresque_ in 1842 by a writer who had just seen Gen. Ventura in Paris, and had obtained from him a complete confirmation of the story told by Capt. Wade.

Another English officer, Mr. Boileau, in a work published in 1840, and Dr. MacGregor, in his medical topography of Lodhiana, narrate two analogous exhumations that they separately witnessed. The question therefore merits serious examination.--_A. de Rochas, in La Nature_.

*   *   *   *   *

Some experiments recently made by M. Olszewsky appear to show that liquid oxygen is one of the best of refrigerants. He found that when liquefied oxygen was allowed to vaporize under the pressure of one atmosphere, a temperature as low as -181.4° C. was produced. The temperature fell still further when the pressure on the liquid oxygen was reduced to nine millimeters of mercury. Though the pressure was reduced still further to four millimeters of mercury, yet the oxygen remained liquid. Liquefied nitrogen, when allowed to evaporate under a pressure of sixty millimeters of mercury, gave a temperature of -214° C., only the surface of the liquid gas became opaque from incipient solidification. Under lower pressures the nitrogen solidified, and temperatures as low as -225° C. were recorded by the hydrogen thermometer. The lowest temperature obtained by allowing liquefied carbonic oxide to vaporize was -220.5° C.

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CONVALLARIA.

By OTTO A. WALL, M.D., Ph.G.

Cnovallaria Majalis is a stemless perennial plant, found in both the eastern and western hemispheres, with two elliptic leaves and a one-sided raceme bearing eight or ten bell-shaped flowers. The flowers are fragrant, and perfumes called "Lily of the Valley" are among the popular odors.

Both leaves and flowers have been used in medicine, but the rhizome is the part most frequently used.

[Illustration: CONVALLARIA.]

The fresh rhizome is a creeping, branching rhizome of a pale yellowish white color, which, on drying, darkens to a straw color, or even a brown in places. When dry it is about the thickness of a thick knitting needle, swelling to the thickness of a quill when soaked in water. It is of uniform thickness, except near the leaf-bearing ends, which are thicker marked with numerous leafscars, or bare buds covered with scales, and often having attached the tattered remains of former leaves. Fig. A shows a portion of rhizome, natural size, and Fig. B shows another piece enlarged to double linear size.

The internodes are smooth, the rootlets being attached at the nodes. The rootlets are filiform, and darker in color.

The rhizome is covered by an epidermis, composed of muriform cells of a bright yellow color, after having been treated with liquor potassæ to clear up the tissues. These cells are shown in Fig. G. An examination of the transverse section shows us the endogenous structure, as we find it also in various other drugs (sarsaparilla, etc.), namely, a nucleus sheath, inclosing the fibrovascular bundles and pith, and surrounded by a peri-ligneous or peri-nuclear portion, consisting of soft-walled parenchyma cells, loosely arranged with many small, irregularly triangular, intercellular spaces in the tranverse section. Some of these cells contain bundles of raphides (Fig. 2), one of which bundles is shown crushed in Fig. J. Sometimes these crystals are coarser and less needle-like, as in Fig. K. Fig. C shows a transverse section through the leaf-bearing portion of the rhizome (at a), and is rather irregular on account of the fibrovascular bundles diverging into the base of the leaves of flower-stalks. A more regular appearance is seen in Fig. D, which is a section through the internode (b). In it we see the nuclear sheath, varying in width from one to three cells, and inclosing a number of crescent-shaped fibrovascular bundles, with their convexities toward the center and their horns toward the nuclear sheath. There are also from two to four or five free closed fibrovascular bundles in the central pith.

These fibrovascular bundles consist mainly of dotted or reticulated ducts (Fig. F), but all gradations from, this to the spiroids, or even true spiral ducts (Fig. E). may be found, though the annular and spiral ducts are quite rare. These ducts are often prismatically compressed by each other. The fibrovascular bundles also contain soft-walled prosenchyma cells. The peri-nuclear portion consists of soft-walled parenchyma, smaller near the nuclear sheath and the epidermis, and larger about midway between, and of the same character as the cells of the pith. In longitudinal section they appear rectangular, similar to the walls of the epidermis (G), but with thinner walls.

All parts of the plant have been used in medicine, either separately or together, and according to some authorities the whole flowering plant is the best form in which to use this drug.

The active principles are _convallaramin_ and _convallarin_.

It is considered to act similarly to digitalis as a heart-stimulant, especially when the failure of the heart's action is due to mechanical impediments rather than to organic degeneration. It is best given in the form of fluid extract in the dose of 1 to 5 cubic centimeters (15 to 75 minims), commencing with the smaller doses, and increasing, if necessary, according to the effects produced in each individual case.--_The Pharmacist_.

* * * * *

FLIGHT OF THE BUZZARD.

During my visit to the Southern States of America, I have had several opportunities of watching, under favorable conditions, the flight of the buzzard, the scavenger of Southern cities. Although in most respect this bird's manner of flight resembles that of the various sea-birds which I have often watched for hours sailing steadily after ocean steamships, yet, being a land bird, the buzzard is more apt to give examples of that kind of flight in which a bird remains long over the same place. Instead of sailing steadily on upon outstretched pinions, the buzzard often ascends in a series of spirals, or descends along a similar course. I have not been able to time the continuance of the longest flights during which the wings have not once been flapped, for the simple reason that, in every case where I have attempted to do so, the bird has passed out of view either by upward or horizontal traveling. But I am satisfied that in many cases the bird sweeps onward or about on unflapping wings for more than half an hour.

Now, many treat this problem of aerial flotation as if it were of the nature of a miracle--something not to be explained. Explanations which have been advanced have, it is true, been in many cases altogether untenable. For instance, some have asserted that the albatross, the condor, and other birds which float for a long time without moving their wings--and that, too, in some cases, at great heights above the sea-level, where the air is very thin--are supported by some gas within the hollow parts of their bones, as the balloon is supported by the hydrogen within it. The answer to this is that a balloon is _not_ supported by the hydrogen within it, but by the surrounding air, and in just such degree as the air is displaced by the lighter gas. The air around a bird is only displaced by the bird's volume, and the pressure of the air corresponding to this displacement is not equivalent to more than one five-hundredth part of the bird's weight. Another idea is that when a bird seems to be floating on unmoving wings there is really a rapid fluttering of the feathers of the wings, by which a sustaining power is obtained. But no one who knows anything of the anatomy of the bird will adopt this idea for an instant, and no one who has ever watched with a good field-glass a floating bird of the albatross or buzzard kind will suppose they are fluttering their feathers in this way, even though he should be utterly ignorant of the anatomy of the wings. Moreover, any one acquainted with the laws of dynamics will know that there would be tremendous loss of power in the fluttering movement imagined as compared with the effect of sweeping downward and backward the whole of each wing.

There is only one possible way of explaining the floating power of birds, and that is by associating it with the rapid motion acquired originally by wing flapping, and afterward husbanded, so to speak, by absolutely perfect adjustment and balancing. To this the answer is often advanced that it implies ignorance of the laws of dynamics to suppose that rapid advance can affect the rate of falling, as is implied by the theory that it enables the bird to float.

Now, as a matter of fact, a slight slope of the wings would undoubtedly produce a raising power, and so an answer is at one obtained to this objection. But I venture to assert, with the utmost confidence, that a perfectly horizontal plane, advancing swiftly in a horizontal direction at first, will not sink as quickly, or anything like as quickly, as a similar plane let fall from a position of rest. A cannon-ball, rushing horizontally from the mouth of a cannon, begins to fall just as if it were simply dropped. But the case of a horizontal plane is altogether different. If rapidly advancing, it passes continually over still air; if simply let fall, the air beneath it yields, and presently currents are set up which facilitate the descent of the flat body; but there is no time to set up these aerial movements as the flat body passes rapidly over still air.

As a matter of fact, we know that this difference exists, from the difference in the observed behavior of a flat card set flying horizontally through the air and a similar card held horizontally and then allowed to fall.

I believe the whole mystery of aerial flotation lies here, and that as soon as aerial floating machines are planned on this system, it will be found that the problem of aerial transit--though presenting still many difficulties of detail--is, nevertheless, perfectly soluble.--_R.A. Proctor, in Newcastle Weekly Chronicle_.

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AN ASSYRIAN BASS-RELIEF 2,700 YEARS OLD.

There was exhibited at the last meeting of the Numismatic and Antiquarian Society, in Philadelphia, on May 7, an object of great interest to archæologists, with which, says _The Church_, is also connected a very curious history.

It appears that about forty years ago a young American minister, Rev. W.F. Williams, went as a missionary to Syria, and he visited among places of interest the site of ancient Nineveh about the time that Austin Henry Layard was making his famous explorations and discoveries; he wrote to a friend in Philadelphia that he had secured for him a fine piece of Assyrian sculpture from one of the recently opened temples or palaces, representing a life size figure of a king, clad in royal robes, bearing in one hand a basket and in the other a fir cone. One portion of the stone was covered with hieroglyphics, and was as sharply cut as though it had been carved by a modern hand instead of by an artist who was sleeping in his grave when Nebuchadnezzar, King of Babylon, was yet an infant.

The letter describing this treasure arrived duly, but the stones did not come. It appears that the caravan bringing them down to Alexandretta, from whence they were to be shipped to Philadelphia, was attacked by robbers, and the sculptured stones were thrown upon the desert as useless, and there they remained for some years. Finally they were recovered, shipped to this country (about twenty-five years ago), and arriving at their destination during the absence of the consignee, were deposited temporarily in a subterranean storeroom at his manufactory. In some way they were overlooked, and here they have remained unopened until they were rediscovered a few days ago; meanwhile the missionary and his friend have both passed away, ignorant of the fact that the rare gift had finally reached its destination and had become again lost.

The cuneiform inscription is now being translated by an Assyrian scholar (Rev. Dr. J.P. Peters, of the Divinity School), and its identity is established; it came from the temple of King Assur-nazir-pal, a famous conqueror who reigned from 883 to 859 B.C.

The slab was cut into three sections, 3x3‰ feet each, for convenience of transportation, and they have been somewhat broken on the journey; fortunately, however, this does not obliterate the writing.

Mr. Tolcott Williams, a son of the late missionary, was present at the meeting of the Society, and gave an interesting account of the classic ground from which the slab was obtained. It was one of a number lining the walls of the palace of Assur-nazir-pal. The inscriptions, as translated by Dr. Peters, indicate that this particular slab was carved during the first portion of this king’s reign, and some conception of its great antiquity may be gained when it is stated that he was a contemporary of Ahab and Jehosaphat; he was born not more than a century later than Solomon, and he reigned three centuries before Nebuchadnezzar, King of Babylon. After the slabs were procured, it was necessary to send them on the backs of camels a journey of eight hundred miles across the Great Desert, through a region which was more or less infested at all seasons with roving bands of robbers. Mr. Williams well remembered the interview between his father and the Arab camel owner, who told several conflicting stories by way of preliminary to the confession of the actual facts, in order to account for the non-arrival of the stones at Alexandretta, the sea coast town from whence they were to be shipped to Philadelphia.

Mr. A.E. Outerbridge, Jr., gave a brief account of the finding of these stones in the subterranean storeroom where they had reposed for a period of a quarter of a century. The space between the slabs and the boxes had been packed with camels' hair, which had in progress of time become eaten by insects and reduced to a fine powder. The nails with which the cases were fastened were remarkable both for their peculiar shape and for the extraordinary toughness of the iron, far excelling in this respect the wrought iron made in America to day.

The Rev. Dr. J.P. Peters gave a very instructive exposition of the chronology of the kings of Assyria, their social and religious customs and ceremonies, their methods of warfare, their systems of architecture, etc. He stated that the finest Assyrian bass-reliefs in the British Museum came from the same palace as this specimen, the carving of which is not excelled by any period of the ancient glyptic art. The particular piece of alabaster selected by the artist for this slab was unusually fine, being mottled with nodules of crystallized gypsum.

The cuneiform inscription is not unlike the Hebrew in its character, resembling it about as closely as the Yorkshire dialect resembles good English. The characters are so large and clearly cut that it is a pleasure to read them after the laborious scrutiny of the minute Babylonish clay tablets. The inscription on this slab is identical with a portion of that of the great "Standard Monolith," on which this king subsequently caused to be transcribed the pages, as it were, from the different slabs which were apparently cut at intervals in his reign.

Translation of a Portion of the Cuneiform, Inscription.--"The palace of Assur-nazir-pal, servant of Assur, servant of the god Beltis, the god Ninit, the shining one of Anu and Dagon, servant of the Great Gods, Mighty King, king of hosts, king of the land of Assyria; son of Bin-nirari, a strong warrior, who in the service of Assur his Lord marched vigorously among the princes of the four regions, who had no equal, a mighty leader who had no rival, a king subduing all disobedient to him; who rules multitudes of men; crushing all his foes, even the masses of the rebels.... The city of Calah, which my predecessor, Shalmanezer, King of Assyria had built had fallen into decay: His city I rebuilt; a palace of cedar, box, cypress, for the seat of my royalty, for the fullness of my princedom, to endure for generations, I placed upon it. With plates of copper I roofed it, I hung in its gates folding doors of cedar wood, silver, gold, copper, and iron which my hands had acquired in the lands which I ruled, I gathered in great quantities, and placed them in the midst thereof." O.

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DEPOSITING NICKEL UPON ZINC.

By H.B. SLATER.

To those interested in the electro deposition of nickel upon zinc, the formula given below for a solution and a brief explanation of its use will be of service.

The first sample of this solution was made as an experiment to see what substances could be added to a solution of the double sulphate of nickel and ammonium without spoiling it.

In addition to several other combinations and mixtures of solutions from which I succeeded in obtaining a good deposit, I found that the solution here given would plate almost anything I put into it, and worked especially well upon zinc. In its use no "scraping" or rescouring or any of the many operations which I have seen recommended for zinc needs be resorted to, as the metal "strikes" at once and is deposited in a continuous adherent film of reguline metal, and can be laid on as heavily as nickel is deposited generally.

I believe that the addition of the ammonium chloride simply reduces the resistance of the double sulphate solution, but the office of the potassium chloride is not so easily explained. At least, I have never been able to explain it satisfactorily to myself. It is certain, however, that the solution does not work as well without it, nor does the addition of ammonium chloride in its stead give as fine a result.

Some care is necessary in the management of the current, which should have a density of about 17 amperes per square foot of surface--not much above or below. This may seem a high figure, especially when it is discovered that there is a considerable evolution of gas during the operation.

I have repeatedly used this solution for coating articles of zinc, and always with good success. I have exhibited samples of zinc plated in this solution to those conversant with the deposition of nickel, and they have expressed surprise at the appearance of the work. Some strips of sheet-zinc in my possession have been bent and cut into every conceivable shape without a sign of fracture or curling up at the edges of the nickel coating.

The solution is composed of--

Double sulphate of nickel and ammonium	10 ounces.
Ammonium chloride	4 "
Potassium chloride	2 "
Distilled water	1 gallon.

The salts are dissolved in the water (hot), and the solution is worked at the ordinary temperature, about 16 degrees C.

The zinc may be cleansed in any suitable manner, but must be perfectly clean, of course, and finally rinsed in clean cold water and placed in the bath as quickly as possible; care being taken that it is connected before it touches the solution.--_Electrical World_.

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