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[Illustration]

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LOCOMOTIVE FOR ST. GOTHARD RAILWAY.

We give engravings of one of a type of eight-coupled locomotives constructed for service on the St. Gothard Railway by Herr T.A. Maffei, of Munich. As will be seen from our illustrations, the engine has outside cylinders, these being 20.48 in. in diameter, with 24 in. stroke, and as the diameter of the coupled wheels is 3 ft. 10 in., the tractive force which the engine is capable of exerting amounts to (20.48† x 24) / 46 = 218.4 lb. for each pound of effective pressure per square inch on the pistons. This is an enormous tractive force, as it would require but a mean effective pressure of 102‰ lb. per square inch on the pistons to exert a pull of 10 tons. Inasmuch, however, as the engine weighs 44 tons empty and 51 tons in working order, and as all this weight is available for adhesion, this great cylinder power can be utilized. The cylinders are 6 ft. 10 in. apart from center to center, and they are well secured to the frames, as shown in Fig. 4. The frames are deep and heavy, being 1 3/8 in. thick, and they are stayed by a substantial box framing at the smokebox end, by a cast-iron footplate at the rear end, and by the intermediate plate stays shown. The axle box guides are all fitted with adjusting wedges. The axle bearings are all alike, all being 7.87 in. in diameter by 9.45 in. long. The axles are spaced at equal distances of 4 ft. 3.1 in. apart, the total wheel base being thus 12 ft. 9.3 in. In the case of the 1st, 2d, and 3d axles, the springs are arranged above the axle boxes in the ordinary way, those of the 2d and 3d axles being coupled by compensating beams. In the case of the trailing axle, however, a special arrangement is adopted. Thus, as will be seen on reference to the longitudinal section and plan (Figs. 1 and 2, first page), each trailing axle box receives its load through the horizontal arm of a strong bell-crank lever, the vertical arm of which extends downward and has its lower end coupled to the adjoining end of a strong transverse spring which is pivoted to a pair of transverse stays extending from frame to frame below the ash pan. This arrangement enables the spring for the trailing axle to be kept clear of the firebox, thus allowing the latter to extend the full width between the frames. The trailing wheels are fitted with a brake as shown.

[Illustration: LOCOMOTIVES FOR ST. GOTHARD RAILWAY.]

The valve motion is of the Gooch or stationary link type, the radius rods being cranked to clear the leading axle, while the eccentric rods are bent to clear the second axle. The piston rods are extended through the front cylinder covers and are enlarged where they enter the crossheads, the glands at the rear ends of cylinders being made in halves. The arrangement of the motion generally will be clearly understood on reference to Figs. 1 and 2 without further explanation.

The boiler, which is constructed for a working pressure of 147 lb. per square inch, is unusually large, the barrel being 60.4 in. in diameter inside the outside rings; it is composed of plates 0.65 in. thick. The firebox spreads considerably in width toward the top, as shown in the section, Fig. 5, and to enable it to be got in the back plate of the firebox casing is flanged outward, instead of inward as usual, so as to enable it to be riveted up after the firebox is in place. The inside firebox is of copper and its crown is stayed directly to the crown of the casing by vertical stays, as shown, strong transverse stays extending across the boiler just above the firebox crown to resist the spreading action caused by the arrangement of the crown stays. The firegrate is 6 ft. 11.6 in. long by 3 ft. 4 in. wide.

[Illustration: ST. GOTHARD LOCOMOTIVES.]

The barrel contains 225 tubes 1.97 in. in diameter outside and 13 ft. 9‰ in. long between tube plates. On the top of the barrel is a large dome containing the regulator, as shown in Fig. 1, from which view the arrangement of the gusset stays for the back plate of firebox casing and for the smokebox tube plate will be seen. A grid is placed across the smokebox just above the tubes, and provision is made, as shown in Figs. 1 and 4, for closing the top of the exhaust nozzle, and opening a communication between the exhaust pipes and the external air when the engine is run reversed. The chimney is 15¾ in. in diameter at its lower end and 18.9 in. at the top. The chief proportions of the boiler are as follows:

		Sq. ft
Heating surface:	Tubes	1598.5
	Firebox	102.5

1701.0

Firegrate area	23.3 [1]
Sectional area through tubes (disregarding ferrules)	3.5
Least sectional area of chimney.	1.35
Ratio of firegrate area to heating surface.	1:73
Ratio of flue area through tubes to firegrate area.	1:6.7
Ratio of least sectional area of chimney to firegrate area.	1:17.26

[Transcribers note 1: Best guess, 2nd digit illegible]

The proportion of chimney area to grate is much smaller than in ordinary locomotives, this proportion having no doubt been fixed upon to enable a strong draught to be obtained with the engine running at a slow speed. Of the general fittings of the engine we need give no description, as their arrangement will be readily understood from our engravings, and in conclusion we need only say that the locomotive under notice is altogether a very interesting example of an engine designed for specially heavy work.--_Engineering_.

*   *   *   *   *

THE MERSEY RAILWAY TUNNEL.

The work of connecting Liverpool with Birkenhead by means of a railway tunnel is now an almost certain success. It is probable that the entire cost of the tunnel works will amount to about half a million sterling. The first step was taken about three years ago, when shafts were sunk simultaneously on both sides of the Mersey. The engineers intrusted with the plans were Messrs. Brunlees & Fox, and they have now as their resident representative Mr. A.H. Irvine, C.E. The contractor for the entire work is Mr. John Waddell, and his lieutenant in charge at both sides of the river is Mr. James Prentice. The post of mechanical engineer at the works is filled by Mr. George Ginty. Under these chiefs, a small army of nearly 700 workmen are now employed night and day at both sides of the river in carrying out the tunnel to completion. On the Birkenhead side, the landward excavations have reached a point immediately under Hamilton Square, where Mr. John Laird’s statue is placed, and here there will be an underground station, the last before crossing the river, the length of which will be about 400 feet, with up and down platforms. Riverward on the Cheshire side, the excavators have tunneled to a point considerably beyond the line of the Woodside Stage; while the Lancashire portion of the subterranean work now extends to St. George’s Church, at the top of Lord street, on the one side, and Merseyward to upward of 90 feet beyond the quay wall, and nearly to the deepest part of the river.

When completed, the total length of the tunnel will be three miles one furlong, the distance from wall to wall at each side of the Mersey being about three-quarters of a mile. The underground terminus will be about Church street and Waterloo place, in the immediate neighborhood of the Central Station, and the tunnel will proceed from thence, in an almost direct line, under Lord street and James street; while on the south side of the river it will be constructed from a junction at Union street between the London and Northwestern and Great Western Railways, under Chamberlain street, Green lane, the Gas Works, Borough road, across the Haymarket and Hamilton street, and Hamilton square.

Drainage headings, not of the same size of bore as the part of the railway tunnel which will be in actual use, but indispensable as a means of enabling the railway to be worked, will act as reservoirs into which the water from the main tunnel will be drained and run off to both sides of the Mersey, where gigantic pumps of great power and draught will bring the accumulating water to the surface of the earth, from whence it will be run off into the river. The excavations of these drainage headings at the present time extend about one hundred yards beyond the main tunnel works at each side of the river. The drainage shafts are sunk to a depth of 180 feet, and are below the lowest point of the tunnel, which is drained into them. Each drainage shaft is supplied with two pumping sets, consisting of four pumps, viz., two of 20 in. diameter, and two of 30 in. diameter. These pumps are capable of discharging from the Liverpool shafts 6,100 gallons per minute, and from the Birkenhead 5,040 gallons per minute; and as these pumps will be required for the permanent draining of the tunnel, they are constructed in the most solid and substantial manner. They are worked by compound engines made by Hathorn, Davey & Co., of Leeds, and are supplied with six steel boilers by Daniel Adamson & Co., of Dukinfield, near Manchester.

In addition to the above, there is in course of construction still more powerful pumps of 40 in. diameter, which will provide against contingencies, and prevent delay in case of a breakdown such as occurred lately on the Liverpool side of the works. The nature of the rock is the new red sandstone, of a solid and compact character, favorable for tunneling, and yielding only a moderate quantity of water. The engineers have been enabled to arrange the levels to give a minimum thickness of 25 ft. and an average thickness of 30 ft. above the crown of the tunnel.

Barges are now employed in the river for the purpose of ascertaining the depth of the water, and the nature of the bottom of the river. It is satisfactory to find that the rock on the Liverpool side, as the heading is advanced under the river, contains less and less water, and this the engineers are inclined to attribute to the thick bed of stiff bowlder clay which overlies the rock on this side, which acts as a kind of "overcoat" to the "under garments." The depth of the water in one part of the river is found to be about 72 ft.; in the middle about 90 ft.; and as there is an intermediate depth of rock of about 27 ft., the distance is upward of 100 ft. from the surface of low water to the top of the tunnel.

It is expected that the work will shortly be pushed forward at a much greater speed than has hitherto been the case, for in place of the miner's pick and shovel, which advanced at the rate of about ten yards per week, a machine known as the Beaumont boring machine will be brought into requisition in the course of a day or two, and it is expected to carry on the work at the rate of fifty yards per week, so that this year it may be possible to walk through the drainage heading from Liverpool to Birkenhead. The main tunnel works now in progress will probably be completed and trains running in the course of 18 months or two years.

The workmen are taken down the shaft by which the debris is hoisted, ten feet in diameter, and when the visitor arrives at the bottom he finds himself in quite a bright light, thanks to the Hammond electric light, worked by the Brush machine, which is now in use in the tunnel on both sides of the river. The depth of the pumping shaft is 170 feet, and the shaft communicates directly with the drainage heading. This circular heading now has been advanced about 737 yards. The heading is 7 feet in diameter, and the amount of it under the river is upward of 200 yards on each side. The main tunnel, which is 26 feet wide and 21 feet high, has also made considerable progress at both the Liverpool and Birkenhead ends. From the Liverpool side the tunnel now extends over 430 yards, and from the opposite shore about 590 yards. This includes the underground stations, each of which is 400 feet long, 51 feet wide, and 32 feet high. Although the main tunnel has not made quite the same progress between the shafts as the drainage heading, it is only about 100 yards behind it. When completed, the tunnel will be about a mile in length from shaft to shaft. In the course of the excavations which have been so far carried out, about 70 cubic yards of rock have been turned out for every yard forward.

Ten horses are employed on the Birkenhead side for drawing wagons loaded with debris to the shaft, which, on being hoisted, is tipped into the carts and taken for deposit to various places, some of which are about three miles distant. The tunnel is lined throughout with very solid brickwork, some of which is, 18 inches thick (composed of two layers of blue and two of red brick), and toward the river this brickwork is increased to a thickness of six rings of bricks--three blue and three red. A layer of Portland cement of considerable thickness also gives increased stability to the brick lining and other portions of the tunnel, and the whole of the flooring will be bricked. There are about 22 yards of brickwork in every yard forward. The work of excavation up to the present time has been done by blasting (tonite being employed for this purpose), and by the use of the pick and shovel. At every 45 ft. on alternate sides niches of 18 in. depth are placed for the safety of platelayers. The form of the tunnel is semicircular, the arch having a 13 ft. radius, the side walls a 25 ft. radius, and the base a 40 ft. radius.

Fortunately not a single life has up to the present time been lost in carrying out the exceedingly elaborate and gigantic work, and this immunity from accident is largely owing to the care and skill which are manifested by the heads of the various departments. The Mersey Tunnel scheme may now be looked upon as an accomplished work, and there is little doubt its value as a commercial medium will be speedily and fully appreciated upon completion.

*   *   *   *   *

DAM ACROSS THE OTTAWA RIVER AND NEW CANAL AT CARILLON QUE

By ANDREW BELL Resident Engineer

The natural navigation of the Ottawa River from the head of the Island of Montreal to Ottawa City--a distance of nearly a hundred miles--is interrupted between the villages of Carillon and Grenville which are thirteen miles apart by three rapids, known as the Carillon, Chßte à Blondeau, and Longue Sault Rapids, which are in that order from east to west. The Carillon Rapid is two miles long and has, or had, a fall of 10 feet the Chßte àBlondeau a quarter of a mile with a fall of 4 feet and the Longue Sault six miles and a fall of 46 feet. Between the Carillon and Chßte àBlondeau there is or was a slack water reach of three and a half miles, and between the latter and the foot of the Longue Sault a similar reach of one and a quarter miles.

Small canals limited in capacity to the smaller locks on them which were only 109 feet long 19 feet wide, and 5 to 6 feet of water on the sills, were built by the Imperial Government as a military work around each of the rapids. They were begun in 1819 and completed about 1832. They were transferred to the Canadian Government in 1856. They are built on the north shore of the river, and each canal is about the length of the rapid it surmounts.

[Illustration: THE GREAT DAM ACROSS THE OTTAWA RIVER, AT CARILLON.]

The Grenville Canal (around the Longue Sault) with seven locks, and the Chßte àBlondeau with one lock, are fed directly from Ottawa. But with the Carillon that method was not followed as the nature of the banks there would have in doing so, entailed an immense amount of rock excavation--a serious matter in those days. The difficulty was overcome by locking up at the upper or western end 13 feet and down 23 at lower end, supplying the summit by a 'feeder from a small stream called the North River, which empties into the Ottawa three or four miles below Carillon, but is close to the main river opposite the canal.

In 1870-71 the Government of Canada determined to enlarge these canals to admit of the passage of boats requiring locks 200 feet long, 45 feet wide, and not less than 9 feet of water on the sills at the lowest water. In the case of the Grenville Canal this was and is being done by widening and deepening the old channel and building new locks along side of the old ones. But to do that with the Carillon was found to be inexpedient. The rapidly increasing traffic required more water than the North River could supply in any case, and the clearing up of the country to the north had materially reduced its waters in summer and fall, when most needed. To deepen the old canal so as to enable it to take its supply from the Ottawa would have caused the excavation of at least 1,250,000 cubic yards of rock, besides necessitating the enlargement of the Chßte àBlondeau also.

It was therefore decided to adopt a modification of the plan proposed by Mr. T.C. Clarke, of the present firm of Clarke Reeves & Co, several years before when he made the preliminary surveys for the then proposed "Ottawa Ship Canal," namely to build a dam across the river in the Carillon Rapid but of a sufficient height to drown out the Chßte à Blondeau, and also to give the required depth of water there.

During the summer and fall of 1872 the writer made the necessary surveys of the river with that end in view. By gauging the river carefully in high and low water, and making use of the records which had been kept by the lock masters for twenty years back, it was found that the flow of the river was in extreme low water 26,000 cubic feet per second, and in highest water 190,000 cubic feet per second, in average years about 30,000 and 150,000 cubic feet respectively. The average flow in each year would be nearly a mean between those quantities, namely, about 90,000 cubic feet per second. It was decided to locate the dam where it is now built, namely, about the center of Carillon Rapid, and a mile above the village of that name and to make it of a height sufficient to raise the reach between the head of Carillon and Chßte àBlondeau about six feet, and that above the latter two feet in ordinary water. At the site chosen the river is 1,800 feet wide, the bed is solid limestone, and more level or flat than is generally found in such places--the banks high enough and also composed of limestone. It was also determined to build a slide for the passage of timber near the south shore (see map), and to locate the new canal on the north side.

Contracts for the whole works were given out in the spring of 1873, but as the water remained high all the summer of that year very little could be done in it at the dam. In 1874 a large portion of the foundation, especially in the shallow water, was put in. 1875 and 1876 proved unfavorable and not much could be done, when the works were stopped. They were resumed in 1879, and the dam as also the slide successfully completed, with the exception of graveling of the dam in the fall of 1881. The water was lower that summer than it had been for thirty five years before. The canal was completed and opened for navigation the following spring.

THE DAM

In building such a dam as this the difficulties to be contended against were unusually great. It was required to make it as near perfectly tight as possible and be, of course, always submerged. Allowing for water used by canal and slide and the leakage there should be a depth on the crest of the dam in low water of 2.50 feet and in high of about 10 feet. These depths turned out ultimately to be correct. The river reaches its highest about the middle of May, and its lowest in September. It generally begins to rise again in November. Nothing could be done except during the short low water season, and some years nothing at all. Even at the most favorable time the amount of water to be controlled was large. Then the depth at the site varied in depth from 2 to 14 feet, and at one place was as much as 23 feet. The current was at the rate of from 10 to 12 miles an hour. Therefore, failures, losses, etc., could not be avoided, and a great deal had to be learned as the work progressed. I am not aware that a dam of the kind was ever built, or attempted to be built across a river having such a large flow as the Ottawa.

The method of construction was as follows. Temporary structures of various kinds suited to position, time, etc., were first placed immediately above the site of the dam to break the current. This was done in sections and the permanent dam proceeded with under that protection.

In shallow water timber sills 36 feet long and 12 inches by 12 inches were bolted to the lock up and down stream, having their tops a uniform height, namely, 9.30 feet below the top of dam when finished. These sills were, where the rock was high enough, scribed immediately to it, but if not, they were ’made up’ by other timbers scribed to the rock, as shown by Figs 4 and 5. They were generally placed in pairs about 6 feet apart, and each alternate space left open for the passage of water, to be closed by gates as hereafter described. Each sill was fastened by five 1‰ in. bolts driven into pine plugs forced into holes drilled from 18 inches to 24 inches into the rock. The temporary rock was then removed as far as possible, to allow a free flow of the water.

In the channels of which there are three, having an aggregate width of about 650 feet, cribs 46 feet wide up and down stream were sunk. In the deepest water, where the rock was uneven, they covered the whole bottom up to about five feet of the level of the silts, and on top of that isolated cribs, 46 in. X 6 in. and of the necessary height were placed seven feet apart, as shown at C Figs 2 and 3. At other places similar narrow cribs were placed on the rock, as shown at D, Figs 2 and 3. The tops of all were brought to about the same level as the before mentioned sills. The rock bottom was cleaned by divers of all bowlders, gravel, etc. The cribs were built in the usual manner, of 12 in. X 12 in. timber generally hemlock, and carefully fitted to the rock on which they stand. They were fastened to the rock by 1‰ in. bolts, five on each side of a crib, driven into pine plugs as mentioned for the sills. The drilling was done by long runners from their tops. The upstream side of the cribs were sheeted with 4 in. tamarack plank.

On top of these sills and cribs there was then placed all across river a platform from 36 to 46 feet wide made up of sawed pine timber 12 in. X 12 in., each piece being securely bolted to its neighbor and to the sills and cribs below. It was also at intervals bolted through to the rock.

On top of the "platform" there was next built a flat dam of the sectional form shown by Fig 1. It was built of 12 in. X 12 in. sawed pine timbers securely bolted at the crossings and to the platform, and sheeted all over with tamarack 10 in. thick and the crest covered with

‰ in. boiler plate 3 ft. wide. The whole structure was carefully filled with stone--field stone, or "hard head" generally being used for the purpose.

At this stage of the works, namely, in the fall of 1881 the structure presented somewhat the appearance of a bridge with short spans. The whole river--fortunately low--flowed through the sluices of which there were 113 and also through a bulkhead which had been left alongside of the slide with a water width of 60 ft. These openings had a total sectional area of 4,400 sq. ft., and barely allowed the river to pass, although, of course, somewhat assisted by leakage.

[Illustration: Fig. 1. CROSS SECTION IN DEEP WATER.]

It now only remained, to complete the dam, to close the openings. This was done in a manner that can be readily understood by reference to the cuts. Gates had been constructed with timber 10 in. thick, bolted together. They were hung on strong wooden hinges and, before being closed, laid back on the face of dam as shown at B, Figs. 1, 2, and 3. They were all closed in a short time on the afternoon of 9th November, 1881. To do this it was simply necessary to turn them over, when the strong current through the sluices carried them into their places, as shown at A, Figs. 2 and 3 and by the dotted lines on Fig. 1. The closing was a delicate as well as dangerous operation, but was as successfully done as could be expected. No accident happened further than the displacement of two or three of the gates. The openings thus left were afterward filled up with timber and brushwood. The large opening alongside of the slide was filled up by a crib built above and floated into place.

The design contemplates the filling up with stone and gravel on up-stream side of dam about the triangular space that would be formed by the production of the line of face of flat dam till it struck the rock. Part of that was done from the ice last winter; the balance is being put in this winter.

Observations last summer showed that the calculations as to the raising of the surface of the river were correct. When the depth on the crest was 2.50 feet, the water at the foot of the Longue Sault was found to be 25 in. higher than if no dam existed. The intention was to raise it 24 in.

The timber slide was formed by binding parallel piers about 600 feet long up and down stream, as shown on the map, and 28 ft. apart, with a timber bottom, the top of which at upper end is 3 ft. below the crest of dam. It has the necessary stop logs, with machinery to move them, to control the water. The approach is formed by detached piers, connected by guide booms, extending about half a mile up stream. See map.

Alongside of the south side of the slide a large bulkhead was built, 69 ft. wide, with a clear waterway of 60 ft. It was furnished with stop logs and machinery to handle them. When not further required, it was filled up by a crib as before mentioned.

The following table shows the materials used in the dam and slide, and the cost:

	Timber, cu. ft.	Iron, lb.	Stone filling, cu. yds.	Excavation, cu. yds.	Cost.
Temporary works	134,500	92,000	11,400		$79,000
Permanent dam	265,000	439,600	24,000	6,500	151,000
Slide, including apparatus	296,500	156,400	32,800		102,000
Total	696,000	687,000	68,200	6,500	$332,000

The above does not include cost of surveys, engineering, or superintendence, which amounted to about ten per cent, of the above sum.

[Illustration: DETAILS OF THE OTTAWA RIVER DAM, AT CARILLON.]

The construction of the dam and slide was ably superintended by Horace Merrill, Esq., late superintendent of the "Ottawa River Improvements," who has built nearly all the slides and other works on the Ottawa to facilitate the passage of its immense timber productions.

The contractors were the well known firm of F.B. McNamee & Co., of Montreal, and the successful completion of the work was in a large degree due to the energy displayed by the working member of that firm--Mr. A.G. Nish, formerly engineer of the Montreal harbor.

THE CANAL

The canal was formed by "fencing in" a portion of the river-bed by an embankment built about a hundred feet out from the north shore and deepening the intervening space where necessary. There are two locks--one placed a little above the foot of the rapid (see map), and the other at the end of the dam. Wooden piers are built at the upper and lower ends--the former being 800 ft. long, and the latter 300 ft; both are about 29 ft. high and 35 ft. wide.

The embankment is built, as shown by the cross section, Fig. 6. On the canal side of it there is a wall of rubble masonry F, laid in hydraulic cement, connecting the two locks, and backed by a puddle wall, E, three feet thick; next the river there is crib work, G, from ten to twenty feet wide and the space between brick-work and puddle filled with earth. The outer slope is protected with riprap, composed of large bowlders. This had to be made very strong to prevent the destruction of the bank by the immense masses of moving ice in spring.

The distance between the locks is 3,300 feet.

In building the embankment the crib-work was first put in and followed by a part (in width) of the earth-bank. From that to the shore temporary cross-dams were built at convenient distances apart and the space pumped out by sections, when the necessary excavation was done, and the walls and embankments completed. The earth was put down in layers of not more than a foot deep at a time, so that the bank, when completed, was solid. The water at site of it varied in depth from 15 feet at lower end to 2 feet at upper.

The locks are 200 ft. long in the clear between the gates, and 45 ft wide in the chamber at the bottom. The walls of the lower one are 29 ft. high, and of the upper one 31 ft They are from 10 to 12 ft thick at the bottom,

The locks are built similar to those on the new Lachine and Welland canals, of the very best cut stone masonry, laid in hydraulic cement. The gates are 24 in. thick, made of solid timber, somewhat similar to those in use on the St. Lawrence canals. They are suspended from anchors at the hollow quoins, and work very easily. The miter sills are made of 26 in. square oak. The bottom of the lower lock iis timbered throughout, but the upper one only at the recesses, the rock there being good.

[Illustration: MAP OF THE OTTAWA RIVER AT CARILLON RAPIDS.

SECTION OF RIVER AT DAM. NOTE.--THE LOWEST DOTTED LINE IS LOW WATER BEFORETHE DAM WAS BUILT. THEN THE LINE OF HIGH WATER WAS ABOUT A FOOT ABOVE WHAT IS CREST OF DAM NOW.]

The rise to be overcome by the two locks is 16 ft., but except in medium water, is not equally distributed. In high water nearly the whole lift is on the upper lock, and in low water the lower one. In the very lowest known stage of the river there will never be less than 9 ft. on the miter sills.

As mentioned at the beginning of this article, four locks were required on the old military canal to accomplish what is now done by two.

The canal was opened in May, 1882, and has been a great success, the only drawback--although slight--being that in high water the current for about three-quarters of a mile above the upper pier, and at what was formerly the Chute a Biondeau, is rather strong. These difficulties can be easily overcome--the former by building an embankment from the pier to Brophy’s Island, the latter by removing some of the natural dam of rock which once formed the "Chute."

The following are, in round numbers, the quantities of the principal materials used:

Earth and puddle in embankment ...cub. yds. 148,500

Rock excavation,	"	38,000
Riprap,	"	6,600
Lock masonry	"	14,200
Rubble masonry,	"	16,600
Timber in cribs, lock bottoms and gates	"	368,000
Wrought and cast iron, lb		173,000
Stone filling cu yds		45,300
Concrete	"	830

The total cost to date has been about $570,000, not including surveys, engineering, etc.

The contractors for the canal, locks, etc., were Messrs. R. P. Cooke & Co., of Brockville, Ont., who have built some large works in the States, and who are now engaged building other extensive works for the Canadian Government. The work here reflects great credit on their skill.

On the enlarged Grenville Canal, now approaching completion, there are five locks, taking the place of the seven small ones built by the Imperial Government. It will be open for navigation all through in the spring of 1884, when steamers somewhat larger than the largest now navigating the St. Lawrence between Montreal and Hamilton can pass up to Ottawa City.--_Engineering News_.

*   *   *   *   *

DWELLING HOUSES--HINTS ON BUILDING--"HOME, SWEET HOME."

[Footnote: From a paper read before the Birmingham Architectural Association, Jan 30, 1883]

By WILLIAM HENMAN, A.R.I.B.A.

My intention is to bring to your notice some of the many causes which result in unhealthy dwellings, particularly those of the middle classes of society. The same defects, it is true, are to be found in the palace and the mansion, and also in the artisan’s cottage; but in the former cost is not so much a matter of consideration, and in the latter, the requirements and appliances being less, the evils are minimized. It is in the houses of the middle classes, I mean those of a rental at from £50 to £150 per annum, that the evils of careless building and want of sanitary precautions become most apparent. Until recently sanitary science was but little studied, and many things were done a few years since which even the self-interest of a speculative builder would not do nowadays, nor would be permitted to do by the local sanitary authority. Yet houses built in those times are still inhabited, and in many cases sickness and even death are the result. But it is with shame I must confess that, notwithstanding the advance which sanitary science has made, and the excellent appliances to be obtained, many a house is now built, not only by the speculative builder, but designed by professed architects, and in spite of sanitary authorities and their by-laws, which, in important particulars are far from perfect, are unhealthy, and cannot be truly called sweet homes.

Architects and builders have much to contend with. The perverseness of man and the powers of nature at times appear to combine for the express purpose of frustrating their endeavors to attain sanitary perfection. Successfully to combat these opposing forces, two things are above all necessary, viz 1, a more perfect insight into the laws of nature, and a judicious use of serviceable appliances on the part of the architect; and, 2, greater knowledge, care, and trustworthiness on the part of workmen employed. With the first there will be less of that blind following of what has been done before by others, and by the latter the architect who has carefully thought out the details of his sanitary work will be enabled to have his ideas carried out in an intelligent manner. Several cases have come under my notice, where, by reckless carelessness or dense ignorance on the part of workmen, dwellings which might have been sweet and comfortable if the architect's ideas and instructions had been carried out, were in course of time proved to be in an unsanitary condition. The defects, having been covered up out sight, were only made known in some cases after illness or death had attacked members of the household.

In order that we may have thoroughly sweet homes, we must consider the localities in which they are to be situated, and the soil on which they are to rest. It is an admitted fact that certain localities are more generally healthy than others, yet circumstances often beyond their control compel men to live in those less healthy. Something may, in the course of time, be done to improve such districts by planting, subdrainage, and the like. Then, as regards the soil; our earth has been in existence many an age, generation after generation has come and passed away, leaving behind accumulations of matter on its surface, both animal and vegetable, and although natural causes are ever at the work of purification, there is no doubt such accumulations are in many cases highly injurious to health, not only in a general way, but particularly if around, and worse still, under our dwellings. However healthy a district is considered to be, it is never safe to leave the top soil inclosed within the walls of our houses; and in many cases the subsoil should be covered with a layer of cement concrete, and at times with asphalt on the concrete. For if the subsoil be damp, moisture will rise; if it be porous, offensive matter may percolate through. It is my belief that much of the cold dampness felt in so many houses is caused by moisture rising from the ground inclosed _within_ the outer walls. Cellars are in many cases abominations. Up the cellar steps is a favorite means of entrance for sickness and death. Light and air, which are so essential for health and life, are shut out. If cellars are necessary, they should be constructed with damp proof walls and floors; light should be freely admitted; every part must be well ventilated, and, above all, no drain of any description should be taken in. If they be constructed so that water cannot find its way through either walls or floors, where is the necessity of a drain? Surely the floors can be kept clean by the use of so small an amount of water that it would be ridiculous specially to provide a drain.

The next important but oft neglected precaution is to have a good damp course over the _whole_ of the walls, internal as well as external. I know that for the sake of saving a few pounds (most likely that they may be frittered away in senseless, showy features) it often happens, that if even a damp course is provided in the outer walls, it is dispensed with in the interior walls. This can only be done with impunity on really dry ground, but in too many cases damp finds its way up, and, to say the least, disfigures the walls. Here I would pause to ask: What is the primary reason for building houses? I would answer that, in this country at least, it is in order to protect ourselves from wind and weather. After going to great expense and trouble to exclude cold and wet by means of walls and roofs, should we not take as much pains to prevent them using from below and attacking us in a more insidious manner? Various materials may be used as damp courses. Glazed earthenware perforated slabs are perhaps the best, when expense is no object. I generally employ a course of slates, breaking joint with a good bed of cement above and below; it answers well, and is not very expensive. If the ground is irregular, a layer of asphalt is more easily applied. Gas tar and sand are sometimes used, but it deteriorates and cannot be depended upon for any length of time. The damp course should invariably be placed _above_ the level of the ground around the building, and _below_ the ground floor joists. If a basement story is necessary, the outer walls below the ground should be either built hollow, or coated externally with some substance through which wet cannot penetrate. Above the damp course, the walls of our houses must be constructed of materials which will keep out wind and weather. Very porous materials should be avoided, because, even if the wet does not actually find its way through, so much is absorbed during rainy weather that in the process of drying much cold is produced by evaporation. The fact should be constantly remembered, viz., that evaporation causes cold. It can easily be proved by dropping a little ether upon the bulb of a thermometer, when it will be seen how quickly the mercury falls, and the same effect takes place in a less degree by the evaporation of water. Seeing, then, that evaporation from so small a surface can lower temperature so many degrees, consider what must be the effect of evaporation from the extensive surfaces of walls inclosing our houses. This experiment (thermometer with bulb inclosed in linen) enables me as well to illustrate that curious law of nature which necessitates the introduction of a damp course in the walls of our buildings; it is known as capillary or molecular attraction, and breaks through that more powerful law of gravitation, which in a general way compels fluids to find their own level. You will notice that the piece of linen over the bulb of the thermometer, having been first moistened, continues moist, although only its lower end is in water, the latter being drawn up by capillary attraction; or we have here an illustration more to the point: a brick which simply stands with its lower end in water, and you can plainly see how the damp has risen.

From these illustrations you will see how necessary it is that the brick and stone used for outer walls should be as far as possible impervious to wet; but more than that, it is necessary the jointing should be non-absorbent, and the less porous the stone or brick, the better able must the jointing be to keep out wet, for this reason, that when rain is beating against a wall, it either runs down or becomes absorbed. If both brick and mortar, or stone and mortar be porous, it becomes absorbed; if all are non-porous, it runs down until it finds a projection, and then drops off; but if the brick or stone is non-porous, and the mortar porous, the wet runs down the brick or stone until it arrives at the joint, and is then sucked inward. It being almost impossible to obtain materials quite waterproof, suitable for external walls, other means must be employed for keeping our homes dry and comfortable. Well built hollow walls are good. Stone walls, unless very thick, should be lined with brick, a cavity being left between. A material called Hygeian Rock Building Composition has lately been introduced, which will, I believe, be found of great utility, and, if properly applied, should insure a dry house. A cavity of one-half an inch is left between the outer and inner portion of the wall, whether of brick or stone, which, as the building rises, is run in with the material made liquid by heat; and not only is the wall waterproofed thereby, but also greatly strengthened. It may also be used as a damp course.

Good, dry walls are of little use without good roofs, and for a comfortable house the roofs should not only be watertight and weathertight, but also, if I may use the term, heat-tight. There can be no doubt that many houses are cold and chilly, in consequence of the rapid radiation of heat through the thin roofs, if not through thin and badly constructed walls. Under both tiles and slates, but particularly under the latter, there should be some non-conducting substance, such as boarding, or felt, or pugging. Then, in cold weather heat will be retained; in hot weather it will be excluded. Roofs should be of a suitable pitch, so that neither rain nor snow can find its way in in windy weather. Great care must be taken in laying gutters and flats. With them it is important that the boarding should be well laid in narrow widths, and in the direction of the fall; otherwise the boards cockle and form ridges and furrows in which wet will rest, and in time decay the metal.

After having secured a sound waterproof roof, proper provision must be made for conveying therefrom the water which of necessity falls on it in the form of rain. All eaves spouting should be of ample size, and the rain water down pipes should be placed at frequent intervals and of suitable diameter. The outlets from the eaves spouting should not be contracted, although it is advisable to cover them with a wire grating to prevent their becoming choked with dead leaves, otherwise the water will overflow and probably find its way through the walls. All joints to the eaves spouting, and particularly to the rain-water down pipes, should be made watertight, or there is great danger, when they are connected with the soil drains, that sewer gas will escape at the joints and find its way into the house at windows and doors. There should be a siphon trap at the bottom of each down pipe, unless it is employed as a ventilator to the drains, and then the greatest care should be exercised to insure perfect jointings, and that the outlet be well above all windows. Eaves spouting and rain-water down pipes should be periodically examined and cleaned out. They ought to be painted inside as well as out, or else they will quickly decay, and if of iron they will rust, flake off, and become stopped.

It is impossible to have a sweet home where there is continual dampness. By its presence chemical action and decay are set up in many substances which would remain in a quiescent state so long as they continued dry. Wood will rot; so will wall papers, the paste used in hanging them, and the size in distemper, however good they have been in the first instance; then it is that injurious exhalations are thrown off, and the evil is doubtless very greatly increased if the materials are bad in themselves. Quickly grown and sappy timber, sour paste, stale size, and wall papers containing injurious pigments are more easily attacked, and far more likely to fill the house with bad smells and a subtile poison. Plaster to ceilings and walls is quickly damaged by wet, and if improper materials, such as road drift, be used in its composition, it may become most unsavory and injurious to health. The materials for plaster cannot be too carefully selected, for if organic matter be present, the result is the formation of nitrates and the like, which combine with lime and produce deliquescent salts, viz, those which attract moisture. Then, however impervious to wet the walls, etc., may be, signs of dampness will be noticed wherever there is a humid atmosphere, and similar evils will result as if wet had penetrated from the exterior. Organic matter coming into contact with plaster, and even the exhalations from human beings and animals, will in time produce similar effects. Hence stables, water closets, and rooms which are frequently crowded with people, unless always properly ventilated, will show signs of dampness and deterioration of the plaster work; wall paper will become detached from the walls, paint will blister and peel off, and distemper will lose its virtue. To avoid similar mishaps, sea sand, or sand containing salt, should never be used either for plaster or mortar. In fact, it is necessary that the materials for mortar should be as free from salts and organic matter as those used for plaster, because the injurious effects of their presence will be quickly communicated to the latter.

Unfortunately, it is not alone by taking precaution against the possibility of having a damp house that we necessarily insure a "sweet home." The watchful care of the architect is required from the cutting of the first sod until the finishing touches are put on the house. He must assure himself that all is done, and nothing left undone which is likely to cause a nuisance, or worse still, jeopardize the health of the occupiers. Yet, with all his care and the employment of the best materials and apparatus at his command, complete success seems scarcely possible of attainment. We have all much to learn, many things must be accomplished and difficulties overcome, ere we can "rest and be thankful."

It is impossible for the architect to attempt to solve all the problems which surround this question. He must in many cases employ such materials and such apparatus as can be obtained; nevertheless, it is his duty carefully to test the value of such materials and apparatus as may be obtainable, and by his experience and scientific knowledge to determine which are best to be used under varying circumstances.

But to pass on to other matters which mar the sweetness of home. With many, I hold that the method usually employed for warming our dwellings is wasteful, dirty, and often injurious to health. The open fire, although cheerful in appearance, is justly condemned. It is wasteful, because so small a percentage of the value of the fuel employed is utilized. It is dirty, because of the dust and soot which result therefrom. It is unhealthy, because of the cold draughts which in its simplest form are produced, and the stifling atmosphere which pervades the house when the products of imperfect combustion insist, as they often do, in not ascending the flues constructed for the express purpose of carrying them off; and even when they take the desired course, they blacken and poison the external atmosphere with their presence. Some of the grates known as ventilating grates dispose of one of the evils of the ordinary open fire, by reducing the amount of cold draught caused by the rush of air up the flues. This is effected, as you probably know, by admitting air direct from the outside of the house to the back of the grate, where it is warmed, and then flows into the rooms to supply the place of that which is drawn up the chimneys. Provided such grates act properly and are well put together, so that there is no possibility of smoke being drawn into the fresh air channels, and that the air to be warmed is drawn from a pure source, they may be used with much advantage; although by them we must not suppose perfection has been attained. The utilization of a far greater percentage of heat and the consumption of all smoke must be aimed at. It is a question if such can be accomplished by means of an open fire, and it is a difficult matter to devise a method suited in every respect to the warming of our dwellings, which at the same time is equally cheering in appearance. So long as we are obliged to employ coal in its crude form for heating purposes, and are content with the waste and dirt of the open fire, we must be thankful for the cheer it gives in many a home where there are well constructed grates and flues, and make the best use we can of the undoubted ventilating power it possesses.

A constant change of air in every part of our dwellings is absolutely necessary that we may have a "sweet home," and the open fireplace with its flue materially helps to that end; but unless in every other respect the house is in a good sanitary condition, the open fire only adds to the danger of residing in such a house, because it draws the impure air from other parts into our living rooms, where it is respired. Closed stoves are useful in some places, such as entrance halls. They are more economical than the open fireplaces; but with them there is danger of the atmosphere, or rather, the minute particles of organic matter always floating in the air, becoming burnt and so charging the atmosphere with carbonic acid. The recently introduced slow-combustion stoves obviate this evil.

It is possible to warm our houses without having separate fireplaces in each room, viz., by heated air, hot water, or steam; but there are many difficulties and some dangers in connection therewith which I can scarcely hope to see entirely overcome. In America steam has been employed with some success, and there is this advantage in its use, that it can be conveyed a considerable distance. It is therefore possible to have the furnace and boilers for its production quite away from the dwelling houses and to heat several dwellings from one source, while at the same time it can be employed for cooking purposes. In steam, then, we have a useful agent, which might with advantage be more generally employed; but when either it or hot water be used for heating purposes, special and adequate means of ventilation must be employed. Gas stoves are made in many forms, and in a few cases can be employed with advantage; but I believe they are more expensive than a coal fire, and it is most difficult to prevent the products of combustion finding their way into the dwellings. Gas is a useful agent in the kitchen for cooking purposes, but I never remember entering a house where it was so employed without at once detecting the unpleasant smell resulting. It is rare to find any special means for carrying off the injurious fumes, and without such I am sure gas cooking stoves cannot be healthy adjuncts to our homes.

The next difficulty we have to deal with is artificial lighting. Whether we employ candle, oil lamp, or gas, we may be certain that the atmosphere of our rooms will become contaminated by the products of combustion, and health must suffer. In order that such may be obviated, it must be an earnest hope that ere long such improvements will be made in electric lighting, that it may become generally used in our homes as well as in all public buildings. Gas has certainly proved itself a very useful and comparatively inexpensive illuminating power, but in many ways it contaminates the atmosphere, is injurious to health, and destructive to the furniture and fittings of our homes. Leakages from the mains impregnate the soil with poisonous matter, and it rarely happens that throughout a house there are no leakages. However small they may be, the air becomes tainted. It is almost impossible, at times, to detect the fault, or if detected, to make good without great injury to other work, in consequence of the difficulty there is in getting at the pipes, as they are generally embedded in plaster, etc. All gas pipes should be laid in positions where they can be easily examined, and, if necessary, repaired without much trouble. In France it is compulsory that all gas pipes be left exposed to view, except where they must of necessity pass through the thickness of a wall or floor, and it would be a great benefit if such were required in this country.

The cooking processes which necessarily go on often result in unpleasant odors pervading our homes. I cannot say they are immediately prejudicial to health; but if they are of daily or frequent occurrence, it is more than probable the volatile matters which are the cause of the odors become condensed upon walls, ceiling, or furniture, and in time undergo putrefaction, and so not only mar the sweetness of home, but in addition affect the health of the inmates. Cooking ranges should therefore be constructed so as to carry off the fumes of cooking, and kitchens must be well ventilated and so placed that the fumes cannot find their way into other parts of the dwelling. In some houses washing day is an abomination. Steam and stife then permeate the building, and, to say the least, banish sweetness and comfort from the home. It is a wonder that people will, year after year, put up with such a nuisance.

If washing must be done home, the architect may do something to lessen the evil by placing the washhouse in a suitable position disconnected from the living part of the house, or by properly ventilating it and providing a well constructed boiler and furnace, and a flue for carrying off the steam.

There is daily a considerable amount of refuse found in every home, from the kitchen, from the fire-grate, from the sweeping of rooms, etc., and as a rule this is day after day deposited in the ash-pit, which but too often is placed close to the house, and left uncovered. If it were simply a receptacle for the ashes from the fire-grates, no harm would result, but as all kinds of organic matter are cast in and often allowed to remain for weeks to rot and putrefy, it becomes a regular pest box, and to it often may be traced sickness and death. It would be a wise sanitary measure if every constructed ash pit were abolished. In place thereof I would substitute a galvanized iron covered receptacle of but moderate size, mounted upon wheels, and it should be incumbent on the local authorities to empty same every two or three days. Where there are gardens all refuse is useful as manure, and a suitable place should be provided for it at the greatest distance from the dwellings. Until the very advisable reform I have just mentioned takes place, it would be well if refuse were burnt as soon as possible. With care this may be done in a close range, or even open fire without any unpleasant smells, and certainly without injury to health. It must be much more wholesome to dispose of organic matter in that way while fresh than to have it rotting and festering under our very noses.

A greater evil yet is the privy. In the country, where there is no complete system of drainage, it may be tolerated when placed at a distance from the house; but in a crowded neighborhood it is an abomination, and, unless frequently emptied and kept scrupulously clean, cannot fail to be injurious to health. Where there is no system of drainage, cesspools must at times be used, but they should be avoided as much as possible. They should never be constructed near to dwellings, and must always be well ventilated. Care should be taken to make them watertight, otherwise the foul matter may percolate through the ground, and is likely to contaminate the water supply. In some old houses cesspools have been found actually under the living rooms.

I would here also condemn the placing of r. w. tanks under any portion of the dwelling house, for many cases of sickness and death have been traced to the fact of sewage having found its way through, either by backing up the drains, or by the ignorant laying of new into old drains. Earth closets, if carefully attended to, often emptied, and the receptacles cleaned out, can be safely employed even within doors; but in towns it is difficult to dispose of the refuse, and there must necessarily be a system of drainage for the purpose of taking off the surface water; it is thereupon found more economical to carry away all drainage together, and the water closet being but little trouble, and, if properly looked after, more cleanly in appearance, it is generally preferred, notwithstanding the great risks which are daily run in consequence of the chance of sewer-gas finding an entrance into the house by its means. After all, it is scarcely fair to condemn outright the water closet as the cause of so many of the ills to which flesh is subject. It is true that many w. c. apparatus are obviously defective in construction, and any architect or builder using such is to be condemned. The old pan closet, for instance, should be banished. It is known to be defective, and yet I see it is still made, sold, and fixed, in dwelling houses, notwithstanding the fact that other closet pans far more simple and effective can be obtained at less cost. The pan of the closet should be large, and ought to retain a layer of water at the bottom, which, with the refuse, should be swept out of the pan by the rush of water from the service pipe. The outlet may be at the side connected with a simple earthenware s-trap with a ventilating outlet at the top, from which a pipe may be taken just through the wall. From the S-trap I prefer to take the soil pipe immediately through the wall, and connect with a strong 4 in. iron pipe, carefully jointed, watertight, and continued of the same size to above the tops of all windows. This pipe at its foot should be connected with a ventilating trap, so that all air connection is cut off between the house and the drains. All funnel-shaped w. c. pans are objectionable, because they are so liable to catch and retain the dirt.

Wastes from baths, sinks, and urinals should also be ventilated and disconnected from the drains as above, or else allowed to discharge above a gulley trap. Excrement, etc., must be quickly removed from the premises if we are to have "sweet homes," and the w.c. is perhaps the most convenient apparatus, when properly constructed, which can be employed. By taking due precaution no harm need be feared, or will result from its use, provided that the drains and sewers are rightly constructed and properly laid. It is then to the sewers, drains, and their connections our attention must be specially directed, for in the majority of cases they are the arch-offenders. The laying of main sewers has in most cases been intrusted to the civil engineer, yet it often happens architects are blamed, and unjustly so, for the defective work over which they had no control. When the main sewers are badly constructed, and, as a result, sewer gas is generated and allowed to accumulate, ordinary precautions may be useless in preventing its entrance by some means or other to our homes, and special means and extra precautions must be adopted. But with well constructed and properly ventilated sewers, every architect and builder should be able to devise a suitable system of house drainage, which need cause no fear of danger to health. The glazed stoneware pipe, now made of any convenient size and shape, is an excellent article with which to construct house-drains. The pipes should be selected, well burnt, well glazed, and free from twist. Too much care cannot be exercised in properly laying them. The trenches should be got out to proper falls, and unless the ground is hard and firm, the pipes should be laid upon a layer of concrete to prevent the chance of sinking. The jointing must be carefully made, and should be of cement or of well tempered clay, care being taken to wipe away all projecting portions from the inside of the pipes. A clear passage-way is of the utmost importance. Foul drains are the result of badly joined and irregularly laid pipes, wherein matter accumulates, which in time ferments and produces sewer-gas. The common system of laying drains with curved angles is not so good as laying them in straight lines from point to point, and at every angle inserting a man-hole or lamp-hole, This plan is now insisted upon by the Local Government Board for all public buildings erected under their authority.

It might, with advantage, be adopted for all house-drains.

Now, in consequence of the trouble and expense attending the opening up and examination of a drain, it may often happen that although defects are suspected or even known to exist, they are not remedied until illness or death is the result of neglect. But with drains laid in straight lines, from point to point, with man holes or lamp holes at the intersections, there is no reason why the whole system may not easily be examined at any time and stoppages quickly removed. The man holes and lamp-holes may, with advantage, be used as means for ventilating the drains and also for flushing them. It is of importance that each house drain should have a disconnecting trap just before it enters the main sewer. It is bad enough to be poisoned by neglecting the drainage to one's own property, but what if the poison be developed elsewhere, and by neglect permitted to find its way to us. Such will surely happen unless some effective means be employed for cutting off all air connection between the house-drains and the main sewer. I am firmly convinced that simply a smoky chimney, or the discovery of a fault in drainage weighs far more, in the estimation of a client in forming his opinion of the ability of an architect, than the successful carrying out of an artistic design. By no means do I disparage a striving to attain artistic effectiveness, but to the study of the artistic, in domestic architecture at least, add a knowledge of sanitary science, and foster a habit of careful observation of causes and effects. Comfort is demanded in the home, and that cannot be secured unless dwellings are built and maintained with perfect sanitary arrangements and appliances.--_The Building News_.

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HOUSE AT HEATON

This house, which belongs to Mr J. N. D'Andrea, is built on the Basque principle, under one roof, with covered balconies on the south side, the northside being kept low to give the sun an opportunity of shining in winter on the house and greenhouse adjacent, as well as to assist in the more picturesque grouping of the two. On this side is placed, approached by porch and lobby, the hall with a fireplace of the "olden time," lavatory, etc., butler's pantry, w. c., staircase, larder, kitchen, scullery, stores, etc.

On the south side are two sitting rooms, opening into a conservatory. There are six bedrooms, a dining-room, bath room, and housemaid's sink.

The walls are built of colored wall stones known as "insides," and half-timbered brickwork covered with the Portland cement stucco, finished Panan, and painted a cream-color.

All the interior woodwork is of selected pitch pine, the hall being boarded throughout. Colored lead light glass is introduced in the upper parts of the windows in every room, etc.

The architect is Mr. W. A. Herbert Martin, of Bradford.--_Architect_

[Illustration: HOUSE AT HEATON, BRADFORD.]

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A MANSARD ROOF DWELLING.

The principal floor of this design is elevated three feet above the surface of the ground, and is approached by the front steps leading to the platform. The height of the first floor is eleven feet, the second ten feet, and the cellar six feet six inches in the clear. The porch is so constructed that it can be put on either the front or side of the house, as it may suit the owner. The rooms, eight in number, are airy and of convenient size. The kitchen has a range, sink, and boiler, and a large closet, to be used as a pantry. The windows leading out to the porch will run to the floor, with heads running into the walls. In the attic the chambers are 10x10 feet, 13x14 feet, 12x13 feet, 10x10‰ feet, and a hall 6 feet wide, with large closets and cupboards for each chamber. The building is so constructed that an addition can be made to the rear any time by using the present kitchen as a dining room and building a new kitchen.

[Illustration: A MANSARD ROOF DWELLING. First Floor.]

[Illustration: A MANSARD ROOF DWELLING. Second Floor.]

These plans will prove suggestive to those contemplating the building of a new house, even if radical changes are made in the accompanying designs.--_American Cultivator_.

[Illustration: A MANSARD ROOF DWELLING. Front Elevation.]

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THE HISTORY OF THE ELECTRIC TELEGRAPH.

[Footnote: Aug. Guerout in _La LurmiŁre Electrique_.]

An endeavor has often been made to carry the origin of the electric telegraph back to a very remote epoch by a reliance on those more or less fanciful descriptions of modes of communication based upon the properties of the magnet.

It will prove not without interest before entering into the real history of the telegraph to pass in review the various documents that relate to the subject.

In continuation of the 21st chapter of his _Magia naturalis_, published in 1553, J. B. Porta cites an experiment that had been made with the magnet as a means of telegraphing. In 1616, Famiano Strada, in his _Prolusiones Academicæ, takes up this idea, and speaks of the possibility of two persons communicating by the aid of two magnetized needles influenced by each other at a distance. Galileo, in _Dialogo intorno_, written between 1621 and 1632 and Nicolas Caboeus, of Ferrara, in his _Philosophia magnetica_, both reproduce analogous descriptions, not however without raising doubts as to the possibility of such a system.

A document of the same kind, to which great importance has been attached is found in the _Recreations mathematiques_ published at Rouen in 1628, under the pseudonym of Van Elten, and reprinted several times since, with the annotations and additions of Mydorge and Hamion and which must, it appears, be attributed to the Jesuit Leurechon. In his chapter on the magnet and the needles that are rubbed therewith, we find the following passage.

"Some have pretended that, by means of a magnet or other like stone, absent persons might speak with one another. For example, Claude being at Paris, and John at Rome, if each had a needle that had been rubbed with some stone, and whose virtue was such that in measure as one needle moved at Paris the other would move just the same at Rome, and if Claude and John each had an alphabet, and had agreed that they would converse with each other every afternoon at 6 o'clock, and the needle having made three and a half revolutions as a signal that Claude, and no other, wished to speak to John, then Claude wishing to say to him that the king is at Paris would cause his needle to move, and stop at T, then at H, then at E, then at K, I, N, G and so on. Now, at the same time, John's needle, according with Claude's, would begin to move and then stop at the same letters, and consequently it would be easily able to write or understand what the other desired to signify to it. The invention is beautiful, but I do not think there can be found in the world a magnet that has such a virtue. Neither is the thing expedient, for treason would be too frequent and too covert."

The same idea was also indicated by Joseph Glanville in his _Scepsis scientifica_, which appeared in 1665, by Father Le Brun, in his _Histoire critique des pratiques superstitieuses_, and finally by the AbbØ Barthelemy in 1788.

The suggestion offered by Father Kircher, in his _Magnes sive de arte magnetica_, is a little different from the preceding. The celebrated Jesuit father seeks however, to do nothing more than to effect a communication of thoughts between two rooms in the same building. He places, at short distances from each other, two spherical vessels carrying on their circumference the letters of the alphabet, and each having suspended within it, from a vertical wire a magnetized figure. If one of these latter he moved, all the others must follow its motions, one after the other, and transmission will thus be effected from the first vessel to the last. Father Kircher observes that it is necessary that all the magnets shall be of the same strength, and that there shall be a large number of them, which is something not within the reach of everybody. This is why he points out another mode of transmitting thought, and one which consists in supporting the figures upon vertical revolving cylinders set in motion by one and the same cord hidden with in the walls.

There is no need of very thoroughly examining all such systems of magnetic telegraphy to understand that it was never possible for them to have a practical reality, and that they were pure speculations which it is erroneous to consider as the first ideas of the electric telegraph.

We shall make a like reserve with regard to certain apparatus that have really existed, but that have been wrongly viewed as electric telegraphs. Such are those of Comus and of Alexandre. The first of these is indicated in a letter from Diderot to Mlle. Voland, dated July 12, 1762. It consisted of two dials whose hands followed each other at a distance, without the apparent aid of any external agent. The fact that Comus published some interesting researches on electricity in the _Journal de Physique_ has been taken as a basis for the assertion that his apparatus was a sort of electrical discharge telegraph in which the communication between the two dials was made by insulated wires hidden in the walls. But, if it be reflected how difficult it would have been at that epoch to realize an apparatus of this kind, if it be remembered that Comus, despite his researches on electricity, was in reality only a professor of physics to amuse, and if the fact be recalled that cabinets of physics in those days were filled with ingenious apparatus in which the surprising effects were produced by skillfully concealed magnets, we shall rather be led to class among such apparatus the so-called "Comus electric telegraph."

We find, moreover, in Guyot's _Recreations physiques et mathematiques_--a work whose first edition dates back to the time at which Comus was exhibiting his apparatus--a description of certain communicating dials that seem to be no other than those of the celebrated physicist, and which at all events enables us to understand how they worked.

Let one imagine to himself two contiguous chambers behind which ran one and the same corridor. In each chamber, against the partition that separated it from the corridor, there was a small bracket, and upon the latter, and very near the wall, there was a wooden dial supported on a standard, but in no wise permanently fixed upon the bracket. Each dial carried a needle, and each circumference was inscribed with twenty-five letters of the alphabet. The experiment that was performed with these dials consisted in placing the needle upon a letter in one of the chambers, when the needle of the other dial stopped at the same letter, thus making it possible to transmit words and even sentences. As for the means of communication between the two apparatus, that was very simple: One of the two dials always served as a transmitter, and the other as a receiver. The needle of the transmitter carried along in its motion a pretty powerful magnet, which was concealed in the dial, and which reacted through the partition upon a very light magnetized needle that followed its motions, and indicated upon an auxiliary dial, to a person hidden in the corridor, the letter on which the first needle had been placed. This person at once stepped over to the partition corresponding to the receiver, where another auxiliary dial permitted him to properly direct at a distance the very movable needle of the receiver. Everything depended, as will be seen, upon the use of the magnet, and upon a deceit that perfectly accorded with Comus' profession. There is, then, little thought in our opinion that if the latter's apparatus was not exactly the one Guyot describes, it was based upon some analogous artifice.

Jean Alexandre's telegraph appears to have borne much analogy with Comus'. Its inventor operated it in 1802 before the prefect of Indre-et-Loire. As a consequence of a report addressed by the prefect of Vienne to Chaptal, and in which, moreover, the apparatus in question was compared to Comus', Alexandre was ordered to Paris. There he refused to explain upon what principle his invention was based, and declared that he would confide his secret only to the First Consul. But Bonaparte, little disposed to occupy himself with such an affair, charged Delambre to examine it and address a report to him. The illustrious astronomer, despite the persistence with which Alexandre refused to give up his secret to him, drew a report, the few following extracts from which will, we think, suffice to edify the reader:

"The pieces that the First Consul charged me to examine did not contain enough of detail to justify an opinion. Citizen Beauvais (friend and associate of Alexandre) knows the inventor's secret, but has promised him to communicate it to no one except the First Consul. This circumstance might enable me to dispense with any report; for how judge of a machine that one has not seen and does not know the agent of? All that is known is that the _telegraphe intime_ consists of two like boxes, each carrying a dial on whose circumference are marked the letters of the alphabet. By means of a winch, the needle of one dial is carried to all the letters that one has need to use, and at the same instant the needle of the second box repeats, in the same order, all the motions and indications of the first.

"When these two boxes are placed in two separate apartments, two persons can write to and answer one another, without seeing or being seen by one another, and without any one suspecting their correspondence. Neither night nor fog can prevent the transmission of a dispatch.... The inventor has made two experiments--one at Portiers and the other at Tours--in the presence of the prefects and mayors, and the record shows that they were fully successful. To-day, the inventor and his associate ask that the First Consul be pleased to permit one of the boxes to be placed in his apartment and the other at the house of Consul Cambaceres in order to give the experiment all the _Øclat_ and authenticity possible; or that the First Consul accord a ten minutes' interview to citizen Beauvais, who will communicate to him the secret, which is so easy that the simple _expose_ of it would be equivalent to a demonstration, and would take the place of an experiment.... If, as one might be tempted to believe from a comparison with a bell arrangement, the means adopted by the inventor consisted in wheels, movements, and transmitting pieces, the invention would be none the less astonishing.... If, on the contrary, as the Portier's account seems to prove, the means of communication is a fluid, there would be the more merit in his having mastered it to such a point as to produce so regular and so infallible effects at such distances.... But citizen Beauvais ... desires principally to have the First Consul as a witness and appreciator.... It is to be desired, then, that the First Consul shall consent to hear him, and that he may find in the communication that will be made to him reasons for giving the invention a good reception and for properly rewarding the inventor."

But Bonaparte remained deaf, and Alexandre persisted in his silence, and died at Angers, in 1832, in great poverty, without having revealed his secret.

As, in 1802, Volta's pile was already invented, several authors have supposed an application of it in Alexandre's apparatus. "Is it not allowable to believe," exclaims one of these, "that the electric telegraph was at that time discovered?" We do not hesitate to respond in the negative. The pile had been invented for too short a time, and too little was then known of the properties of the current, to allow a man so destitute of scientific knowledge to so quickly invent all the electrical parts necessary for the synchronic operation of the two needles. In this _telegraphe intime_ we can only see an apparatus analogous to the one described by Guyot, or rather a synchronism obtained by means of cords, as in Kircher's arrangement. The fact that Alexandre's two dials were placed on two different stories, and distant, horizontally, fifteen meters, in nowise excludes this latter mode of transmission. On another hand, the mystery in which Alexandre was shrouded, his declaration relative to the use of a fluid, and the assurance with which he promised to reveal his secret to the First Consul, prove absolutely nothing, for too often have the most profoundly ignorant people--the electric girl, for example--befooled learned bodies by the aid of the grossest frauds. From the standpoint of the history of the electric telegraph, there is no value, then, to be attributed to this apparatus of Alexandre, any more than there is to that of Comus or to _any_ of the dreams based upon the properties of the magnet.

The history of the electric telegraph really begins with 1753, the date at which is found the first indication of a telegraph truly based upon the use of electricity. This telegraph is described in a letter written by Renfrew, dated Feb. 1, 1753, and signed with the initials "C.M.," which, in all probability, were those of a savant of the time--Charles Marshall. A few extracts from this letter will give an idea of the precision with which the author described his invention:

"Let us suppose a bundle of wires, in number equal to that of the letters of the alphabet, stretched horizontally between two given places, parallel with each other and distant from each other one inch.

"Let us admit that after every twenty yards the wires are connected to a solid body by a juncture of glass or jeweler’s cement, so as to prevent their coming in contact with the earth or any conducting body, and so as to help them to carry their own weight. The electric battery will be placed at right angles to one of the extremities of the wires, and the bundle of wires at each extremity will be carried by a solid piece of glass. The portions of the wires that run from the glass support to the machine have sufficient elasticity and stiffness to return to their primitive position after having been brought into contact with the battery. Very near to this same glass support, on the opposite side, there descends a ball suspended from each wire, and at a sixth or a tenth of an inch beneath each ball there is placed one of the letters of the alphabet written upon small pieces of paper or other substance light enough to be attracted and raised by the electrified ball. Besides this, all necessary arrangements are taken so that each of these little papers shall resume its place when the ball ceases to attract.

[Illustration: FIG. 1.--LESAGE’S TELEGRAPH.]

"All being arranged as above, and the minute at which the correspondence is to begin having been fixed upon beforehand, I begin the conversation with my friend at a distance in this way: I set the electric machine in motion, and, if the word that I wish to transcribe is ’Sir,’ for example, I take, with a glass rod, or with any other body electric through itself or insulating, the different ends of the wires corresponding to the three letters that compose the word. Then I press them in such a way as to put them in contact with the battery. At the same instant, my correspondent sees these different letters carried in the same order toward the electrified balls at the other extremity of the wires. I continue to thus spell the words as long as I judge proper, and my correspondent, that he may not forget them, writes down the letters in measure as they rise. He then unites them and reads the dispatch as often as he pleases. At a given signal, or when I desire it, I stop the machine, and, taking a pen, write down what my friend sends me from the other end of the line."

The author of this letter points out, besides, the possibility of keeping, in the first place, all the springs in contact with the battery, and, consequently, all the letters attracted, and of indicating each letter by removing its wire from the battery, and consequently making it fall. He even proposed to substitute bells of different sounds for the balls, and to produce electric sparks upon them. The sound produced by the spark would vary according to the bell, and the letters might thus be heard.

Nothing, however, in this document authorizes the belief that Charles Marshall ever realized his idea, so we must proceed to 1774 to find Lesage, of Geneva, constructing a telegraph that was based upon the principle indicated twenty years before in the letter of Renfrew.

The apparatus that Lesage devised (Fig. 1) was composed of 24 wires insulated from one another by a non conducting material. Each of these wires corresponded to a small pith ball suspended by a thread. On putting an electric machine in communication with such or such a one of these wires, the ball of the corresponding electrometer was repelled, and the motion signaled the letter that it was desired to transmit. Not content with having realized an electric telegraph upon a small scale, Lesage thought of applying it to longer distances.

"Let us conceive," said he in a letter written June 22, 1782, to Mr. Prevost, of Geneva, "a subterranean pipe of enameled clay, whose cavity at about every six feet is separated by partitions of the same material, or of glass, containing twenty-four apertures in order to give passage to as many brass wires as these diaphragms are to sustain and keep separated. At each extremity of this pipe are twenty-four wires that deviate from one another horizontally, and that are arranged like the keys of a clavichord; and, above this row of wire ends, are distinctly traced the twenty-four letters of the alphabet, while beneath there is a table covered with twenty-four small pieces of gold-leaf or other easily attractable and quite visible bodies."

Lesage had thought of offering his secret to Frederick the Great; but he did not do so, however, and his telegraph remained in the state of a curious cabinet experiment. He had, nevertheless, opened the way, and, dating from that epoch, we meet with a certain number of attempts at electrostatic telegraphy. [1]

[Footnote 1: Advantage has been taken of a letter from Alexander Volta to Prof. Barletti (dated 1777), indicating the possibility of firing his electric pistol from a great distance, to attribute to him a part in the invention of the telegraph. We have not shared in this opinion, which appears to us erroneous, since Volta, while indicating the possibility above stated, does not speak of applying such a fact to telegraphy.]

The first in date is that of Lemond, which is spoken of by Arthur Young (October 16, 1787), in his _Voyage Agronomique en France_:

"In the evening," says he, "we are going to Mr. Lemond's, a very ingenious mechanician, and one who has a genius for invention.... He has made a remarkable discovery in electricity. You write two or three words upon paper; he takes them with him into a room and revolves a machine within a sheath at the top of which there is an electrometer--a pretty little ball of feather pith. A brass wire is joined to a similar cylinder, and electrified in a distant apartment, and his wife on remarking the motions of the ball that corresponds, writes down the words that they indicate; from whence it appears that he has formed an alphabet of motions. As the length of the wire makes no difference in the effect, a correspondence might be kept up from very far off, for example with a besieged city, or for objects much more worthy of attention. Whatever be the use that shall be made of it, the discovery is an admirable one."

And, in fact, Lemond's telegraph was of the most interesting character, for it was a single wire one, and we already find here an alphabet based upon the combination of a few elementary signals.

The apparatus that next succeeds is the electric telegraph that Reveroni Saint Cyr proposed in 1790, to announce lottery numbers, but as to the construction of which we have no details. In 1794 Reusser, a German, made a proposition a little different from the preceding systems, and which is contained in the _Magazin für das Neueste aus der Physik und Naturgeschichte_, published by Henri Voigt.

"I am at home," says Reusser, "before my electric machine, and I am dictating to some one on the other side of the street a complete letter that he is writing himself. On an ordinary table there is fixed vertically a square board in which is inserted a pane of glass. To this glass are glued strips of tinfoil cut out in such a way that the spark shall be visible. Each strip is designated by a letter of the alphabet, and from each of them starts a long wire. These wires are inclosed in glass tubes which pass underground and run to the place whither the dispatch is to be transmitted. The extremities of the wires reach a similar plate of glass, which is likewise affixed to a table and carries strips of tinfoil similar to the others. These strips are also designated, by the same letters, and are connected by a return wire with the table of him who wishes to dictate the message. If, now, he who is dictating puts the external armature of a Leyden jar in contact with the return wire, and the ball of this jar in contact with a metallic rod touching that of the tinfoil strip which corresponds with the letter which he wishes to dictate to the other, sparks will be produced upon the nearest as well as upon the remotest strips, and the distant correspondent, seeing such sparks, may immediately write down the letter marked. Will an extended application of this system ever be made? That is not the question; it is possible. It will be very expensive; but the post hordes from Saint Petersburg to Lisbon are also very expensive, and if any one should apply the idea on a large scale, I shall claim a recompense."

Every letter, then, was signaled by one or several sparks that started forth on the breaking of the strip; but we see nothing in this document to authorize the opinion which has existed, that every tinfoil strip was a sort of magic tablet upon which the sparks traced the very form of the letter to be transmitted.

Voigt, the editor of the _Magazin_, adds, in continuation of Reusser's communication: "Mr. Reusser should have proposed the addition to this arrangement of a vessel filled with detonating gas which could be exploded in the first place, by means of the electric spark, in order to notify the one to whom something was to be dictated that he should direct his attention to the strips of tinfoil."

This passage gives the first indication of the use of a special call for the telegraph. The same year (1794), in a work entitled _Versuch über Telegraphie und Telegraphen_, Boeckmann likewise proposed the use of the pistol as a call signal, in conjunction with the use of a line composed of two wires only, and of discharges in the air or a vacuum, grouped in such a way as to form an alphabet.

Experiments like those indicated by Boeckmann, however, seem to have been made previous to 1794, or at that epoch, at least, by Cavallo, since the latter describes them in a _Treatise on Electricity_ written in English, and a French translation of which was published in 1795. In these experiments the length of the wires reached 250 English feet. Cavallo likewise proposed to use as signals combustible or detonating materials, and to employ as a call the noise made by the discharge of a Leyden jar.

In 1796 occurred the experiments of Dr. Francisco Salva and of the Infante D. Antonio. The following is what we may read on this subject in the _Journal des Sciences_:

"Prince de la Paix, having learned that Dr. Francisco Salva had read before the Royal Academy of Sciences of Barcelona a memoir on the application of electricity to telegraphy, and that he had presented at the same time an electric telegraph of his own invention, desired to examine this machine in person. Satisfied as to the accuracy and celerity with which we can converse with another by means of it, he obtained for the inventor the honor of appearing before the king. Prince de la Paix, in the presence of their majesties and of several lords, caused the telegraph to converse to the satisfaction of the whole court. The telegraph conversed some days afterward at the residence of the Infante D. Antonio.

"His Highness expressed a desire to have a much completer one that should have sufficient electrical power to communicate at great distances on land and sea. The Infante therefore ordered the construction of an electric machine whose plate should be more than forty inches in diameter. With the aid of this machine His Highness intends to undertake a series of useful and curious experiments that he has proposed to Dr. D. Salva."

In 1797 or ’98 (some authors say 1787), the Frenchman, Betancourt, put up a line between Aranjuez and Madrid, and telegraphed through the medium of discharges from a Leyden jar.

But the most interesting of the telegraphs based upon the use of static electricity is without doubt that of Francis Ronalds, described by the latter, in 1823, in a pamphlet entitled _Descriptions of an Electrical Telegraph and of some other Electrical Apparatus_, but the construction of which dates back to 1816.

What is peculiarly interesting in Ronalds’ apparatus is that it presents for the first time the use of two synchronous movements at the two stations in correspondence.

The apparatus is represented in Fig. 2. It is based upon the simultaneous working of two pith-ball electrometers, combined with the synchronous running of two clock-work movements. At the two stations there were identical clocks for whose second hand there had been substituted a cardboard disk (Fig. 3), divided into twenty sectors. Each of these latter contained one figure, one letter, and a conventional word. Before each movable disk there was a screen, A (Fig. 2), containing an aperture through which only one sector could, be seen at a time. Finally, before each screen there was a pith-ball electrometer. The two electrometers were connected together by means of a conductor (C) passing under the earth, and which at either of its extremities could be put in communication with either an electric machine or the ground. A lever handle, J, interposed into the circuit a Volta’s pistol, F, that served as a call.

When one of the operators desired to send a dispatch to the other he connected the conductor with the machine, and, setting the latter in operation, discharged his correspondent’s pistol as a signal. The call effected, the first operator continued to revolve the machine so that the balls of pith should diverge in the two electrometers. At the same time the two clocks were set running. When the sender saw the word "attention" pass before the slit in the screen he quickly discharged the line, the balls of the two electrometers approached each other, and, if the two clocks agreed perfectly, the correspondent necessarily saw in the aperture in his screen the same word, "attention." If not, he moved the screen in consequence, and the operation was performed over until he could send, in his turn, the word "ready." Afterward, the sender transmitted in the same way one of the three words, "letters," "figures," "dictionary," in order to indicate whether he wished to transmit letters or figures, or whether the letters received, instead of being taken in their true sense, were to be referred to a conventional vocabulary got up in advance. It was after such preliminaries that the actual transmission of the dispatch was begun. The pith balls, which were kept constantly apart, approached each other at the moment the letter to be transmitted passed before the aperture in the screen.

Ronalds, in his researches, busied himself most with the construction of lines. He put up on the grounds near his dwelling an air line 8 miles long; and, to do so, stretched fine iron wire in zigzag fashion between two frames 18 meters apart. Each of these frames carried thirty-seven hooks, to which the wire was attached through the intermedium of silk cords. He laid, besides, a subterranean line of 525 feet at a depth of 4 feet. The wire was inclosed within thick glass tubes which were placed in a trough of dry wood, of 2 inch section, coated internally and externally with pitch. This trough was, moreover, filled full of pitch and closed with a cover of wood. Ronalds preferred these subterranean conductors to air lines. A portion of one of them that was laid by him at Hammersmith figured at the Exhibition of 1881, and is shown in Fig. 4.

Nearly at the epoch at which Ronalds was experimenting in England, a certain Harrisson Gray Dyar was also occupying himself with electrostatic telegraphy in America. According to letters published only in 1872 by American journals, Dyar constructed the first telegraph in America. This line, which was put up on Long Island, was of iron wire strung on poles carrying glass insulators, and, upon it, Dyar operated with static electricity. Causing the spark to act upon a movable disk covered with litmus paper, he produced by the discoloration of the latter dots and dashes that formed an alphabet.

[Illustration: FIG. 2.]

These experiments, it seems, were so successful that Dyar and his relatives resolved to construct a line from New York to Philadelphia; but quarrels with his copartners, lawsuits, and other causes obliged him to leave for Rhode Island, and finally for France in 1831. He did not return to America till 1858.

Dyar, then, would seem to have been the first who combined an alphabet composed of dots and dashes. On this point, priority has been claimed by Swaim in a book that appeared at Philadelphia in 1829 under the title of _The Mural Diagraph_, and in a communication inserted in the _Comptes Rendus_ of the Academic des Sciences for Nov. 27, 1865.

[Illustration: FIG. 3.]

In 1828, likewise, Victor Triboaillet de Saint Amand proposed to construct a telegraph line between Paris and Brussels. This line was to be a subterranean one, the wire being covered with gum shellac, then with silk, and finally with resin, and being last of all placed in glass tubes. A strong battery was to act at a distance upon an electroscope, and the dispatches were to be transmitted by the aid of a conventional vocabulary based upon the number of the electroscope’s motions.

Finally, in 1844, Henry Highton took out a patent in England for a telegraph working through electricity of high tension, with the use of a single line wire. A paper unrolled regularly between two points, and each discharge made a small hole in it, But this hole was near one or the other of the points according as the line was positively or negatively charged. The combination of the holes thus traced upon two parallel lines permitted of the formation of an alphabet. This telegraph was tried successfully over a line ten miles long, on the London and Northwestern Railway.

[Illustration: FIG. 4.]

We have followed electrostatic telegraphs up to an epoch at which telegraphy had already entered upon a more practical road, and it now remains for us to retrace our steps toward those apparatus that are based upon the use of the voltaic current.

* * * * *

Prof. Dolbear observes that if a galvanometer is placed between the terminals of a circuit of homogeneous iron wire and heat is applied, no electric effect will be observed; but if the structure of the wire is altered by alternate bending or twisting into a helix, then the galvanometer will indicate a current. The professor employs a helix connected with a battery, and surrounding a portion of the wire in circuit with the galvanometer. The current in the helix magnetizes the circuit wire inclosed, and the galvanometer exhibits the presence of electricity. The experiment helps to prove that magnetism is connected with some molecular change of the magnetized metal.

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ELECTRICAL TRANSMISSION AND STORAGE.

[Footnote: From a recent lecture in London before the Institute of Civil Engineers.]

By Dr. C. WILLIAM SIEMENS, F.R.S, Mem. Inst. C.E.

Dr. Siemens, in opening the discourse, adverted to the object the Council had in view in organizing these occasional lectures, which were not to be lectures upon general topics, but the outcome of such special study and practical experience as members of the Institution had exceptional opportunities of acquiring in the course of their professional occupation. The subject to be dealt with during the present session was that of electricity. Already telegraphy had been brought forward by Mr. W. H. Preece, and telephonic communication by Sir Frederick Bramwell.

Thus far electricity had been introduced as the swift and subtile agency by which signals were produced either by mechanical means or by the human voice, and flashed almost instantaneously to distances which were limited, with regard to the former, by restrictions imposed by the globe. To the speaker had been assigned the task of introducing to their notice electric energy in a different aspect. Although still giving evidence of swiftness and precision, the effects he should dwell upon were no longer such as could be perceived only through the most delicate instruments human ingenuity could contrive, but were capable of rivaling the steam engine, compressed air, and the hydraulic accumulator in the accomplishment of actual work.

In the early attempts at magneto electric machines, it was shown that, so long as their effect depended upon the oxidation of zinc in a battery, no commercially useful results could have been anticipated. The thermo-battery, the discovery of Seebeck in 1822, was alluded to as a means of converting heat into electric energy in the most direct manner; but this conversion could not be an entire one, because the second law of thermo-dynamics, which prevented the realization as mechanical force of more than one seventh part of the heat energy produced in combustion under the boiler, applied equally to the thermo-electric battery, in which the heat, conducted from the hot points of juncture to the cold, constituted a formidable loss. The electromotive force of each thermo-electric element did not exceed 0.036 of a volt, and 1,800 elements were therefore necessary to work an incandescence lamp.

A most useful application of the thermo-electric battery for measuring radiant heat, the thermo pile, was exhibited. By means of an ingenious modification of the electrical pyrometer, named the bolometer, valuable researches in measuring solar radiations had been made by Professor Langley.

Faraday's great discovery of magneto-induction was next noticed, and the original instrument by which he had elicited the first electric spark before the members of the Royal Institution in 1831, was shown in operation. It was proved that although the individual current produced by magnetoinduction was exceedingly small and momentary in action, it was capable of unlimited multiplication by mechanical arrangements of a simple kind, and that by such multiplication the powerful effects of the dynamo machine of the present day were built up. One of the means for accomplishing such multiplication was the Siemens armature of 1856. Another step of importance was that involved in the Pacinotti ring, known in its practical application as the machine of Gramme. A third step, that of the self exciting principle, was first communicated by Dr. Werner Siemens to the Berlin Academy, on the 17th of January, 1867, and by the lecturer to the Royal Society, on the 4th of the following month. This was read on the 14th of February, when the late Sir Charles Wheatstone also brought forward a paper embodying the same principle. The lecturer's machine, which was then exhibited, and which might be looked upon as the first of its kind, was shown in operation; it had done useful work for many years as a means of exciting steel magnets. A suggestion contained in Sir Charles Wheatstone's paper, that "a very remarkable increase of all the effects, accompanied by a diminution in the resistance of the machine, is observed when a cross wire is placed so as to divert a great portion of the current from the electro-magnet," had led the lecturer to an investigation read before the Royal Society on the 4th of March, 1880, in which it was shown that by augmenting the resistance upon the electro-magnets 100 fold, valuable effects could be realized, as illustrated graphically by means of a diagram. The most important of these results consisted in this, that the electromotive force produced in a "shunt-wound machine," as it was called, increased with the external resistance, whereby the great fluctuations formerly inseparable from electric arc lighting could be obviated, and thus, by the double means of exciting the electro-magnets, still greater uniformity of current was attainable.

The conditions upon which the working of a well conceived dynamo machine must depend were next alluded to, and it was demonstrated that when losses by unnecessary wire resistance, by Foucault currents, and by induced currents in the rotating armature were avoided, as much as 90 per cent., or even more, of the power communicated to the machine was realized in the form of electric energy, and that _vice versa_ the reconversion of electric into mechanical energy could be accomplished with similarly small loss. Thus, by means of two machines at a moderate distance apart, nearly 80 per cent, of the power imparted to one machine could be again yielded in the mechanical form by the second, leaving out of consideration frictional losses, which latter need not be great, considering that a dynamo machine had only one moving part well balanced, and was acted upon along its entire circumference by propelling force. Jacobi had proved, many years ago, that the maximum efficiency of a magneto-electric engine was obtained when

$e / E = w / W = ‰$

which law had been frequently construed, by Verdet (Theorie Mecanique de la Chaleur) and others, to mean that one-half was the maximum theoretical efficiency obtainable in electric transmission of power, and that one half of the current must be necessarily wasted or turned into heat. The lecturer could never be reconciled to a law necessitating such a waste of energy, and had maintained, without disputing the accuracy of Jacobi's law, that it had reference really to the condition of maximum work accomplished with a given machine, whereas its efficiency must be governed by the equation:

$e / E = w / W =$ nearly 1

From this it followed that the maximum yield was obtained when two dynamo machines (of similar construction) rotated nearly at the same speed, but that under these conditions the amount of force transmitted was a minimum. Practically the best condition of working consisted in giving to the primary machine such proportions as to produce a current of the same magnitude, but of 50 per cent, greater electromotive force than the secondary; by adopting such an arrangement, as much as 50 per cent, of the power imparted to the primary could be practically received from the secondary machine at a distance of several miles. Professor Silvanus Thompson, in his recent Cantor Lectures, had shown an ingenious graphical method of proving these important fundamental laws.

The possibility of transmitting power electrically was so obvious that suggestions to that effect had been frequently made since the days of Volta, by Ritchie, Jacobi, Henry, Page, Hjorth, and others; but it was only in recent years that such transmission had been rendered practically feasible.

Just six years ago, when delivering his presidential address to the Iron and Steel Institute, the lecturer had ventured to suggest that "time will probably reveal to us effectual means of carrying power to great distances, but I cannot refrain from alluding to one which is, in my opinion, worthy of consideration, namely, the electrical conductor. Suppose water power to be employed to give motion to a dynamo-electrical machine, a very powerful electrical current will be the result, which may be carried to a great distance, through a large metallic conductor, and then be made to impart motion to electromagnetic engines, to ignite the carbon points of electric lamps, or to effect the separation of metals from their combinations. A copper rod 3 in. in diameter would be capable of transmitting 1,000 horse power a distance of say thirty miles, an amount sufficient to supply one-quarter of a million candle power, which would suffice to illuminate a moderately-sized town." This suggestion had been much criticised at the time, when it was still thought that electricity was incapable of being massed so as to deal with many horse power of effect, and the size of conductor he had proposed was also considered wholly inadequate. It would be interesting to test this early calculation by recent experience. Mr. Marcel Deprez had, it was well known, lately succeeded in transmitting as much as three horse power to a distance of 40 kilometers (25 miles) through a pair of ordinary telegraph wires of 4 millimeters in diameter. The results so obtained had been carefully noted by Mr. Tresca, and had been communicated a fortnight ago to the French Academy of Sciences. Taking the relative conductivity of iron wire employed by Deprez, and the 3 in. rod proposed by the lecturer, the amount of power that could be transmitted through the latter would be about 4,000 horse power. But Deprez had employed a motor-dynamo of 2,000 volts, and was contented with a yield of 32 per cent. only of the energy imparted to the primary machine, whereas he had calculated at the time upon an electromotive force of 200 volts, and upon a return of at least 40 per cent. of the energy imparted. In March, 1878, when delivering one of the Science Lectures at Glasgow, he said that a 2 in. rod could be made to accomplish the object proposed, because he had by that time conceived the possibility of employing a current of at least 500 volts. Sir William Thomson had at once accepted these views, and with the conceptive ingenuity peculiar to himself, had gone far beyond him, in showing before the Parliamentary Electric Light Committee of 1879, that through a copper wire of only ‰ in. diameter, 21,000 horse power might be conveyed to a distance of 300 miles with a current of an intensity of 80,000 volts. The time might come when such a current could be dealt with, having a striking distance of about 12 ft. in air, but then, probably, a very practical law enunciated by Sir William Thomson would be infringed. This was to the effect that electricity was conveyed at the cheapest rate through a conductor, the cost of which was such that the annual interest upon the money expended equaled the annual expenditure for lost effect in the conductor in producing the power to be conveyed. It appeared that Mr. Deprez had not followed this law in making his recent installations.

Sir William Armstrong was probably first to take practical, advantage of these suggestions in lighting his house at Cragside during night time, and working his lathe and saw bench during the day, by power transmitted through a wire from a waterfall nearly a mile distant from his mansion. The lecturer had also accomplished the several objects of pumping water, cutting wood, hay, and swedes, of lighting his house, and of carrying on experiments in electro-horticulture from a common center of steam power. The results had been most satisfactory; the whole of the management had been in the hands of a gardener and of laborers, who were without previous knowledge of electricity, and the only repairs that had been found necessary were one renewal of the commutators and an occasional change of metallic contact brushes.

An interesting application of electric transmission to cranes, by Dr. Hopkinson, was shown in operation.

Among the numerous other applications of the electrical transmission of power, that to electrical railways, first exhibited by Dr. Werner Siemens, at the Berlin Exhibition of 1879, had created more than ordinary public attention. In it the current produced by the dynamo machine, fixed at a convenient station and driven by a steam engine or other motor, was conveyed to a dynamo placed upon the moving car, through a central rail supported upon insulating blocks of wood, the two

working rails serving to convey the return current. The line was 900 yards long, of 2 ft gauge, and the moving car served its purpose of carrying twenty visitors through the exhibition each trip. The success of this experiment soon led to the laying of the Lichterfelde line, in which both rails were placed upon insulating sleepers, so that the one served for the conveyance of the current from the power station to the moving car, and the other for completing the return circuit. This line had a gauge of 3 ft. 3 in., was 2,500 yards in length, and was worked by two dynamo machines, developing an aggregate current of 9,000 watts, equal to 12 horse power. It had now been in constant operation since May 16, 1881, and had never failed in accomplishing its daily traffic.
A line half a kilometer in length, but of 4 ft. 8‰ in. gauge was established by the lecturer at Paris in connection with the Electric Exhibition of 1881. In this case, two suspended conductors in the form of hollow tubes with a longitudinal slit were adopted, the contact being made by metallic bolts drawn through these slit tubes, and connected with the dynamo machine on the moving car by copper ropes passing through the roof. On this line 95,000 passengers were conveyed within the short period of seven weeks.

An electric tramway, six miles in length, had just been completed, connecting Portrush with Bush Mills, in the north of Ireland, in the installation of which the lecturer was aided by Mr. Traill, as engineer of the company by Mr. Alexander Siemens, and by Dr. E. Hopkinson, representing his firm. In this instance the two rails, 3 ft. apart, were not insulated from the ground, but were joined electrically by means of copper staples and formed the return circuit, the current being conveyed to the car through a T iron placed upon short standards, and insulated by means of insulate caps. For the present the power was produced by a steam engine at Portrush, giving motion to a shunt-wound dynamo of 15,000 watts=20 horse power, but arrangements were in progress to utilize a waterfall of ample power near Bush Mills, by means of three turbines of 40 horse power each, now in course of erection. The working speed of this line was restricted by the Board of Trade to ten miles an hour, which was readily obtained, although the gradients of the line were decidedly unfavorable, including an incline of two miles in length at a gradient of 1 in 38. It was intended to extend the line six miles beyond Bush Mills, in order to join it at Dervock station with the north of Ireland narrow gauge railway system.

The electric system of propulsion was, in the lecturer’s opinion, sufficiently advanced to assure practical success under suitable circumstances--such as for suburban tramways, elevated lines, and above all lines through tunnels; such as the Metropolitan and District Railways. The advantages were that the weight, of the engine, so destructive of power and of the plant itself in starting and stopping, would be saved, and that perfect immunity from products of combustion would be insured The experience at Lichterfelde, at Paris, and another electric line of 765 yards in length, and 2 ft. 2 in. gauge, worked in connection with the Zaukerode Colliery since October, 1882, were extremely favorable to this mode of propulsion. The lecturer however did not advocate its prospective application in competition with the locomotive engine for main lines of railway. For tramways within populous districts, the insulated conductor involved a serious difficulty. It would be more advantageous under these circumstances to resort to secondary batteries, forming a store of electrical energy carried under the seats of the car itself, and working a dynamo machine connected with the moving wheels by means of belts and chains.

The secondary battery was the only available means of propelling vessels by electrical power, and considering that these batteries might be made to serve the purpose of keel ballast, their weight, which was still considerable, would not be objectionable. The secondary battery was not an entirely new conception. The hydrogen gas battery suggested by Sir Wm. Grove in 1841, and which was shown in operation, realized in the most perfect manner the conception of storage, only that the power obtained from it was exceedingly slight. The lecturer, in working upon Sir Wm. Grove’s conception, had twenty-five years ago constructed a battery of considerable power in substituting porous carbon for platinum, impregnating the same with a precipitate of lead peroxidized by a charging current. At that time little practical importance attached however to the object, and even when Plante, in 1860, produced his secondary battery, composed of lead plates peroxidized by a charging current, little more than scientific curiosity was excited. It was only since the dynamo machine had become an accomplished fact that the importance of this mode of storing energy had become of practical importance, and great credit was due to Faure, to Sellon, and to Volckmar for putting this valuable addition to practical science into available forms. A question of great interest in connection with the secondary battery had reference to its permanence. A fear had been expressed by many that local action would soon destroy the fabric of which it was composed, and that the active surfaces would become coated with sulphate of lead, preventing further action. It had, however, lately been proved in a paper read by Dr. Frankland before the Royal Society, corroborated by simultaneous investigations by Dr. Gladstone and Mr. Tribe, that the action of the secondary battery depended essentially upon the alternative composition and decomposition of sulphate of lead, which was therefore not an enemy, but the best friend to its continued action.

In conclusion, the lecturer referred to electric nomenclature, and to the means for measuring and recording the passage of electric energy. When he addressed the British Association at Southampton, he had ventured to suggest two electrical units additional to those established at the Electrical Congress in 1881, viz.: the watt and the joule, in order to complete the chain of units connecting electrical with mechanical energy and with the unit quantity of heat. He was glad to find that this suggestion had met with a favorable reception, especially that of the watt, which was convenient for expressing in an intelligible manner the effective power of a dynamo machine, and for giving a precise idea of the number of lights or effective power to be realized by its current, as well as of the engine power necessary to drive it; 746 watts represented 1 horse-power.

Finally, the watt meter, an instrument recently developed by his firm, was shown in operation. This consisted simply of a coil of thick conductor suspended by a torsion wire, and opposed laterally to a fixed coil of wire of high resistance. The current to be measured flowed through both coils in parallel circuit, the one representing its quantity expressible in amperes, and the other its potential expressible in volts. Their joint attractive action expressed therefore volt-amperes or watts, which were read off upon a scale of equal divisions.

The lecture was illustrated by experiments, and by numerous diagrams and tables of results. Measuring instruments by Professors Ayrton and Perry, by Mr. Edison and by Mr. Boys, were also exhibited.

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ON THE PREPARATION OF GELATINE PLATES.

[Footnote: Being an abstract of the introductory lecture to a course on photography at the Polytechnic Institute, November 11.]

By E. HOWARD FARMER, F.C.S.

Since the first announcement of these lectures, our Secretary has asked me to give a free introductory lecture, so that all who are interested in the subject may come and gather a better idea as to them than they can possibly do by simply leading a prospectus. This evening, therefore, I propose to give first a typical lecture of the course, and secondly, at its conclusion, to say a few words as to our principal object. As the subject for this evening's lecture I have chosen, "The Preparation of Gelatine Plates," as it is probably one of very general interest to photographers.

Before preparing our emulsion, we must first decide upon the particular materials we are going to use, and of these the first requisite is nitrate of silver. Nitrate of silver is supplied by chemists in three principal conditions:

1. The ordinary crystallized salt, prepared by dissolving silver in nitric acid, and evaporating the solution until the salt crystallizes out. This sample usually presents the appearance of imperfect crystals, having a faint yellowish tinge, and a strong odor of nitrous fumes, and contains, as might be expected, a considerable amount of free acid.

2. Fused nitrate, or "lunar caustic," prepared by fusing the crystallized salt and casting it into sticks. Lunar caustic is usually alkaline to test paper.

3. Recrystallized silver nitrate, prepared by redissolving the ordinary salt in distilled water, and again evaporating to the crystallizing point. By this means the impurities and free acid are removed.

I have a specimen of this on the table, and it consists, as you observe, of fine crystals which are perfectly colorless and transparent; it is also perfectly neutral to test paper. No doubt either of these samples can be used with success in preparing emulsions, but to those who are inexperienced, I recommend that the recrystallized salt be employed. We make, then, a solution of recrystallized silver nitrate in distilled water, containing in every 12 ounces of solution 1… ounces of the salt.

The next material we require is a soluble bromide. I have here specimens of various bromides which can be employed, such as ammonium, potassium, barium, and zinc bromides; as a rule, however, either the ammonium or potassium salt is used, and I should like to say a few words respecting the relative efficiency of these two salts.

1. As to ammonium bromide. This substance is a highly unstable salt. A sample of ammonium bromide which is perfectly neutral when first prepared will, on keeping, be found to become decidedly acid in character. Moreover, during this decomposition, the percentage of bromine does not remain constant; as a rule, it will be found to contain more than the theoretical amount of bromine. Finally, all ammonium salts have a most destructive action on gelatine; if gelatine, which has been boiled for a short time with either ammonium bromide or ammonium nitrate, be added to an emulsion, it will be found to produce pink fog--and probably frilling--on plates prepared with the emulsion. For these reasons, I venture to say that ammonium bromide, which figures so largely in formulæ for gelatine emulsions, is one of the worst bromides that can be employed for that purpose, and is, indeed, a frequent source of pink fog and frilling.

2. As to potassium bromide. This is a perfectly stable substance, can be readily obtained pure, and is constant in composition; neither has it (nor the nitrate) any appreciable destructive action on gelatine. We prepare, then, a solution of potassium bromide in water containing in every 12 ounces of solution 1 ounce of the salt. On testing it with litmus paper, the solution may be either slightly alkaline or neutral; in either case, it should be faintly acidified with hydrochloric acid.

The last material we require is the gelatine, one of the most important, and at the same time the most difficult substance to obtain of good quality. I have various samples here--notably Nelson's No. 1 and "X opaque;" Coignet's gold medal; Heinrich's; the Autotype Company's; and Russian isinglass.

The only method I know of securing a uniform quality of gelatine is to purchase several small samples, make a trial emulsion with each, and buy a stock of the sample which gives the best results. To those who do not care to go to this trouble, equal quantities of Nelson's No. 1 and X opaque, as recommended by Captain Abney, can be employed. Having selected the gelatine, 1… ounces should be allowed to soak in water, and then melted, when it will be found to have a bulk of about 6 ounces.

In order to prepare our emulsion, I take equal bulks of the silver nitrate and potassium bromide solutions in beakers, and place them in the water bath to get hot. I also take an equal bulk of hot water in a large beaker, and add to it one-half an ounce of the gelatine solution to every 12 ounces of water. Having raised all these to about 180° F., I add (as you observe) to the large beaker containing the dilute gelatine a little of the bromide, then, through a funnel having a fine orifice, a little of the silver, swirling the liquid round during the operation; then again some bromide and silver, and so on until all is added.

When this is completed, a little of the emulsion is poured on a glass plate, and examined by transmitted light; if the mixing be efficient, the light will appear--as it does here--of an orange or orange red color.

It will be observed that we keep the bromide in excess while mixing. I must not forget to mention that to those experienced in mixing, by far the best method is that described by Captain Abney in his Cantor lectures, of keeping the silver in excess.

The emulsion, being properly mixed, has now to be placed in the water bath, and kept at the boiling point for forty-five minutes. As, obviously, I cannot keep you waiting while this is done, I propose to divide our emulsion into two portions, allowing one portion to stew, and to proceed with the next operation with the remainder.

Supposing, then, this emulsion has been boiled, it is placed in cold water to cool. While it is cooling, let us consider for a moment what takes place during the boiling. It is found that during this time the emulsion undergoes two remarkable changes:

1. The molecules of silver bromide gradually aggregate together, forming larger and larger particles.

2. The emulsion increases rapidly in sensitiveness. Now what is the cause, in the first place, of this aggregation of molecules: and, in the second place, of the increase of sensitiveness? We know that the two invariably go together, so that we are right in concluding that the same cause produces both.

It might be thought that heat is the cause, but the same changes take place more slowly in the cold, so we can only say that heat accelerates the action, and hence must conclude that the prime cause is one of the materials in the emulsion itself.

Now, besides the silver bromide, we have in the emulsion water, gelatine, potassium nitrate, and a small excess of potassium bromide; and in order to find which of these is the cause, we must make different emulsions, omitting in succession each of these materials. Suppose we take an emulsion which has just been mixed, and, instead of boiling it, we precipitate the gelatine and silver bromide with alcohol; on redissolving the pellicle in the same quantity of water, we have an emulsion the same as previously, with the exception that the niter and excess of potassium bromide are absent. If such an emulsion be boiled, we shall find the remarkable fact that, however long it be boiled, the silver bromide undergoes no change, neither does the emulsion become any more sensitive. We therefore conclude, that either the niter or the small excess of potassium bromide, or both together, produce the change.

Now take portions of a similarly washed emulsion, and add to one portion some niter, and to another some potassium bromide; on boiling these we find that the one containing niter does not change, while that containing the potassium bromide rapidly undergoes the changes mentioned.

Here, then, by a direct appeal to experiment, we prove that to all appearance comparatively useless excess of potassium bromide is really one of the most important constituents of the emulsion.

The following table gives some interesting results respecting this action of potassium bromide:

Excess of potash bromide.	Time to acquire maximum sensitiveness.
0.2 grain per ounce	no increase after six hours.
2.0 " "	about one-half an hour.
20.0 " "	seven minutes.

I must here leave the _rationale_ of the process for the present, and proceed with the next operation.

Our emulsion being cold, I add to it, for every 6 ounces of mixed emulsion, 1 ounce of a saturated cold solution of potassium bichromate; then, gently swirling the mixture round, a few drops of a dilute (1 to 8) solution of hydrochloric acid, and place it on one side for a minute or two.

When hydrochloric acid is added to bichromate of potash, chromic acid is liberated. Now, chromic acid has the property of precipitating gelatine, so that what I hope to have done is to have precipitated the gelatine in this emulsion, and which will carry down the silver bromide as well. You see here I can pour off the supernatant liquid clear, leaving our silver and gelatine as a clot at the bottom of the vessel.

Another action of chromic acid is, that it destroys the action of light on silver bromide, so that up to this point operations can be carried on in broad daylight.

The precipitated emulsion is now taken into the dark room and washed until the wash water shows no trace of color; if there be a large quantity, this is best done on a fine muslin filter; if a small quantity, by decantation.

Having been thoroughly washed, I dissolve the pellicle in water by immersing the beaker containing it in the water bath. I then add the remaining gelatine, and make up the whole with 3 ounces of alcohol and water to 30 ounces for the quantities given. I pass the emulsion through a funnel containing a pellet of cotton wool in order to filter it, and it is ready for coating the plates.

To coat a plate, I place it on this small block of leveled wood, and pour on down a glass rod a small quantity of the emulsion, and by means of the rod held horizontally, spread it over the plate. I then transfer the plate to this leveled slab of plate glass, in order that the emulsion on it may set. As soon as set, it is placed in the drying box.

This process, as here described, does not give plates of the highest degree of sensitiveness, to attain which a further operation is necessary; they are, however, of exceedingly good quality, and very suitable for landscape work.--_Photo. News_.

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PICTURES ON GLASS.

The invention of M. E. Godard, of Paris, has for its object the reproduction of images and drawings, by means of vitrifiable colors on glass, wood, stone, on canvas or paper prepared for oil-painting and on other substances having polished surfaces, e. g., earthenware, copper, etc. The original drawings or images should be well executed, and drawn on white, or preferably bluish paper, similar to paper used for ordinary drawings. In the patterns for glass painting, by this process, the place to be occupied is marked by the lead, before cutting the glass to suit the various shades which compose the color of a panel, as is usually done in this kind of work; the operation changes only when the glass cutter hands these sheets over to the man who undertakes the painting. The sheets of glass are cut according to the lines of the drawing, and after being well cleaned, they are placed on the paper on the places for which they have been cut out. If the window to be stained is of large size and consists of several panels, only one panel is proceeded with at a time. The glass is laid on the reverse side of the paper (the side opposite to the drawing), the latter having been made transparent by saturating it with petroleum. This operation also serves to fix the outlines of the drawing more distinctly, and to give more vigor to the dark tone of the paper. When the paper is thus prepared, and the sheets of glass each in its place, they are coated by means of a brush with a sensitizing solution on the side which comes into contact with the paper. This coating should be as thin and as uniform as possible on the surface of the glass. For more perfectly equalizing the coating, a second brush is used.

The sensitizing solution which serves to produce the verifiable image is prepared as follows: Bichromate of ammonia is dissolved in water till the latter is saturated; five grammes of powdered dextrin or glucose are then dissolved in 100 grammes of water; to either of these solutions is added 10 per cent. of the solution of bichromate, and the mixture filtered.

The coating of the glass takes place immediately afterward in a dark room; the coated sheets are then subjected to a heat of 50° or 60° C. (120° to 140° Fahr.) in a small hot chamber, where they are laid one after the other on a wire grating situated 35 centimeters above the bottom. Care should be taken not to introduce the glass under treatment into the hot chamber before the required degree of heat has been obtained. A few seconds are sufficient to dry each sheet, and the wire grating should be large enough to allow of the dried glass being laid in rows, on one side where the heat is less intense. For the reproduction of the pictures or images a photographic copying frame of the size of the original is used. A stained glass window being for greater security generally divided into different panels, the size of one panel is seldom more than one square meter. If the picture to be reproduced should be larger in size than any available copying frame, the prepared glass sheets are laid between two large sheets of plate-glass, and part after part is proceeded with, by sliding the original between the two sheets. A photographic copying frame, however, is always preferable, as it presses the glass sheets better against the original. The original drawing is laid fiat on the glass of the frame. The lines where the lead is to connect the respective sheets of glass are marked on the drawing with blue or red pencil. The prepared sheets of glass are then placed one after the other on the original in their respective places, so that the coated side comes in contact with the original. The frame is then closed. It should be borne in mind that the latter operations must be performed in the dark room. The closed frame is now exposed to light. If the operations are performed outdoors, the frame is laid flat, so that the light falls directly on it; if indoors, the frame is placed inclined behind a window, so that it may receive the light in front. The time necessary for exposing the frame depends upon the light and the temperature; for instance, if the weather is fine and cloudless and the temperature from 16° to 18° C. (60° to 64° Fahr.), it will require from 12 to 15 minutes.

It will be observed that the time of exposure also depends on the thickness of the paper used for the original. If, however, the weather is dark, it requires from 30 to 50 minutes for the exposure. It will be observed that if the temperature is above 25° C. (about 80° Fahr.), the sheets of glass should be kept very cool and be less dried; otherwise, when exposed the sheets are instantly metallized, and the reproduction cannot take place. The same inconvenience takes place if the temperature is beneath 5° C. (41° Fahr.). In this case the sheets should be kept warm, and care should be taken not to expose the frame to the open air, but always behind a glass window at a temperature of from 14° to 18° C. (about 60° Fahr.). The time necessary for the exposure can be ascertained by taking out one of the many pieces of glass, applying to the sensitive surface a vitrifiable color, and observing whether the color adheres well. If the color adheres but slightly to the dark, shady portions of the image, the exposure has been too long, and the process must be recommenced; if, on the contrary, the color adheres too well, the exposure has not been sufficient, the frames must be closed again, and the exposure continued. When the frame has been sufficiently exposed, it is taken into the dark room, the sensitized pieces of glass laid on a plate of glass or marble with the sensitive surface turned upward, and the previously prepared vitrifiable color strewed over it by means of a few light strokes of a brush. This powder does not adhere to the parts of the picture fully exposed to light, but adheres only to the more or less shady portions of the picture. This operation develops on the glass the image as it is on the paper. Thirty to 40 grammes of nitric acid are added to 1,000 grammes of wood-spirit, such as is generally used in photography, and the prepared pieces of glass are dipped into the bath, leaving them afterward to dry. If the bath becomes of a yellowish color, it must be renewed. This bath has for its object to remove the coating of bichromate, so as to allow the color to adhere to the glass, from which it has been separated by the layer of glucose and bichromate, which would prevent the vitrification. The bath has also for its object to render the light parts of the picture perfectly pure and capable of being easily retouched or painted by hand. The application of variously colored enamels and the heating are then effected as in ordinary glass painting. The same process may be applied to marble, wood, stone, lava, canvas prepared for oil painting, earthenware, pure or enameled iron. The result is the same in all cases, and the process is the same as with glass, with the difference only that the above named materials are not dipped into the bath, but the liquid is poured over the objects after the latter have been placed in an inclined position.

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PREPARATION OF HYDROGEN SULPHIDE FROM COAL-GAS.

By I. TAYLOR, B.A., Science Master at Christ College, Brecon.

Hydrogen sulphide may be prepared very easily, and sufficiently pure for ordinary analytical purposes, by passing coal-gas through boiling sulphur. Coal-gas contains 40 to 50 per cent, of hydrogen, nearly the whole of which may, by means of a suitable arrangement, be converted into sulphureted hydrogen. The other constituents of coal-gas--methane, carbon monoxide, olefines, etc.--are not affected by passing through boiling sulphur, and for ordinary laboratory work their removal is quite unnecessary, as they do not in any way interfere with the precipitation of metallic sulphides.

[Illustration: PREPARATION OF HYDROGEN SULPHIDE FROM COAL-GAS.]

A convenient apparatus for the preparation of hydrogen sulphide from coal-gas, such as we have at present in use in the Christ College laboratory, consists of a retort, R, in which sulphur is placed. Through the tubulure of the retort there passes a bent glass-tube, T E, perforated near the closed end, F, with a number of small holes. (The perforations are easily made by piercing the partially softened glass with a white-hot steel needle; an ordinary crotchet needle, the hook having been removed and the end sharpened, answers the purpose very well.) The end, T, of the glass tube is connected by caoutchouc tubing with the coal-gas supply, the perforated end dipping into the sulphur. The neck of the retort, inclined slightly upward to allow the condensed sulpur, as it remelts, to flow back, is connected with awash bottle, B, to which is attached the flask, F, containing the solution through which it is required to pass the hydrogen sulphide; F is connected with an aspirator, A.

About one pound of sulphur having been introduced into the retort and heated to the boiling-point, the tap of the aspirator is turned on and a current of coal-gas drawn through the boiling sulphur; the hydrogen sulphide formed is washed by the water contained in B, passes on into F, and finally into the aspirator. The speed of the current may be regulated by the tap, and as the aspirator itself acts as a receptacle for excess of gas, very little as a rule escapes into the room, and consequently unpleasant smells are avoided.

This method of preparing sulphureted hydrogen will, I think, be found useful in the laboratory. It is cleanly, much cheaper than the ordinary method, and very convenient. During laboratory work, a burner is placed under the retort and the sulphur kept hot, so that its temperature may be quickly raised to the boiling-point when the gas is required. From time to time it is necessary to replenish the retort with sulphur and to remove the condensed portions from the neck.--_Chem. News_.

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"SETTING" OF GYPSUM.--This setting is the result of two distinct, though simultaneous, phenomena. On the one hand, portions of anhydrous calcium sulphate, when moistened with water, dissolve as they are hydrated, forming a supersaturated solution. On the other hand, this same solution deposits crystals of the hydrated sulphate, gradually augment in bulk, and unite together.--_H. Le Chatellier_.

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[Continued from SUPPLEMENT No. 383, page 6118.]

MALARIA.

By JAMES H. SALISBURY, A.M., M.D.

PRIZE ESSAY OF THE ALBANY MEDICAL COLLEGE ALUMNI ASSOCIATION, FEB., 1882.

VII.

I have made careful microscopic examinations of the blood in several cases of Panama fever I have treated, and find in all severe cases many of the colorless corpuscles filled more or less with spores of ague vegetation and the serum quite full of the same spores (see Fig. N, Plate VIII.).

Mr. John Thomas. Panama fever. Vegetation in blood and colorless corpuscles. (Fig N, Plate VIII.) Vegetation, spores of, in the colorless corpuscles of the blood. Spores in serum of blood adhering to fibrin filaments.

Mr. Thomas has charge of the bridge building on the Tehuantepec Railroad. Went there about one year ago. Was taken down with the fever last October. Returned home in February last, all broken down. Put him under treatment March 15, 1882. Gained rapidly (after washing him out with hot water, and getting his urine clear and bowels open every day) on two grains of quinia every day, two hours, till sixteen doses were taken. After an interval of seven days, repeated the quinia, and so on. This fever prevails on all the low lands, as soon as the fresh soil is exposed to the drying rays of the sun. The vegetation grows on the drying soil, and the spores rise in the night air, and fall after sunrise. All who are exposed to the night air, which is loaded with the spores, suffer with the disease. The natives of the country suffer about as badly as foreigners. Nearly half of the workmen die of the disease. The fever is a congestive intermittent of a severe type.

Henry Thoman. Leucocythæmia. Spleen 11 inches in diameter, two white globules to one red. German. Thirty-six years of age. Weight, 180 pounds. Colorless corpuscles very large and varying much in size, as seen at N. Corpuscles filled--many of them--with the spores of ague vegetation. Also spores swimming in serum.

This man has been a gardener back of Hoboken on ague lands, and has had ague for two years preceding this disease.

I will now introduce a communication made to me by a medical gentleman who has followed somewhat my researches for many years, and has taken great pains of time and expense to see if my researches are correct.

REPORT ON THE CAUSE OF AGUE.--BY DR. EPHRAIM CUTTER, TO THE WRITER

At your request I give the evidence on which I base my opinion that your plan in relation to ague is true.

From my very start into the medical profession, I had a natural intense interest in the causes of disease, which was also fostered by my father, the late Dr. Cutter, who honored his profession nearly forty years. Hence, I read your paper on ague with enthusiasm, and wrote to you for some of the plants of which you spoke. You sent me six boxes containing soil, which you said was full of the gemiasmas. You gave some drawings, so that I should know the plants when I saw them, and directed me to moisten the soil with water and expose to air and sunlight. In the course of a few days I was to proceed to collect. I faithfully followed the instructions, but without any success. I could detect no plants whatever,

This result would have settled the case ordinarily, and I would have said that you were mistaken, as the material submitted by yourself failed as evidence. But I thought that there was too much internal evidence of the truth of your story, and having been for many years an observer in natural history, I had learned that it is often very difficult for one to acquire the art of properly making examinations, even though the procedures are of the simplest description. So I distrusted, not you, but myself, and hence, you may remember, I forsook all and fled many hundred miles to you from my home with the boxes you had sent me. In three minutes after my arrival you showed me how to collect the plants in abundance from the very soil in the boxes that had traveled so far backward and forward, from the very specimens on which I had failed to do so.

The trouble was with me--that I went too deep with my needle. You showed me it was simply necessary to remove the slightest possible amount on the point of a cambric needle; deposit this in a drop of clean water on a slide cover with, a covering glass and put it under your elegant 1/5 inch objective, and there were the gemiasmas just as you had described.

I have always felt humbled by this teaching, and I at the time rejoiced that instead of denouncing you as a cheat and fraud (as some did at that time), I did not do anything as to the formation of an opinion until I had known more and more accurately about the subject.

I found all the varieties of the palmellae you described in the boxes, and I kept them for several years and demonstrated them as I had opportunity. You also showed me on this visit the following experiments that I regarded as crucial:

1st. I saw you scrape from the skin of an ague patient sweat and epithelium with the spores and the full grown plants of the Gemiasma verdans.

2d. I saw you take the sputa of a ague patient and demonstrate the spores and sporangia of the Gemiasma verdans.

3d. I saw you take the urine of a female patient suffering from ague (though from motives of delicacy I did not see the urine voided--still I believe that she did pass the urine, as I did not think it necessary to insult the patient), and you demonstrated to me beautiful specimens of Gemiasma rubra. You said it was not common to find the full development in the urine of such cases, but only in the urine of the old severe cases. This was a mild case.

4th. I saw you take the blood from the forearm of an ague patient, and under the microscope I saw you demonstrate the gemiasma, white and bleached in the blood. You said that the coloring matter did not develop in the blood, that it was a difficult task to demonstrate the plants in the blood, that it required usually a long and careful search of hours sometimes, and at other times the plants would be obtained at once.

When I had fully comprehended the significance of the experiments I was filled with joy, and like the converts in apostolic times I desired to go about and promulgate the news to the profession. I did so in many places, notably in New York city, where I satisfactorily demonstrated the plants to many eminent physicians at my room at the Fifth Avenue Hotel; also before a medical society where more than one hundred persons were present. I did all that I could, but such was the preoccupation of the medical gentlemen that a respectful hearing was all I got. This is not to be wondered at, as it was a subject, now, after the lapse of nearly a decade and a half, quite unstudied and unknown. After this I studied the plants as I had opportunity, and in 1877 made a special journey to Long Island, N.Y., for the purpose of studying the plants in their natural habitat, when they were in a state of maturity. I have also examined moist soils in localities where ague is occasionally known, with other localities where it prevails during the warm months.

Below I give the results, which from convenience I divide into two parts: 1st. Studies of the ague plants in their natural habitat. 2d. Studies of the ague plants in their unnatural habitat (parasitic). I think one should know the first before attempting the second.

First--Studies to find in their natural habitat the palmellæ described as the Gemiasma rubra, Gemiasma verdans, Gemiasma plumba, Gemiasma alba, Protuberans lamella.

Second--_Outfit_.--Glass slides, covers, needles, toothpicks, bottle of water, white paper and handkerchief, portable microscope with a good Tolles one inch eyepiece, and one-quarter inch objective.

Wherever there was found on low, marshy soil a white incrustation like dried salt, a very minute portion was removed by needle or toothpick, deposited on a slide, moistened with a drop of water, rubbed up with a needle or toothpick into a uniformly diffused cloud in and through the water. The cover was put on, and the excess of water removed by touching with a handkerchief the edge of the cover. Then the capillary attraction held the cover in place, as is well known. The handkerchief or white paper was spread on the ground at my feet, and the observation conducted at once after the collection and on the very habitat. It is possible thus to conduct observations with the microscope besides in boats on ponds or sea, and adding a good kerosene light in bed or bunk or on lounge.

August 11, 1877.--Excursion to College Point, Flushing, Long Island:

Observation 1. 1:50 P.M. Sun excessively hot. Gathered some of the white incrustation on sand in a marsh west of Long Island Railroad depot. Found some Gemiasma verdans, G. rubra; the latter were dry and not good specimens, but the field swarmed with the automobile spores. The full developed plant is termed sporangia, and seeds are called spores.

Observation 2. Another specimen from same locality, not good; that is, forms were seen but they were not decisive and characteristic.

Observation 3. Earth from Wallabout, near Naval Hospital, Brooklyn, Rich in spores (A) with automobile protoplasmic motions, (B) Gemiasma rubra, (C) G. verdans, very beautiful indeed. Plants very abundant.

Observation 4. Walking up the track east of L. I. R.R. depot, I took an incrustation near creek; not much found but dirt and moving spores.

Observation 5. Seated on long marsh grass I scraped carefully from the stalks near the roots of the grass where the plants were protected from the action of the sunlight and wind. Found a great abundance of mature Gemiasma verdans very beautiful in appearance.

Notes.--The time of my visit was most unfavorable. The best time is when the morning has just dawned and the dew is on the grass. One then can find an abundance, while after the sun is up and the air is hot the plants disappear; probably burst and scatter the spores in billions, which, as night comes on and passes, develop into the mature plants, when they may be found in vast numbers. It would seem from this that the life epoch of a gemiasma is one day under such circumstances, but I have known them to be present for weeks under a cover on a slide, when the slide was surrounded with a bandage wet with water, or kept in a culture box. The plants may be cultivated any time in a glass with a water joint. A, Goblet inverted over a saucer; B, filled with water; C, D, specimen of earth with ague plants.

Observation 6. Some Gemiasma verdaus; good specimens, but scanty. Innumerable mobile spores. Dried.

Observation 7. Red dust on gray soil. Innumerable mobile spores. Dried red sporangia of G. rubra.

Observation 8. White incrustation. Innumerable mobile spores. No plants.

Observation 9. White incrustation. Many minute algæbut two sporangia of a pale pink color; another variety of color of gemiasma. Innumerable mobile spores.

Observation 10. Gemiasma verdans and G. rubra in small quantities. Innumerable mobile spores.

Observation 11. Specimen taken from under the shade of short marsh grass. Gemiasma exceedingly rich and beautiful. Innumerable mobile spores.

Observation 12. Good specimens of Gemiasma rubra. Innumerable spores present in all specimens.

Observation 13. Very good specimens of Protuberans lamella.

Observation 14. The same.

Observation 15. Dead Gemiasma verdans and rubra.

Observation 16. Collection very unpromising by macroscopy, but by microscopy showed many spores, mature specimens of Gemiasma rubra and verdans. One empty specimen with double walls.

Observation 17. Dry land by the side of railroad. Protuberans not abundant.

Observation 18. From side of ditch. Filled with mature Geraiasma verdans.

Observation 19. Moist earth near a rejected timber of the railroad bridge. Abundance of Gemiasma verdans, Sphæotheca Diatoms.

Observation 20. Scrapings on earth under high grass. Large mature specimens of Gemiasma rubra and verdans. Many small.

Observation 21. Same locality. Gemiasma rubra and verdans; good specimens.

Observation 22. A dry stem of a last year’s annual plant lay in the ditch not submerged, that appeared as if painted red with iron rust. This redness evidently made up of Gemiasma rubra dried.

Observation 23. A twig submerged in a ditch was scraped. Gemiasma verdans found abundantly with many other things, which if rehearsed would cloud this story.

Observation 24. Scrapings from the dirty end of the stick (23) gave specimens of the beautiful double wall palmellæ and some empty G. verdans.

Observation 25. Stirred up the littoral margins of the ditch with stick found in the path, and the drip showed Gemiasma rubra and verdans mixed in with dirt, debris, other algae, fungi, infusoria, especially diatoms.

Observation 26. I was myself seized with sneezing and discharge running from nostrils during these examinations. Some of the contents of the right nostril were blown on a slide, covered, and examined morphologically. Several oval bodies, round algae, were found with the characteristics of G. verdans and rubra. Also some colorless sporangia, and spores abundantly present. These were in addition to the normal morphological elements found in the excretions.

Observation 27. Dried clay on margin of the river showed dry G. verdans.

Observation 28. Saline dust on earth that had been thrown out during the setting of a new post in the railroad bridge showed some Gemiasma alba.

Observation 29. The dry white incrustation found on fresh earth near railroad track entirely away from water, where it appeared as if white sugar or sand had been sprinkled over in a fine dust, showed an abundance of automobile spores and dry sporangia of G. rubra and verdans. It was not made up of salts from evaporation.

Observation 30. Some very thick, long, green, matted marsh grass was carefully separated apart like the parting of thick hair on the head. A little earth was taken from the crack, and the Protuberans lamella, the Gemiasma rubra and verdans found were beautiful and well developed.

Observation 31. Brooklyn Naval Hospital, August 12, 1877, 4 A.M. Called up by the Quartermaster. With Surgeon C. W. White, U.S.N., took (A) one five inch glass beaker, bottomless, (B) three clean glass slides, (C) chloride of calcium solution, [symbol: dra(ch)m] i to [symbol: ounce] i water. We went, as near as I could judge in the darkness, to about that portion of the wall that lies west of the hospital, southeast corner (now all filled up), where on the 10th of August previously I had found some actively growing specimens of the Gemiasma verdans, rubra, and protuberans. The chloride of calcium solution was poured into a glass tumbler, then rubbed over the inside and outside of the beaker. It was then placed on the ground, the rim of the mouth coming on the soil and the bottom elevated on an old tin pan, so that the beaker stood inclined at an angle of about forty-five degrees with the horizon. The slides were moistened, one was laid on a stone, one on a clod, and a third on the grass. Returned to bed, not having been gone over ten minutes.

At 6 A.M. collected and examined for specimens the drops of dew deposited. Results: In every one of the five instances collected the automobile spores, and the sporangia of the gemiasmas and the protuberans on both sides of slides and beaker. There were also spores and mycelial filaments of fungi, dirt, and zoospores. The drops of dew were collected with capillary tubes such as were used in Edinburgh for vaccine virus. The fluid was then preserved and examined in the naval laboratory. In a few hours the spores disappeared.

Observation 32. Some of the earth near the site of the exposure referred to in Observation 31, was examined and found to contain abundantly the Gemiasma verdans, rubra, Protuberans lamella, confirmed by three more observations.

Observation 33. In company with Surgeon F. M. Dearborne, U.S.N., in charge of Naval Hospital, the same day later explored the wall about marsh west of hospital. Found the area abundantly supplied with palmellæGemiasma rubra, verdans, and Protuberans lamella, even where there was no incrustation or green mould. Made very many examinations, always finding the plants and spores, giving up only when both of us were overcome with the heat.

Observation 34. August, 1881. Visited the Wallabout; found it filled up with earth. August 17. Visited the Flushing district; examined for the gemiasma the same localities above named, but found only a few dried up plants and plenty of spores. With sticks dug up the earth in various places near by. Early in September revisited the same, but found nothing more; the incrustation, not even so much as before. The weather was continuously for a long time very dry, so much so that vegetables and milk were scarce.

The grass and grounds were all dried up and cracked with fissures.

There must be some moisture for the development of the plants. Perhaps if I had been able to visit the spots in the early morning, it would have been much better, as about the same time I was studying the same vegetation on 165th Street and 10th Avenue, New York, and found an abundance of the plants in the morning, but none scarcely in the afternoon.

Should any care to repeat these observations, these limits should be observed and the old adage about "the early bird catching the worm," etc. Some may object to this directness of report, and say that we should report all the forms of life seen. To this I would say that the position I occupy is much different from yours, which is that of discoverer. When a detective is sent out to catch a rogue, he tumbles himself but little with people or things that have no resemblance to the rogue. Suppose he should return with a report as to the houses, plants, animals, etc., he encountered in his search; the report might be very interesting as a matter of general information, but rather out of place for the parties who desire the rogue caught. So in my search I made a special work of catching the gemiasmas and not caring for anything else. Still, to remove from your mind any anxiety that I may possibly not have understood how to conduct my work, I will introduce here a report of search to find out how many forms of life and substances I could recognize in the water of a hydrant fed by Croton water (two specimens only), during the present winter (1881 and 1882) I beg leave to subjoin the following list of species, not individuals, I was able to recognize. In this list you will see the Gemiasma verdans distinguished from its associate objects. I think I can in no other way more clearly show my right to have my honest opinion respected in relation to the subject in question.

[Illustration: MALARIA PLANTS COLLECTED SEPT. 10, 1882, AT WASHINGTON HEIGHTS, 176TH STREET, NEAR 10TH AVENUE, NEW YORK CITY, ETC.

PLATE VIII.--A, B, C, Large plants of Gemiasma verdans. A, Mature plant. B, Mature plant discharging spores and spermatia through a small opening in the cell wall. C, A plant nearly emptied. D, Gemiasma rubra; mature plant filled with microspores. E, Ripe plant discharging contents. F, Ripe plant, contents nearly discharged; a few active spermatia left behind and escaping. G, nearly empty plant. H, Vegetation in the SWEAT of ague cases during the paroxysm of sweating. I, Vegetation in the BLOOD of ague. J, Vegetation in the urine of ague during paroxysm. K, L, M, Vegetation in the urine of chronic cases of severe congestive type. N, Vegetation in BLOOD of Panama fever; white corpuscles distended with spores of Gemiasma. O, Gemiasma alba. P, Gemiasma rubra. Q, Gemiasma verdans. R, Gemiasma alba. O, P, Q, R, Found June 28,1867, in profusion between Euclid and Superior Streets, near Hudson, Cleveland, O. S, Sporangia of Protuberans.]

List of objects found in the Croton water, winter of 1881 and 1882. The specimens obtained by filtering about one barrel of water:

1. Acineta tuberosa.
2. Actinophrys sol.
3. Amoeba proteus.
4. " radiosa.
5. " verrucosa.
6. Anabaina subtularia.
7. Ankistrodesmus falcatus.
8. Anurea longispinis.
9. " monostylus.
10. Anguillula fluviatilis.
11. Arcella mitrata.
12. " vulgaris.
13. Argulus.
14. Arthrodesmus convergens.
15. Arthrodesmus divergens.
16. Astrionella formosa.
17. Bacteria.
18. Bosmina.
19. Botryiococcus.
20. Branchippus stagnalis.
21. Castor.
22. Centropyxis.
23. Chetochilis.
24. Chilomonads.
25. Chlorococcus.
26. Chydorus.
27. Chytridium.
28. Clatbrocystis æuginosa.
29. Closterium lunula.
30. " didymotocum.
31. " moniliferum.
32. Coelastrum sphericum.
33. Cosmarium binoculatum.
34. Cyclops quad.
35. Cyphroderia amp.
36. Cypris tristriata.
37. Daphnia pulex.
38. Diaptomas castor.
39. " sull.
40. Diatoma vulgaris.
41. Difflugia cratera.
42. " globosa.
43. Dinobryina sertularia.
44. Dinocharis pocillum.
45. Dirt.
46. Eggs of polyp.
47. " entomostraca.
48. " plumatella.

49. " bryozoa.
50. Enchylis pupa.
51. Eosphora aurita.
52. Epithelia, animal.
53. " vegetable.
54. Euastrum.
55. Euglenia viridis.
56. Euglypha.
57. Eurycercus lamellatus.
58. Exuvia of some insect.
59. Feather barbs.
60. Floscularia.
61. Feathers of butterfly.
62. Fungu, red water.
63. Fragillaria.
64. Gemiasma verdans.
65. Gomphospheria.
66. Gonium.
67. Gromia.
68. Humus.
69. Hyalosphenia tinctad.
70. Hydra viridis.
71. Leptothrix.
72. Melosira.
73. Meresmopedia.
74. Monactina.
75. Monads.
76. Naviculæ
77. Nitzschia.
78. Nostoc communis.
79. OEdogonium.
80. Oscillatoriaceæ
81. Ovaries of entomostraca.
82. Pandorina morum.
83. Paramecium aurelium.
84. Pediastrum boryanum.
85. " incisum.
86. " perforatum.
87. " pertusum.
88. " quadratum.
89. Pelomyxa.
90. Penium.
91. Peredinium candelabrum.
92. Peredinium cinc.
93. Pleurosigma angulatum.
94. Plumatella.
95. Plagiophrys.
96. Playtiptera polyarthra.
97. Polycoccus.
98. Pollen of pine.
99. Polyhedra tetraºtzica.
100. " triangularis.
101. Polyphema.

102. Protococcus.
103. Radiophrys alba.
104. Raphidium duplex.
105. Rotifer ascus.
106. " vulgaris.
107. Silica.
108. Saprolegnia.
109. Scenedesmus acutus.
110. " obliquus.
111. " obtusum.
112. " quadricauda.
113. Sheath of tubelaria.
114. Sphærotheca spores.
115. Spirogyra.
116. Spicules of sponge.
117. Starch.
118. Staurastrum furcigerum.
119. " gracile.
120. Staurogenum quadratum.
121. Surirella.
122. Synchoeta.
123. Synhedra.
124. Tabellaria.
125. Tetraspore.
126. Trachelomonas.
127. Trichodiscus.
128. Uvella.
129. Volvox globator.
130. " sull.
131. Vorticel.
132. Worm fluke.
133. Worm, two tailed.
134. Yeast.

More forms were found, but could not be determined by me. This list will give an idea of the variety of forms to be met with in the hunt for ague plants; still, they are as well marked in their physical characters as a potato is among the objects of nature. Although I know you are perfectly familiar with algæ, still, to make my report more complete, in case you should see fit to have it pass out of your hands to others, allow me to give a short account of the Order Three of Algæ, namely, the Chlorosporeæ, or Confervoid Algæ, derived from the Micrographic Dictionary, this being an accessible authority.

Algae form a class of the thallophytes or cellular plants in which the physiological functions of the plant are delegated most completely to the individual cell. That is to say, the marked difference of purpose seen in the leaves, stamens, seeds, etc., of the phanerogams or flowering plants is absent here, and the structures carrying on the operations of nutrition and those of reproduction are so commingled, conjoined, and in some cases identified, that a knowledge of the microscopic anatomy is indispensable even to the roughest conception of the natural history of these plants; besides, we find these plants so simple that we can see through and through them while living in a natural condition, and by means of the microscope penetrate to mysteries of organism, either altogether inaccessible, or only to be attained by disturbing and destructive dissection, in the so called higher forms of vegetation. We say "so-called" advisedly, for in the Algæ are included the largest forms of plant life.

The Macrocystis pyrifera, an Algæ, is the largest of all known plants. It is a sea weed that floats free and unattached in the ocean. Covers the area of two square miles, and is 300 feet in depth (Reinsch). At the same time its structure on examination shows it to belong to the same class of plants as the minute palmellæ which we have been studying. Algæ are found everywhere in streams, ditches, ponds, even the smallest accumulations of water standing for any time in the open air, and commonly on walls or the ground, in all permanently damp situations. They are peculiarly interesting in regard to morphological conditions alone, as their great variety of conditions of organization are all variations, as it were, on the theme of the simple vegetable cell produced by change of form, number, and arrangement.

The Algæ comprehend a vast variety of plants, exhibiting a wonderful multiplicity of forms, colors, sizes, and degrees of complexity of structure, but algologists consider them to belong to three orders: 1. Red spored Algæ, called Rhodosporeæ or florideæ. 2. The dark or black spored Algæ, or Melanosporeæ or Fucoideæ. 3. The green spored Algæ, or Chlorosporeæ or Confervoideæ. The first two classes embrace the sea-weeds. The third class, marine and aquatic plants, most of which when viewed singly are microscopic. Of course some naturalists do not agree to these views. It is with order three, Confervoideæ, that we are interested. These are plants growing in sea or fresh water, or on damp surfaces, with a filamentous, or more rarely a leaf-like pulverulent or gelatinous thallus; the last two forms essentially microscopic. Consisting frequently of definitely arranged groups of distinct cells, either of ordinary structure or with their membrane silicified--Diatomaceæ. We note three forms of fructification: 1. Resting spores produced after fertilization either by conjugation or impregnation. 2. Spermatozoids. 3. Zeospores; 2, 4, or multiciliated active automobile cells--gonidia--discharged from the mother cells or plants without impregnation, and germinating directly. There is also another increase by cell division.

SYNOPSIS OF THE FAMILIES.

1. _Lemaneæ_.--Frond filamentous, inarticulate, cartilaginous, leathery, hollow, furnished at irregular distances with whorls or warts, or necklace shaped. Fructification: tufted, simple or branched, necklace shaped filaments attached to the inner surface of the tubular frond, and finally breaking up into elliptical spores. Aquatic.

2. _Batrachospermeæ_--Plants filamentous, articulated, invested with gelatine. Frond composed of aggregated, articulated, longitudinal cells, whorled at intervals with short, horizontal, cylindrical or beaded,

jointed ramuli. Fructification: ovate spores and tufts of antheridial cells attached to the lateral ramuli, which consist of minute, radiating, dichotomous beaded filaments. Aquatic.

3. _Chaetophoraceæ_.--Plants growing in the sea or fresh water, coated by gelatinous substance; either filiform or a number of filaments being connected together constituting gelatinous, definitely formed, or shapeless fronds or masses. Filaments jointed, bearing bristle-like processes. Fructification: zoospores produced from the cell contents of the filaments; resting spores formed from the contents of particular cells after impregnation by ciliated spermatozoids produced in distinct antheridial cells. Coleochæte

4. _Confervaceæ_.--Plants growing in the sea or in fresh water, filamentous, jointed, without evident gelatine (forming merely a delicate coat around the separate filaments) Filaments very variable in appearance, simple or branched; the cells constituting the articulations of the filaments more or less filled with green, or very rarely brown or purple granular matter; sometimes arranged in peculiar patterns on the walls, and convertible into spores or zoospores. Not conjugating.

5. _Zygnemaceæ_.--Aquatic filamentous plants, without evident gelatine, composed of series of cylindrical cells, straight or curved. Cell contents often arranged in elegant patterns on the walls. Reproduction resulting from conjugation, followed by the development of a true spore, in some genera dividing into four sporules before germinating.

6. _OEdogoniaceæ_.--Simple or branched aquatic filamentous plants attached without gelatine. Cell contents uniform, dense, cell division accompanied by circumscissile debiscence of the parent cell, producing rings on the filaments. Reproduction by zoospores formed of the whole contents of a cell, with a crown of numerous cilia; resting spores formed in sporangial cells after fecundation by ciliated spermatozoids formed in antheridial cells.

7. _Siphonaceæ_--Plants found in the sea, fresh water, or on damp ground; of a membranous or horny byaline substance, filled with green or colorless granular matter. Fronds consisting of continuous tubular filaments, either free or collected into spongy masses of various shapes. Crustaceous, globular, cylindrical, or flat. Fructification: by zoospores, either single or very numerous, and by resting spores formed in sporangial cells after the contents have been impregnated by the contents of autheridial cells of different forms.

8 _Oscillatoriaceæ_.--Plants growing either in the sea, fresh water, or on damp ground, of a gelatinous substance and filamentous structure. Filaments very slender, tubular, continuous, filled with colored, granular, transversely striated substance; seldom blanched, though often cohering together so as to appear branched; usually massed together in broad floating or sessile strata, of a very gelatinous nature; occasionally erect and tufted, and still more rarely collected into radiating series bound together by firm gelatine and then forming globose lobed or flat crustaceous fronds. Fructification: the internal

mass or contents separating into roundish or lenticular gonidia.

9. _Nostochacæ_.--Gelatinous plants growing in fresh water, or in damp situations among mosses, etc.; of soft or almost leathery substance, consisting of variously curled or twisted necklace-shaped filaments, colorless or green, composed of simple, or in some stages double rows of cells, contained in a gelatinous matrix of definite form, or heaped together without order in a gelatinous mass. Some of the cells enlarged, and then forming either vesicular empty cells or densely filled sporangial cells. Reproduction: by the breaking up of the filaments, and by resting spores formed singly in the sporanges.

10. _Ulvaceæ_.--Marine or aquatic algae consisting of membranous, flat, and expanded tubular or saccate fronds composed of polygonal cells firmly joined together by their sides.

Reproduced by zoospores formed from the cell contents and breaking out from the surface, or by motionless spores formed from the whole contents.

11. _Palmellaceæ_.--Plants forming gelatinous or pulverulent crusts on damp surfaces of stone, wood, earth, mud, swampy districts, or more or less regular masses of gelatinous substance or delicate pseudo-membranous expansion or fronds, of flat, globular, or tubular form, in fresh water or on damp ground; composed of one or many, sometimes innumerable, cells, with green, red, or yellowish contents, spherical or elliptical form, the simplest being isolated cells found in groups of two, four, eight, etc., in course of multiplication. Others permanently formed of some multiple of four; the highest forms made up of compact, numerous, more or less closely joined cells. Reproduction: by cell division, by the conversion of the cell contents into zoospores, and by resting spores, formed sometimes after conjugation; in other cases, probably, by fecundation by spermatozoids. All the unicellular algæare included under this head.

12. _Desmidiaceæ_.--Microscopic gelatinous plants, of a screen color, growing in fresh water, composed of cells devoid of a silicious coat, of peculiar forms such as oval, crescentic, shortly cylindrical, cylindrical, oblong, etc., with variously formed rays or lobes, giving a more or less stellate form, presenting a bilateral symmetry, the junction of the halves being marked by a division of the green contents; the individual cells being free, or arranged in linear series, collected into fagot-like bundles or in elegant star like groups which are embedded in a common gelatinous coat. Reproduced by division and by resting spores produced in sporangia formed after the conjugation of two cells and union of their contents, and by zoospores formed in the vegetative cells or in the germinating resting spores.

13. _Diatomaceæ_.--Microscopic cellular bodies, growing in fresh, brackish, and sea water: free or attached, single, or embedded in gelatinous tubes, the individual cells (frustules) with yellowish or brown contents, and provided with a silicious coat composed of two usually symmetrical valves variously marked, with a connecting band or

hoop at the suture. Multiplied by division and by the formation of new larger individuals out of the contents of individual conjugated cells; perhaps also by spores and zoospores.

14. _Volvocineæ_.--Microscopic cellular fresh water plants, composed of groups of bodies resembling zoospores connected into a definite form by their enveloping membranes. The families are formed either of assemblages of coated zoospores united in a definite form by the cohesion of their membranes, or assemblages of naked zoospores inclosed in a common investing membrane. The individual zoospore-like bodies, with two cilia throughout life, perforating the membranous coats, and by their conjoined action causing a free co-operative movement of the whole group. Reproduction by division, or by single cells being converted into new families; and by resting spores formed from some of the cells after impregnation by spermatozoids formed from the contents of other cells of the same family.

[Illustration: MALARIA PLANTS COLLECTED AT 165TH STREET, EAST OF 10TH AVENUE, OCT., 1881.

Plate IX.--Large group of malaria plants, Gemiasma verdans, collected at 165th Street, east of 10th Avenue, New York, in October, 1881, by Dr. Ephraim Cutter, and projected by him with a solar microscope. Dr. Cuzner--the artist--outlined the group on the screen and made the finished drawing from the sketch. He well preserved the grouping and relative sizes. The pond hole whence they came was drained in the spring of 1882, and in August was covered with coarse grass and weeds. No plants were found there in satisfactory quantity, but those figured on Plate VIII. were found half a mile beyond. This shows how draining removes the malaria plants.]

From the description I think you have placed your plants in the right family. And evidently they come in the genera named, but at present there is in the authorities at my command so much confusion as to the genera, as given by the most eminent authorities, like Nageli, Kutzing, Braun Rabenht, Cohn, etc., that I think it would be quite unwise for me to settle here, or try to settle here, questions that baffle the naturalists who are entirely devoted to this specialty. We can safely leave this to them. Meantime let us look at the matter as physicians who desire the practical advantages of the discovery you have made. To illustrate this position let us take a familiar case. A boy going through the fields picks and eats an inedible mushroom. He is poisoned and dies. Now, what is the important part of history here from a physician’s point of view? Is it not that the mushroom poisoned the child? Next comes the nomenclature. What kind of agaricus was it? Or was it one of the gasteromycetes, the coniomycetes, the hyphomycetes, the ascomycetes, or one of the physomycetes? Suppose that the fungologists are at swords’ points with each other about the name of the particular fungus that killed the boy? Would the physicians feel justified to sit down and wait till the whole crowd of naturalists were satisfied, and the true name had been settled satisfactorily to all? I trow not; they would warn the family about eating any more; and if the case had not yet perished, they would let the nomenclature go and try all the means that history, research, and instructed common sense would suggest for the recovery.

This leads me here to say that physicians trust too much to the simple dicta of men who may be very eminent in some department of natural history, and yet ignorant in the very department about which, being called upon, they have given an opinion. All everywhere have so much to learn that we should be very careful how we reject new truths, especially when they come from one of our number educated in our own medical schools, studied under our own masters. If the subject is one about which we know nothing, we had better say so when asked our opinion, and we should receive with respect what is respectfully offered by a man whom we know to be honest, a hard worker, eminent in his department by long and tedious labors. If he asks us to look over his evidence, do so in a kindly spirit, and not open the denunciations of bar room vocabularies upon the presenter, simply because we don't see his point. In other words, we should all be receptive, but careful in our assimilation, remembering that some of the great operations in surgery, for example, came from laymen in low life, as the operation for stone, and even the operation of spaying came from a swineherd.

It is my desire, however, to have this settled as far as can be among scientists, but for the practical uses of practicing physicians I say that far more evidence has been adduced by you in support of the cause of intermittent fever than we have in the etiology of many other diseases. I take the position that so long as no one presents a better history of the etiology of intermittent fever by facts and observations, your theory must stand. This, too, notwithstanding what may be said to the contrary.

Certainly you are to be commended for having done as you have in this matter. It is one of the great rights of the profession, and duties also, that if a physician has or thinks he has anything that is new and valuable, to communicate it, and so long as he observes the rules of good society the profession are to give him a respectful hearing, even though he may have made a mistake. I do not think you had a fair hearing, and hence so far as I myself am concerned I indorse your position, and shall do so till some one comes along and gives a better demonstration. Allow me also to proceed with more evidence.

Observation at West Falmouth, Mass., Sept 1, 1877. I made five observations in like manner about the marshes and bogs of this town, which is, as it were, situated on the tendo achillis of Cape Cod, Mass. In only one of these observations did I find any palmellæ like the ague plants, and they were not characteristic.

Chelsea, Mass., near the Naval Hospital, September 5, 1877. Three sets of observations. In all spores were found and some sporangia, but they were not the genuine plants as far as I could judge. They were Protococcaceæ. It is not necessary to add that there are no cases of intermittent fever regarded as originating on the localities named. Still, the ancient history of New England contains some accounts of ague occurring there, but they are not regarded as entirely authentic.

Observation. Lexington, Mass, September 6, 1877. Observation made in a meadow. There was no saline incrustation, and no palmellæ found. No local malaria.

Observation. Cambridge, Mass. Water works on the shore of Fresh Pond. Found a few palmellæ analogous to, but not the ague palmellæ

Observation. Woburn, Mass, September 27, 1877, with Dr. J. M. Moore. Found some palmellæ but scanty. Abundance of spores of cryptogams.

Observation. Stonington, Conn., August 15, 1877. Examined a pond hole nearly opposite the railroad station on the New York Shore Line. Found abundantly the white incrustation on the surface of the soil. Here I found the spores and the sporangias of the gemiasmas verdans and rubra.

Observation 2. Repetition of the last.

Observation 3. I examined some of an incrustation that was copiously deposited in the same locality, which was not white or frosty, but dark brown and a dirty green. Here the spores were very abundant, and a few sporangias of the Gemiasma rubra. Ague has of late years been noted in Connecticut and Rhode Island.

Observations in Connecticut. Middlefield near Middletown, summer of 1878. Being in this locality, I heard that intermittent fever was advancing eastward at the rate of ten miles a year. It had been observed in Middlefield. I was much interested to see if I could find the gemiasmas there. On examining the dripping of some bog moss, I found a plenty of them.

Observations in Connecticut. New Haven. Early in the summer of 1881 I visited this city. One object of my visit was to ascertain the truth of the presence of intermittent fever there, which I had understood prevailed to such an extent that my patient, a consumptive, was afraid to return to his home in New Haven. At this time I examined the hydrant water of the city water works, and also the east shore of the West River, which seemed to be too full of sewage. I found a plenty of the Oscillatoreaceæ but no Palmellæ

In September I revisited the city, taking with me a medical gentleman who, residing in the South, had had a larger experience with the disease than I. From the macroscopical examination he pronounced a case we examined to be ague, but I was not able to detect the plants either in the urine or blood. This might have been that I did not examine long enough. But a little later I revisited the city and explored the soil about the Whitney Water Works, whence the city gets its supply of water, and I had no difficulty in finding a good many of the plants you describe as found by you in ague cases. At a still later period my patient, whom I had set to use the microscope and instructed how to collect the ague plants, set to work himself. One day his mother brought in a film from off an ash pile that lay in the shade, and this her son found was made up of an abundance of the ague plants. By simply winding a wet bandage around the slide, Mr. A. was enabled to keep the plants in good condition until the time of my next visit, when I examined and pronounced them to be genuine plants.

I should here remark that I had in examining the sputa of this patient sent to me, found some of the ague plants. He said that he had been riding near the Whitney Pond, and perceived a different odor, and thought he must have inhaled the miasm. I told him he was correct in his supposition, as no one could mistake the plants; indeed, Prof. Nunn, of Savannah, Ga., my pupil recognized it at once.

This relation, though short, is to me of great importance. So long as I could not detect the gemiasmas in New Haven, I was very skeptical as to the presence of malaria in New Haven, as I thought there must be some mistake, it being a very good cloak to hide under (malaria). There is no doubt but that the name has covered lesions not belonging to it. But now the positive demonstrations above so briefly related show to my mind that the local profession have not been mistaken, and have sustained their high reputation.

I should say that I have examined a great deal of sputa, but, with the exception of cases that were malarious, I have not encountered the mature plants before. Of course I have found them as you did, in my own excretions as I was traveling over ague bogs.

[_To be continued_.]

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ICHTHYOL.

DR. P.G. UNNA, of Hamburg, has lately been experimenting on the dermato therapeutic uses of a substance called ichthyol, obtained by Herr Rudolph Schroter by the distillation of bituminous substances and treatment with condensed sulphuric acid. This body, though tar-like in appearance, and with a peculiar and disagreeable smell of its own, does not resemble any known wood or coal tar in its chemical and physical properties. It has a consistence like vaseline, and its emulsion with water is easily washed off the skin. It is partly soluble in alcohol, partly in ether with a changing and lessening of the smell, and totally dissolves in a mixture of both. It may be mixed with vaseline, lard, or oil in any proportions. Its chemical constitution is not well established, but it contains sulphur, oxygen, carbon, hydrogen, and also phosphorus in vanishing proportions, and it may be considered comparable with a 10 per cent, sulphur salve. Over ordinary sulphur preparations it has this advantage, that the sulphur is in very intimate and stable union, so that ichthyol can be united with lead and mercury preparations without decomposition. Ichthyol when rubbed undiluted on the normal skin does not set up dermatitis, yet it is a resolvent, and in a high degree a soother of pain and itching. In psoriasis it is a fairly good remedy, but inferior to crysarobin in P. inveterata. It is useful also locally in rheumatic affections as a resolvent and anodyne, in acne, and as a parasiticide. The most remarkable effects, however, were met with in eczema, which was cured in a surprisingly short time. From an experience in the treatment of thirty cases of different kinds--viz., obstinate circumscribed moist patches on the hands and arms, intensely itching papular eczema of the flexures and face, infantile moist eczemas, etc.--he recommends the following procedure. As with sulphur preparations, he begins with a moderately strong preparation, and as he proceeds reduces the strength of the application. For moist eczema weaker preparations (20 to 30 per cent. decreased to 10 per cent.) must be used than for the papular condition (50 per cent. reduced to 20 per cent.), and the hand, for example, will require a stronger application than the face, and children a weaker one than adults; but ichthyol may be used in any strength from a 5 per cent. to a 40 to 50 per cent. application or undiluted. For obstinate eczema of the hands the following formula is given as very efficacious: R. Lithargyri 10.0; coq.c. aceti, 30.0; ad reman. 20.0; adde olei olivar., adipis, aa 10.0; ichthyol 10.0, M. ft. ung. Until its internal effects are better known, caution is advised as to its very widespread application, although Herr Schroter has taken a gramme with only some apparent increase of peristalsis and appetite.--_Lancet_.

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AUTOPSY TABLE.

The illustration represents an autopsy table placed in the Coroner’s Department of the New York Hospital, designed by George B. Post and Frederick C. Merry.

An amphitheater, fitted up for the convenience of the jury and those interested when inquests are held, surrounds the table, which is placed in the center of the floor, thus enabling the subject to be viewed by the coroner’s jury and other officials who may be present.

The mechanical construction of this table will be readily understood by the following explanation:

The top, indicated by letter, A, is made of thick, heavy, cast glass, concaved in the direction of the strainer, as shown. It is about eight feet long and two feet and six inches wide, in one piece, an opening being left in the center to receive the strainer, so as to allow the fluid matter of the body, as well as the water with which it is washed, to find its way to the waste pipe below the table, and thus avoid soiling or staining the floor,

The strainer is quite large, with a downward draught which passes through a large flue, as shown by letter, F, connected above the water seal of the waste trap and trunk of the table to the chimney of the boiler house, as indicated by the arrows, carrying down all offensive odors from the body, thereby preventing the permeating of the air in the room.

[Illustration: IMPROVED AUTOPSY TABLE.]

The base of the table, indicated by letter, B, represents a ground swinging attachment, which enables the turning of the table in any direction.

D represents the cold water supply cock and handle, intersecting with letter, E, which is the hot water cock, below the base, as shown, and then upward to a swing or ball joint, C, then crossing under the plate glass top to the right with a hose attachment for the use of the operator. Here a small hose pipe is secured, for use as may be required in washing off all matter, to insure the clean exposure of the parts to be dissected. The ball swing, C, enables the turning of the table in any direction without disturbing the water connections. This apparatus has been in operation since the building of the hospital in 1876, and has met all the requirements in connection with its uses.--_Hydraulic Plumber_.

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THE EXCITING PROPERTIES OF OATS.

Experiments have been recently made by Mr. Sanson with a view to settling the question whether oats have or have not the excitant property that has been attributed to them. The nervous and muscular excitability of horses was carefully observed with the aid of graduated electrical apparatus before and after they had eaten a given quantity of oats, or received a little of a certain principle which Mr. Sanson succeeded in isolating from oats. The chief results of the inquiry are as follows: The pericarp of the fruit of oats contains a substance soluble in alcohol and capable of exciting the motor cells of the nervous system. This substance is not (as some have thought) vanilline or the odorous principle of vanilla, nor at all like it. It is a nitrogenized matter which seems to belong to the group of alkaloids; is uncrystallizable, finely granular, and brown in mass. The author calls it "avenine." All varieties of cultivated oats seem to elaborate it, but they do so in very different degrees. The elaborated substance is the same in all varieties. The differences in quantity depend not only on the variety of the plant but also on the place of cultivation. Oats of the white variety have much less than those of the dark, but for some of the former, in Sweden, the difference is small; while for others, in Russia, it is considerable. Less than 0.9 of the excitant principle per cent. of air-dried oats, the dose is insufficient to certainly affect the excitability of horses, but above this proportion the excitant action is certain. While some light-colored oats certainly have considerable excitant power, some dark oats have little. Determination of the amount of the principle present is the only sure basis of appreciation, though (as already stated) white oats are likely to be less exciting than dark. Crushing or grinding the grain weakens considerably the excitant property, probably by altering the substance to which it is due; the excitant action is more prompt, but much less strong and durable. The action, which is immediate and more intense with the isolated principle, does not appear for some minutes after the eating of oats; in both cases it increases to a certain point, then diminishes and disappears. The total duration of the effect is stated to be an hour per kilogramme of oats ingested.

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FILARIA DISEASE.

The rapid strides which our knowledge has made during the past few years in the subject of the filaria parasite have been mainly owing to the diligent researches of Dr. Patrick Manson, who continues to work at the question. In the last number of the _Medical Reports for China_, Dr. Manson deals with the phenomenon known as "filarial periodicity," and with the fate of embryo parasites not removed from the blood. The intimate pathology of the disease, and the subject of abscess caused by the death of the parent filaria, also receive further attention.
An endeavor to explain the phenomenon of "filarial periodicity" by an appeal to the logical "method of concomitant variations" takes Manson into an interesting excursion which is not productive of any positive results; nor is any more certain conclusion come to with regard to the fate of the embryos which disappear from the blood during the day time. Manson does not incline to the view that there is a diurnal intermittent reproduction of embryos with a corresponding destruction. An original and important speculation is made with respect to the intimate pathology of elephantiasis, chyluria, and lymph scrotum, which is thoroughly worthy of consideration. Our readers are probably aware that the parent filaria and the filaria sanguinis hominis may exist in the human body without entailing any apparent disturbance. The diameter of an embryo filaria is about the same as that of a red blood disk, one three-thousandth of an inch. The dimensions of an ovum are one seven-hundred-and-fiftieth by one five-hundredth of an inch. If we imagine the parent filaria located in a distal lymphatic vessel to abort and give birth to ova instead of embryos, it may be understood that the ova might be unable to pass such narrow passages as the embryo could, and this is really the hypothesis which Manson has put forward on the strength of observations made on two cases. The true pathology of the elephantoid diseases may thus be briefly summarized: A parent filaria in a distant lymphatic prematurely expels her ova; these act as emboli to the nearest lymphatic glands, whence ensues stasis of lymph,

regurgitation of lymph, and partial compensation by anastomoses of lymphatic vessels; this brings about hypertrophy of tissues, and may go on to lymphorrhoea or chyluria, according to the site of the obstructed lymphatics. It may be objected that too much is assumed in supposing that the parent worm is liable to miscarry. But as Manson had sufficient evidence in two cases that such abortions had happened, he thinks it is not too much to expect their more frequent occurrence. The explanation given of the manner in which elephantoid disease is produced applies to most, if not all, diseases, with one exception, which result from the presence of the parasite in the human body. The death of the parent parasite in the afferent lymphatic may give rise to an abscess, and the frequency with which abscess of the scrotum or thigh is met with in Chinese practice is, in Manson's opinion, attributable to this. Dr. Manson's report closes with an account of a case of abscess of the thigh, with varicose inguinal glands, in which fragments of a mature worm were discovered in the contents of the abscess.--_Lancet_.

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THE SPECTRAL MASDEVALLIA.

(_M. chimæra_.)

Of all orchids no genus we can just now call to mind is more distinct or is composed of species more widely divergent in size, form, structure, and color than is this one of Masdevallia. It was founded well nigh a century ago by Ruiz and Pavon on a species from Mexico, M. uniflora. which, so far as I know, is nearly if not quite unknown to present day cultivators. When Lindley wrote his "Genera and Species" in 1836, three species of Masdevallias only were known to botanists but twenty-five years later, when he prepared his "Folio Orchidaceæ" nearly forty species were; known in herbaria, and to-day perhaps fully a hundred kinds are grown in our gardens, while travelers tell us of all the gorgeous beauties which are known to exist high up on the cloud-swept sides of the Andes and Cordilleras of the New World. The Masdevallia is confined to the Western hemisphere alone, and as in bird and animal distribution, so in the case of many orchids we find that when any genus is confined to one hemisphere, those who look for another representative genus in the other are rarely disappointed. Thus hornbills in the East are represented by toucans in the West, and the humming bird of the West by the sunbird of the East, and so also in the Malayan archipelago. Notably in Borneo we find bolbophyls without pseudo bulbs, and with solitary or few flowered scapes and other traits singularly suggestive at first sight of the Western Masdevallia. Thus some bolbophyl, for example, have caudal appendages to their sepals, as in Masdevallias, and on the other hand some Masdevallias have their labellums hinged and oscillatory, which is so commonly the case as to be "almost characteristic" in the genus Bolbophyllum or Sarcopodium. Speaking generally, Masdevallias, coming as most of them do from high altitudes, lend themselves to what is now well known as "cool treatment," and cultivators find it equally necessary to offer them moisture in abundance both at the root and in the atmosphere, also seeing that when at home in cloud-land they are often and well nigh continually drenched by heavy dews and copious showers.

Of all the cultivated Masdevallias, none are so weirdly strange and fascinating as is the species M. chimæra, which is so well illustrated in the accompany engraving. This singular plant was discovered by Benedict Roezl, and about 1872 or 1873 I remember M. Lucien Linden calling upon me one day, and among other rarities showing me a dried flower of this species. I remember I took up a pen and rapidly made a sketch of the flower, which soon after appeared (1873, p. 3) in _The Florist_, and was perhaps the first published figure of the plant. It was named by Professor Reichenbach, who could find for it no better name than that of the mythical monster Chimæra, than which, as an old historian tells us, no stranger bogy ever came out of the earth’s inside. Our engraving shows the plant about natural size, and indicates the form and local coloring pretty accurately. The ground color is yellowish, blotched with lurid brownish crimson, the long pendent tails being blood color, and the interior of the sepals are almost shaggy. The spectral appearance of the flower is considerably heightened by the smooth, white, slipper-like lip, which contrasts so forcibly in color and texture with the lurid shagginess around it. Sir J. D. Hooker, in describing this species in the _Botanical Magazine_, t. 6, 152, says that the aspect of the curved scape as it bears aloft its buds and hairy flowers is very suggestive of the head and body of a viper about to strike. Dr. Haughton, F.R.S., told me long ago that Darlingtonia californica always reminds him of a cobra when raised and puffed out in a rage, and certainly the likeness is a close one.

Grown in shallow teak wood baskets, suspended near the roof in a partially shaded structure, all the chimæroid section of Masdevallia succeed even better than when grown in pots or pans, as they have a Stanhopea-like habit of pushing out their flowers at all sorts of deflected angles. A close glance at the engraving will show that for convenience sake the artist has propped up the flower with a stick, this much arrangement being a necessity, so as to enable the tails to lie diagonally across the picture. From tip to tip the flower represented is 9 inches, or not so much by 7 inches as the flower measured in Messrs. Backhouse’s nursery at York.--_The Garden_.

[Illustration: THE SPECTRAL MASDEVALLIA.--MASDEVALLIA CHIMÆRA (Natural Size)]

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SURVEY OF THE BLACK CAÑON.

It is rumored again that a survey is soon to be made through the heaviest portion of the Black Canon of the Gunnison. For a long distance the walls of syenite rise to the stupendous height of 3,000 feet, and for 1,800 feet the walls of the caæon are arched not many feet from the bed of the river. If the survey is successful, and the Denver and Rio Grande is built through the caæon, it will undoubtedly be the grandest piece of engineering on the American continent. The river is very swift, and it is proposed to build a boat at the western end, and provision it for a length of time, allowing it to float with the stream, but controlled by ropes. If the boat goes, the chances are that the baby road goes, too.--_Gunnison (Colo.) Review_.

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THE ANCIENT MISSISSIPPI AND ITS TRIBUTARIES.

[Footnote: This lecture was delivered in the Chapel of the State University, at Columbia, as an inaugural address on January 10, 1883, and illustrated by projections. The author has purposely avoided the very lengthy details of scientific observation by which the conclusions have been arrived at relating to the former wonderful condition of the Mississippi, and the subsequent changes to its present form: as a consideration of them would not only cause him to go beyond the allotted time, but might, perhaps, prove tiresome.]

By J. W. SPENCER, B.A.Sc., Ph.D., F.G.S., Professor of Geology in the State University of Missouri.

Physical geology is the science which deals with the past changes of the earth's crust, and the causes which have produced the present geographical features, everywhere seen about us. The subject of the present address must therefore be considered as one of geology rather than of geography, and I propose to trace for you the early history of the great Mississippi River, of which we have only a diminished remnant of the mightiest river that ever flowed over any terrestrial continent.

By way of introduction, I wish you each to look at the map of our great river, with its tributaries as we now see it, draining half of the central portion of the continent, but which formerly drained, in addition, at least two of our great lakes, and many of the great rivers at the present time emptying into the colder Arctic Sea.

Let us go back, in time, to the genesis of our continent. There was once a time in the history of the earth when all the rocks were in a molten condition, and the waters of our great oceans in a state of vapor, surrounding the fiery ball. Space is intensely cold. In course of time the earth cooled off, and on the cold, solid crust geological agencies began to work. It is now conceded by the most accomplished physicists that the location of the great continents and seas was determined by the original contraction and cooling of the earth's crust; though very greatly modified by a long succession of changes, produced by the agencies of "water, air, heat, and cold," through probably a hundred million of years, until the original rock surface of the earth has been worked over to a depth of thirty or forty miles.

Like human history, the events of these long _æons_ are divided into periods. The geologist divides the past history of the earth and its inhabitants into five Great Times; and these, again, into ages, periods, epochs, and eras.

At the close of the first Great Time--called Archæan--the continent south of the region of the great lakes, excepting a few islands, was still submerged beneath a shallow sea, and therefore no portion of the Mississippi was yet in existence. At the close of the second great geological Time--the Palæozoic--the American continent had emerged sufficiently from the ocean bed to permit the flow of the Ohio, and of the Mississippi, above the mouth of the former river, although they were not yet united.

Throughout the third great geological Time--the Mesozoic--these rivers grew in importance, and the lowest portions of the Missouri began to form a tributary of some size. Still the Ohio had not united with the Mississippi, and both of these rivers emptied into an arm of the Mexican Gulf, which then reached to a short distance above what is now their junction.

In point of time, the Ohio is probably older than the Mississippi, but the latter river grew and eventually absorbed the Ohio as a tributary.

In the early part of the fourth great geological Time--the Cenozoic--nearly the whole continent was above water. Still the Gulf of Mexico covered a considerable portion of the extreme Southern States, and one of its bays extended as far north as the mouth of the Ohio, which had not yet become a tributary of the Mississippi. The Missouri throughout its entire length was at this time a flowing river.

I told you that the earth's crust had been worked over to a depth of many miles since geological time first commenced. Subsequently, I have referred to the growth of the continent in different geological periods. All of our continents are being gradually worn down by the action of rains, rills, rivulets, and rivers, and being deposited along the sea margins, just as the Mississippi is gradually stretching out into the Gulf, by the deposition of the muds of the delta. This encroachment on the Gulf of Mexico may continue, yea, doubtless will, until that deep body of water shall have been filled up by the remains of the continent, borne down by the rivers; for the Mississippi alone carries annually 268 cubic miles of mud into the Gulf, according to Humphreys and Abbot. This represents the valley of the Mississippi losing one foot off its whole surface in 6,000 years. And were this to continue without any elevation of the land, the continent would all be buried beneath the sea in a period of about four and a half million years. But though this wasting is going on, the continent will not disappear, for the relative positions of the land and water are constantly changing; in some cases the land is undergoing elevation, in others, subsidence. Prof. Hilgard has succeeded in measuring known changes of level, in the lower Mississippi Valley, and records the continent as having been at least 450 feet higher than at present (and if we take the coast survey soundings, it seems as if we might substitute 3,000 feet as the elevation), and subsequently at more than 450 feet lower, and then the change back to the present elevation.

Let us now study the history of the great river in the last days of the Cenozoic Time, and early days of the fifth and last great Geological Time, in which we are now living--the Quaternary, or Age of Man--an epoch which I have called _the "Great River Age_."

It is to the condition of the Mississippi during this period and its subsequent changes to its present form that I wish particularly to call your attention. During the Great River age we know that the eastern coast of the continent stood at least 1,200 feet higher than at present. The region of the Lower Mississippi was also many hundred feet higher above the sea level than now. Although we have not the figures for knowing the exact elevation of the Upper Mississippi, yet we have the data for knowing that it was very much higher than at the present day.

The Lower Mississippi, from the Gulf to the mouth of the Ohio River, was of enormous size flowing through a valley with an average width of about fifty miles, though varying from about twenty-five to seventy miles.

In magnitude, we can have some idea, when we observe the size of the lower three or four hundred miles of the Amazon River, which has a width of about fifty miles. But its depth was great, for the waters not only filled a channel now buried to a depth of from three to five hundred feet, but stood at an elevation much higher than the broad bottom lands which now constitute those fertile alluvial flats of the Mississippi Valley, so liable to be overflowed.

From the western side, our great river received three principal tributaries--the Red River of the South, the Washita, and the Arkansas, each flowing in valleys from two to ten miles in width, but now represented only by the depauperated streams meandering from side to side, over the flat bottom lands, generally bounded by bluffs.

The Mississippi from the east received no important tributaries south of the Ohio; such rivers as the Yazoo being purely modern and wandering about in the ancient filled-up valley as does the modern Mississippi itself.

So far we find that the Mississippi below the mouth of the Ohio differed from the modern river in its enormous magnitude and direct course.

From the mouth of the Ohio to that of the Minnesota River, at Fort Snelling, the characteristics of the Mississippi Valley differ entirely from those of the lower sections. It generally varies from two to ten miles in width, and is bounded almost everywhere by bluffs, which vary in height from 150 to 500 feet, cut through by the entrances of occasional tributaries.

The bottom of the ancient channel is often 100 feet or more below the present river, which wanders about, from side to side, over the "bottom lands" of the old valley, now partly filled with debris, brought down by the waters themselves, and deposited since the time when the pitch of the river began to be diminished. There are two places where the river flows over hard rock. These are at the rapids near the mouth of the Des Moines River, and a little farther up, at Rock Island. These portions of the river do not represent the ancient courses, for subsequent to the Great River Age, according to General Warren, the old channels became closed, and the modern river, being deflected, was unable to reopen its old bed.

The Missouri River is now the only important tributary of this section of the Mississippi from the west. Like the western tributaries, farther south, it meanders over broad bottom lands, which in some places reach a width of ten miles or more, bounded by bluffs. During the period of the culmination, it probably discharged nearly as much water as the Upper Mississippi. At that time there were several other tributaries of no mean size, such as the Des Moines, which filled valleys, one or two miles wide, but now represented only by shrunken streams.

The most interesting portion of our study refers to the ancient eastern tributaries, and the head waters of the great river.

The greater portion of the Ohio River flows over bottom lands, less extensive than those of the west, although bounded by high bluffs. The bed of the ancient valley is now buried to a depth of sometimes a hundred feet or more. However, at Louisville, Ky., the river flows over hard rock, the ancient valley having been filled with river deposits on which that city is built, as shown first by Dr. Newberry, similar to the closing of the old courses of the Mississippi, at Des Moines Rapids and Rock Island. However, the most wonderful changes in the course of the Ohio are further up the river. Mr. Carll, of Pennsylvania, in 1880, discovered that the Upper Alleghany formerly emptied into Lake Erie, and the following year I pointed out that not only the Upper Alleghany, but the whole Upper Ohio, formerly emptied into Lake Erie, by the Beaver and Mahoning Valleys (reversed), and the Grand River (of Ohio). Therefore, only that portion of the Ohio River from about the Pennsylvania-Ohio State line sent its waters to the Mexican Gulf, during the Great River Age.

Other important differences in the river geology of our country were Lake Superior emptying directly into the northern end of Lake Michigan, and Lake Michigan discharging itself, somewhere east of Chicago, into an upper tributary of the Illinois River. Even now, by removing rock to a depth of ten feet, some of the waters of Lake Michigan have been made to flow into the Illinois, which was formerly a vastly greater river than at present, for the ancient valley was from two to ten miles wide, and very deep, though now largely filled with drift.

The study of the Upper Ancient Mississippi is the most important of this address. The principal discoveries were made only a few years since, by General G.K. Warren, of the Corps of Engineers, U.S.A. At Ft. Snelling, a short distance above St. Paul, the modern Minnesota River empties into the Mississippi, but the ancient condition was the converse. At Ft. Snelling, the valleys form one continuous nearly straight course, about a mile wide, bounded by bluffs 150 feet high. The valley of the Minnesota is large, but the modern river is small. The uppermost valley of the Mississippi enters this common valley at nearly right angles, and is only a quarter of a mile wide and is completely filled by the river. Though this body of water is now the more important, yet in former days it was relatively a small tributary.

The character of the Minnesota Valley is similar to that of the Mississippi below Ft. Snelling, in being bounded by high bluffs and having a width of one or two miles, or more, all the way to the height of land, between Big Stone Lake and Traverse Lake, the former of which drains to the south, from an elevation of 992 feet above the sea, and the latter only half a dozen miles distant (and eight feet higher) empties, by the Red River of the North, into Lake Winnipeg. During freshets, the swamps between these two lakes discharge waters both ways. The valley of the Red River is really the bed of an immense dried-up lake. The lacustrine character of the valley was recognized by early explorers, but all honor to the name of General Warren, who, in observing that the ancient enormous Lake Winnipeg formerly sent its waters southward to the Mexican Gulf, made the most important discovery in fluviatile geology--a discovery which will cause his name to be honored in the scientific world long after his professional successes have been forgotten.

General Warren considered that the valley of Lake Winnipeg only belonged to the Mississippi since the "Ice Age," and explained the changes of drainage of the great north by the theory of the local elevation of the land. Facts which settle this question have recently been collected in Minnesota State by Mr. Upham, although differently explained by that geologist. However, he did not go far enough back in time, for doubtless the Winnipeg Valley discharged southward before the last days of the "Ice Age," and the great changes in the river courses were not entirely produced by local elevation, but also by the filling of the old water channels with drift deposits and sediments. Throughout the bottom of the Red River Valley a large number of wells have been sunk to great depths, and these show the absence of hard rock to levels below that of Lake Winnipeg; but some portions of the Minnesota River flow over hard rock at levels somewhat higher. Whether the presence of these somewhat higher rocks is due entirely to the local elevation, which we know took place, or to the change in the course of the old river, remains to be seen.

Mr. Upham has also shown that there is a valley connecting the Minnesota River, at Great Bend at Mankato, with the head waters of the Des Moines River, as I predicted to General Warren a few months before his death. At the time when Lake Winnipeg was swollen to its greatest size, extending southward into Minnesota, as far as Traverse Lake, it had a length of more than 600 miles and a breadth of 250 miles.

Its greatest tributary was the Saskatchewan--a river nearly as large as the Missouri. It flowed in a deep broad caæon now partly filled with drift deposits, in some places, to two hundred feet or more in depth.

Another tributary, but of a little less size, was the Assiniboine, now emptying into the Red River, at the city of Winnipeg. Following up this river, in a westerly direction, one passes into the Qu'Appelle Valley--the upper portion of which is now filled with drift, as first shown by Prof. H. Y. Hind. This portion of the valley is interesting, for through it, before being filled with drift, the south branch of the Saskatchewan River formerly flowed, and constituted an enormous river. But subsequent to the Great River Age, when choked with drift, it sent its waters to the North Saskatchewan as now seen. There were many other changes in the course of the ancient rivers to the north, but I cannot here record them.

As we have seen, the ancient Mississippi and its tributaries were vastly larger rivers than their modern representatives. At the close of the Great River Age, the whole continent subsided to many hundred feet below its present level, or some portions to even thousands of feet. During this subsidence, the Mississippi States north of the Ozark Mountains formed the bed of an immense lake, into the quiet waters of which were deposited soils washed down by the various rivers from the northwestern and north central States and the northern territories of Canada. These sediments, brought here from the north, constitute the bluff formation of the State, and are the source of the extraordinary fertility of our lands, on which the future greatness of our State depends. However, time will not permit me to enter into the application of the facts brought forward to agricultural interests. But although this address is intended to be in the realm of pure science, I cannot refrain from saying a word to our engineering students as to the application of knowledge of river geology to their future work. The subject of river geology is yet in its infancy, and I have known of much money being squandered for want of its knowledge. In one case, I saved a company several thousand dollars, though I should have been willing to give a good subscription to see the work carried out from the scientific point of view.

I will briefly indicate a few interesting points to the engineer. Sometimes in making railway cuttings it is possible to find an adjacent buried valley through which excavations can be made without cutting hard rock. In bridge building especially, in the western country, a knowledge of the buried valleys is of the utmost importance. Again, in sinking for coal do not begin your work from the bed of a valley, unless it be of hard rock, else you may have to go through an indefinite amount of drift and gravel; and once more, in boring for artesian wells, it sometimes happens that good water can be obtained in the loose drift filling these ancient valleys; but when you wish to sink into harder rock, do not select your site of operations on an old buried valley, for the cost of sinking through gravel is greater than through ordinary rock.

In closing, let us consider to what the name Mississippi should be given. In point of antiquity, the Ohio and Upper Mississippi are of about the same age, but since the time when ingrowing southward they united, the latter river has been the larger. The Missouri River, though longer than the Mississippi, is both smaller and geographically newer--the upper portion much newer.

Above Ft. Snelling, the modern Mississippi, though the larger body of water, should be considered as a tributary to that now called Minnesota, while the Minnesota Valley is really a portion of the older Mississippi Valley--both together forming the parent river, which when swollen to the greatest volume had the Saskatchewan River for a tributary, and formed the grandest and mightiest river of which we have any record.--_Kansas City Review_.

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