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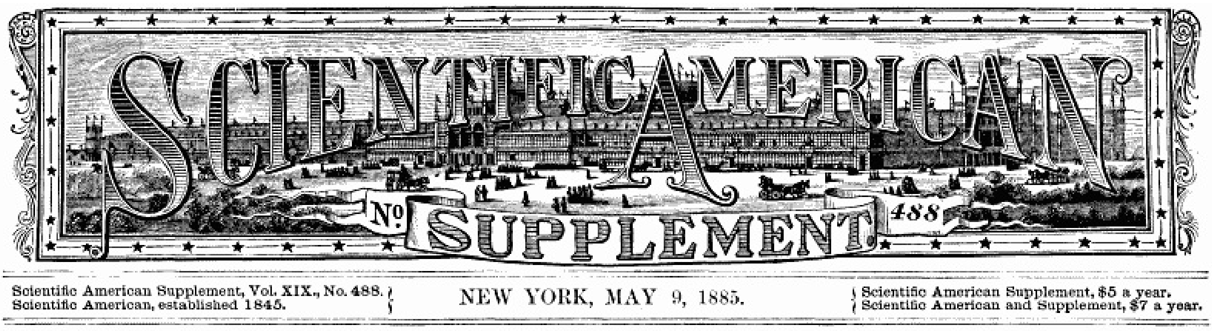

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ACKNOWLEDGMENTS.

We give in this number of our SUPPLEMENT several articles with illustrations, for which we are indebted to *La Nature*. They are entitled Electric Light Apparatus for Military Purposes, The Otoscope, A New Seismograph, Dinocrates' Project, The Xylophone, Plan of an Elevated Railway for Paris.

A VISIT TO THE CREUSOT WORKS.

Here we are at the great forge (Fig. 1), that wonderful creation which has not its like in France, that gigantic construction which iron has wholly paid for, and which covers a space of twenty-four acres. We first remark two puddling halls, each of which contains 50 furnaces and 9 steam hammers. It is in these furnaces that the iron is puddled. The ball or bloom thus obtained is afterward taken to the hammer, which crushes it and expels the scoriæ.

FIG. 1.—THE GREAT HALL OF FORGES AT THE CREUSOT WORKS.

The puddler's trade, which is without doubt the most laborious one in metallurgy, will surely soon be lightened through the use of steam. Two rotary furnaces actuated by this agent have been in operation for a few years at Creusot, and each is yielding 20 tons of iron per day.

We have but a court of 130 feet in width to cross in order to reach the rolling mill. At the entrance to this we enjoy one of the most beautiful sights that the immense works can offer. For a length of 1,240 feet we perceive on one side a series of rolling machines, and on the other a row of reverberatory furnaces that occasionally give out a dazzling light. In the intervals are fiery blocks that are being taken to the rolling machines, in order to be given the most diverse forms, according to the requirements of commerce.

The iron obtained by puddling is not as yet in its definite state, but the rolling mill completes what the puddling hall does in the rough. Five hundred and fifty thousand tons of iron, all shaped, are taken from the forge every day. To reach such a result it requires no less than 3,000 workmen and a motive power of 7,000 horses.

But do not be appalled at the cost of the coal, for, thanks to ingenious processes, the heat lost from the furnaces nearly suffices to run the boilers. If we remark that a power of one horse does in one hour the equivalent of a man's labor per day, we conclude that these machines (which run night and day) represent an army of 160,000 men that lends its gratuitous aid to the workmen of the forge. This is what is called progress in industry.

We have just seen that iron is obtained in small masses. These can be welded upon heating them to 1,500 or 2,000 degrees. It is impossible to manufacture a large piece exempt from danger from the weldings. Cast iron always has defects that are inherent to its nature, and these are all the more dangerous in that they are hidden. Steel is exempt from these defects, and, moreover, whatever be the size of the ingot, its homogeneousness is perfect. This is what has given the idea of manufacturing from it enormous marine engines and those gigantic guns that the genius of destruction has long coveted.

Ah, if the good sense of men does not suffice to put a limit to their increasing progress, bridges, viaducts, and tunnels will take it upon themselves, if need be, to bar their passage. But, in order to forge large ingots, it became necessary before all to increase the power of the steam hammer. The Creusot establishment, which endowed metallurgy with this valuable machine, had allowed itself to be eclipsed, not by the number (for it had 57), but by the dimensions of the largest one. In 1875, the Krupp works constructed one of 50 tons, and their example was followed at Perm, St. Petersburg, and Woolwich. It was then that Mr. Henry Schneider put in execution a bold project that he had studied with his father, that of constructing a 100 ton steam hammer, along with the gigantic accessories necessary (Fig. 2). It became necessary to erect a building apart for its reception. This structure covers a surface of one and three-quarter roods, and reaches a height of 98 feet in the center. As for the hammer, imagine uprights 25 feet in height, having the shape of the letter A, surmounted with a cylinder 19½ feet in length and of a section of 3½ square yards.

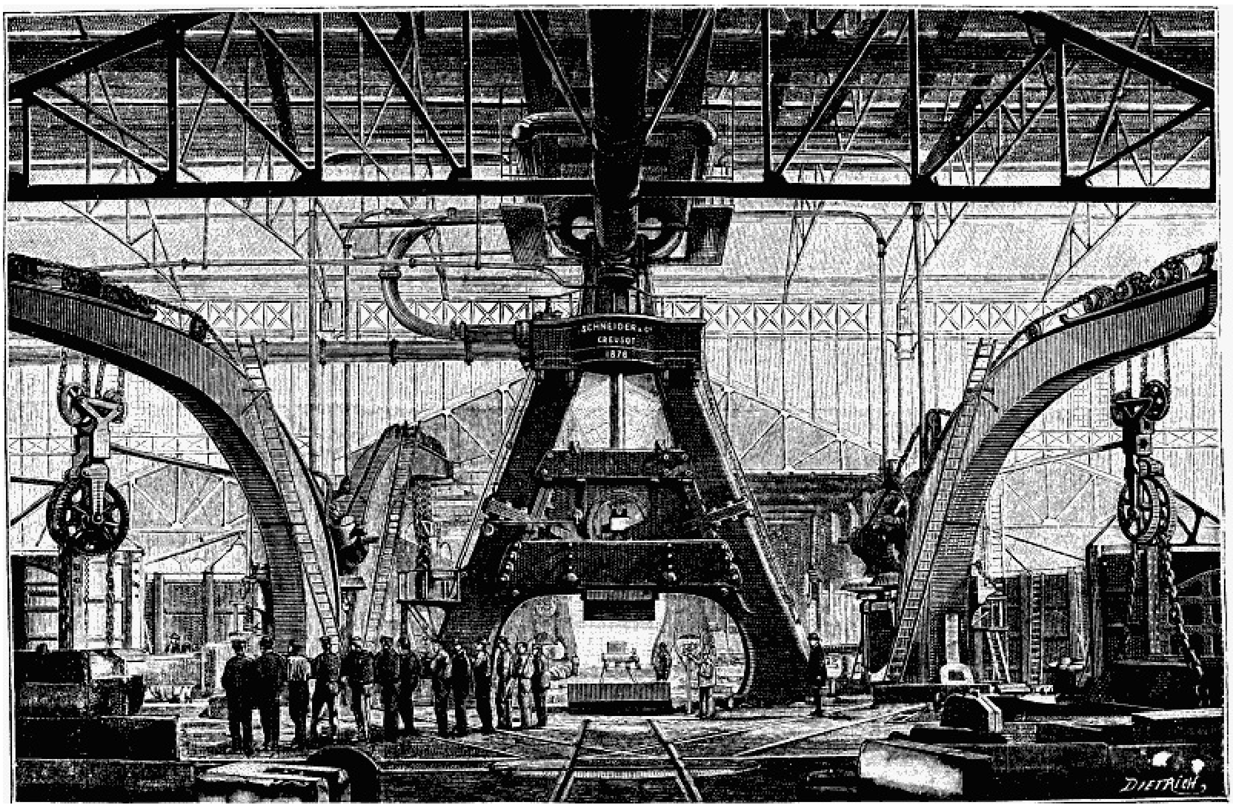


Fig. 2.—THE CREUSOT ONE HUNDRED TON STEAM HAMMER.

The piston which moves in this cylinder, under a pressure of 5 atmospheres, is capable of lifting a weight of 100 tons. The hammer, which is fixed to this piston by a rod, has therefore an ascensional force of 88,000 pounds. It can be raised 16 feet above the anvil, and this gives it a power three and a third times greater than that of the Prussian hammer. Large guns can therefore be made in France just as well as in Germany.

This enormous mass is balanced in space at the will of one man, who, by means of a lever, opens and closes two valves without the least effort. This colossal hammer required an anvil worthy of it. This weighs 720 tons, and rests upon granite in the center of 196 feet of masonry.

The hammer is surrounded with four furnaces heated by gas, and duty is done for each of these by steam cranes capable of lifting 350,000 pounds. These cranes take the glowing block from the furnace, place it upon the anvil, and turn it over on every side at the will of the foreman. Under this hammer a cannon is forged as if it were a mere bolt. The piece is merely rough-shaped upon the anvil, and a metallic car running upon a 36 foot track carries it to the adjusting shop. There the cannon is turned, bored, and rifled, and nothing remains but to temper it, that is to say, to plunge it into a bath after it has been heated white hot. For this purpose an enormous ditch has been dug in which there is a cylindrical furnace, and alongside of it there is a well of oil. The car brings the cannon to the edge of the ditch, and a steam crane performs the operation of tempering with as much ease as we would temper a knife blade.

In the presence of such engines of attack it was necessary to think of defense. The hammer that forges the cannon also gives us the armor plate to brave it. This time the ingot is flattened under the blows of the hammer, and even takes the rounded form of the stern, if it be so desired. Thus is obtained the wall of steel that we wish.

Will it be possible to keep up the fight long? In order that one may get some idea of this for himself, let us rapidly describe an entirely peaceful contest that took place recently upon the coast of Italy. Two rival plates, one of them English and the other French, were placed in the presence of the Spezia gun, which weighs 100 tons. These plates were strongly braced with planks and old armor plate. Three shots were to be fired at each of the plates.

In the first shot the ball was of hardened cast iron, and weighed 1,990 pounds. The English plate was filled with fissures, while the Creusot did not show a single one. The ball penetrated it about seven inches, and was broken into small pieces.

In the second shot the projectile was the same, but the charge was greater. The shot may be calculated from the velocity, which was 1,530 feet. It was equal to what the great hammer would give were it to fall from a height of a hundred yards. The English plate was completely shivered, while the French exhibited but six very fine fissures radiating from the point struck. The ball entered 8 inches, and was broken as in the first experiment.

The third shot fired was with a steel ball, against the French plate, the English being *hors de combat*. The penetration was the same; the ball was not broken, but was flattened at the point like the head of a bolt.

We should like to speak of those magnificent workshops in which the immense naval pieces are adjusted, where the shafts of helixes 60 feet in length are turned, and of the boiler works, where one may see generators that have a heating surface exceeding 2,000 square feet, for it requires no less than that to supply 8,000 H.P., and thus triumph over the force of inertia and those colossal iron-clads. But how describe in a magazine article what the eye cannot take in in a day?

Despite all our regrets, we have to pass over some things, but our duty will not have been performed if we omit the history of the works.

Creusot, which to-day is a regularly-built city with a population of 28,000 souls, was in 1782 but a poor hamlet called Charbonniere. The existence there of a coal bed had long been known, and iron ore had been found not far off. But how establish works in a locality deprived of a water course, and distant from the large ways of communication?

In 1782 the steam engine, which Watt had just finally improved, removed the first difficulty, and the second was soon to disappear, thanks to a projected canal. An iron foundry was then established there under the patronage of Louis XIV., while the Queen had glassworks erected.

As long as the war lasted the foundry supported itself through casting cannons and balls, but after the year 1815 it became necessary either to transform the works or sell them. It was decided to do the latter. The Messrs. Chagot, who became purchasers in the sum of $180,000, were in turn obliged to sell out in 1826. Creusot was then ceded to Messrs. Manby & Wilson, who already had works at Charenton. At the end of seven years of efforts this firm made a failure, and, finally, in 1836, after six million dollars had been swallowed up, Creusot was bought for $536,000, by Messrs. Adolphe & Eugene Schneider & Co. The period of reverses was at an end, and one of continued success was begun.

The new managers had seen that carriage by steam was soon to follow, and open up to metallurgy an entirely new horizon. The works were quickly transformed and enlarged, and in 1838, the first French locomotive was turned out of them. After locomotives came steamboats. It was then that the necessity of forging large pieces gave the idea of a steam hammer.

By a coincidence that can only be explained by the needs of the epoch, the English came upon the same discovery almost at the same time, and the Creusot patent antedated the English one by only two months.

Two years afterward, frigates such as the Labrador, Orenoque, Albatros, etc., of 450 H.P., were rivaling English vessels on the ocean.

After the death of Mr. Adolphe Schneider, on the 3d of August, 1845, his brother Eugene, left sole manager, displayed an activity that it would be difficult to exceed. He made himself familiar with the resources and productions of foreign countries and of France, and then made up his mind what to do. He desired to make his works the finest in the world, and it has been seen from what precedes that, after twenty years of effort, his aim has been attained. What a rapid progress for so short a time! In 1838, the first locomotive that was not of English origin appeared to us like a true phenomenon; a few years afterward the Creusot locomotives were crossing the Channel in order to roll proudly over the railways of a rival nation.

A general, no matter how skillful, could not conquer with an undisciplined army, so the education of the workmen's children was one of the things that the founder of this great industrial center had constantly in mind. Mr. H. Schneider has continued the work of his father, and has considerably extended it, at Creusot as well as in the annexed establishments. The number of pupils who frequent the schools exceeded 6,000 in 1878.

The work is not confined to educating the children, but a retreat is afforded the parents, without putting them under any restraint.

After twenty-five years' service a workman receives an income of $100 if he is a bachelor, and $150 if married, but upon one condition, however, and that is that he is a Frenchman. For $1.20 a month he is lodged in a pretty little house surrounded with a garden, and, if he is sick, he is attended gratuitously.

These benefits are not addressed to ingrates, as was proved by the profound sorrow that reigned in the little city when the death of the benefactor of Creusot was learned.—*Science et Nature*.

LE CREUSOT.

The members of the American Gun Foundry Board visited these works in 1883, and give the following in their report: The most important steel works in France are situated at Le Creusot, and bear the name of the location in which they are situated. These works have advanced year by year in importance and in magnitude since their purchase by Mr. Eugene Schneider.

This gentleman's death, in 1875, was a source of mourning to the whole town, the inhabitants of which looked up to him as a father. The grateful people have erected to his memory a monument in the market square.

Under the administration of his son, Mr. Henry Schneider, the fame of the products of the works has been enhanced, and the proportions of the establishment have been much increased. The whole number of workmen now employed here and at other points amounts to 15,000; and it is the great center of industry of the adjoining region. At no other place in the world is steel handled in such masses.

It would be foreign to the purpose of this report to dwell on the many objects of commerce which are supplied from these works, but it is safe to say that no proposed work can be of such magnitude as to exceed the resources of the establishment.

For the preparation of metal for cannon and armor-plates Le Creusot is thoroughly equipped. The iron is produced on the premises from the purest imported ores, and the manufacture of the steel is carried on by the most approved application of the open-hearth system with the Siemens furnace; the chemical and mechanical tests are such as to satisfy the most exacting demands of careful government officials; and the executive ability apparent in all the departments and the evident condition of discipline that pervades the whole establishment inspire confidence in the productions of the labor.

The capacity for casting steel is represented by seven open-hearth furnaces of 18 tons each, equal to 126 tons; and the process of casting large ingots is a model of order and security. Ladles capable of holding the contents of one furnace, mounted upon platform cars, are successively filled at a previously determined interval of time and run on railways to a convenient position over the mould; before the first ladle is exhausted the supply from the succeeding one has commenced to run, and so on to the completion of the casting, the supply to the mould being uninterrupted during the entire process. The precision with which the several ladles are brought into position in succession makes it entirely unnecessary to provide a common reservoir into which all the furnaces may discharge. By this process the casting of a 45 ton ingot, which was witnessed by the Board, was effected in 23 minutes.

The process of tempering the gun-tubes was also witnessed by the Board. The excavation of the pit is, as at St. Chamond, 15 meters deep, with the furnace at one end and the oil tank (100 tons) at the other. One side of the upright furnace is constructed in the form of a door, which, by a convenient arrangement for swinging, is made to turn on its hinges. Thus, when the tube is raised to the right temperature, it is seized by the traveling crane, the door of the furnace swung open, and the tube at once advanced to the tank in which it is immersed.

All tubes are immersed in oil the second time, but at a temperature much below that to which they are raised at the first immersion. This process constitutes the annealing after tempering.

The manufacture of steel-armor plates is a specialty of Le Creusot, which is engaged in an active competition with the manufacturers of compound armor. Plates up to 60 centimeters in thickness and 3 meters wide are forged here; they are tempered after forging, but what subsequent treatment they receive was not explained.

The tempering pit for the plates consists of an excavation of convenient size, in the center of which is placed a tank containing 180 tons of oil. At the four corners of the pit are furnaces in which the plates are raised to a proper temperature. When sufficiently heated, a plate is seized by a walking crane and immersed in the oil.

Hoops for cannon are manufactured here in large quantities. They are cut from solid ingots, and those for guns up to 24 centimeters are rolled like railway tires; those for larger calibers are forged on a mandrel. Jackets of large size are also manufactured; these are made from solid ingots, which, after being forged, are bored out.

At Le Creusot a remarkable test of hoops was witnessed, which exemplifies not only the excellence of the manufacture of the steel but also the exacting character of the French requirements. The hoops for naval guns are made with the interior surface slightly conical. When forged, turned, and brought under a hammer, a standard mandrel of steel, conically shaped to suit the form of the cone in the hoop, but of a slightly increased diameter, is introduced, the smaller end of the mandrel being able to enter the larger end of the hoop. The mandrel is then forced in by the hammer until its lower edge has passed through the hoop. The blows are then made to operate on the upper edge, detaching it from the mandrel. Careful measurements are taken of the diameter of the hoop before and after this test, and it is required that the measurement subsequent to the operation shall show that the hoop has partially, but not entirely, returned to the diameter that it had before the entrance of the mandrel. This would show that there is left to the metal a small margin within its elastic limit. A system of manufacture which can comply with such a refinement of exactitude must be very precise.

Perhaps the most striking feature at Le Creusot is the forge, where is assembled an array of steam hammers not equaled in the world, viz.:

One 100 ton hammer with a fall of 5 meters.
One 40 ton hammer with a fall of 3 meters.
One 15 ton hammer with a fall of 3 meters.
Two 10 ton hammers with a fall of 2½ meters.
One 8 ton hammer with a fall of 2½ meters.

As the 100 ton hammer at these works is the largest in the world, some particulars concerning it will be appropriate.

The foundations are composed of a mass of masonry laid in cement resting on bed rock, which occurs at a depth of 11 meters, an anvil block of cast iron, and a filling-in of oak timber designed to diminish by its elasticity the vibrations resulting from the blows of the hammer. The masonry foundation presents a cube of 600 meters. Its upper surface is covered with a layer of oak about one meter in thickness, placed horizontally, on which rests the anvil block.

At the Perm foundry in Russia the anvil block for the 50 ton hammer is made in one piece, moulded and cast on the spot it was intended to occupy. Its weight is 622 tons. At Le Creusot, however, this idea was not approved, and it was determined to construct the block in six horizontal courses, each bedded upon plane surfaces. Each course is formed of two castings, except the upper one, a single block, which weighs 120 tons and supports the anvil. Thus formed in 11 pieces, it is 5.6 meters high, 33 square meters at the base, and 7 square meters at the top. Its entire weight is 720 tons.

The space between the block and the sides of the masonry in which it rests is filled in solidly with oak. The block is thus independent of the frame of the superstructure.

The legs of the frame, inclining toward each other in the form of an A, are secured at their bases to a foundation plate embedded in the masonry. They are hollow, of cast iron, and of rectangular cross section, each leg in two pieces joined midway of their length by flanges and bolts. The legs are also bound together by four plates of wrought iron, which, at the same time, holds the guides. The height of the legs is 10.25 meters, and their weight, with the guides, 250 tons. The binding plates weigh together about 25 tons, and the foundation plates 90 tons.

The entablature of the frame work weighs 30 tons; on it is placed the steam cylinder, single acting, made in two pieces, each 3 meters long united by flanges and bolts. The diameter of the cylinder is 1.9 meters, giving a surface of 27,345 square centimeters (deducting the section of the rod, which is 36 centimeters in diameter); which, for 5 atmospheres, gives a pressure under the piston of about 140 tons. As the weight of the hammer is 100 tons, it is evident that it can be raised with great velocity.

The stroke of the piston in the cylinder is 5 meters. This height of fall, multiplied by the 100,000 kilogrammes of the mass, gives a working force of 500,000 kilogrammeters, or about 1,640 foot tons. The width between the legs is 7.5 meters, and the free height under the cross ties 3 meters, thus providing ample space for maneuvering large masses of metal.

The entire height of this colossal structure from the base of the masonry foundation to the upper part of the steam cylinder is 31 meters (102 feet), but notwithstanding this unfavorable condition for stability and the enormous effect resulting from a shock of 500,000 kilogrammeters, everything is so well proportioned that there is but slight vibration.

The workman who maneuvers the hammer is placed on a platform on one of the legs, about 3 meters above the floor. He is here protected from the heat reflected from the mass of metal during the operation of forging.

PLAN FOR AN ELEVATED RAILWAY AT PARIS.

Elevated railways have been in operation for a long time in New York, Berlin, and Vienna, and the city of Paris has decided to have recourse to this mode of carriage, so indispensable to large cities. The question of establishing a line of railways in our capital has been open, as well known, since 1871. During this period of nearly fourteen years this grave subject has at various times given rise to serious discussions, in which the most competent engineers have taken part, and numerous projects relating to the solution that it calls for have been put forth.

The problem to be solved is of the most complex nature, and the engineers who have studied it have not been able to come to an agreement except as regards a small number of points. It may even be said that unanimity exists upon but a single point, and that is that the means of locomotion in Paris do not answer the requirements of the public, and that there is an urgent necessity for new ones. The capital question, that of knowing whether the railway to be built shall be beneath or above ground, is not yet settled; for, up to the present, no project has been prescribed in one direction or the other.

While some extol the underground solution as being the only one that, without interfering with circulation in the streets, permits of establishing a double-track railway capable of giving passage to ordinary rolling stock and of connecting directly with the large lines, others, objecting that such a road could not give satisfaction to the taste of Parisians, and that it would necessitate work out of proportion to the advantages gained, conclude upon the adoption of an open air railway.

Preferences generally are evidently for this latter solution.

We have received from a learned engineer, Mr. Jules Garnier, a project for an elevated railway, which appears to us to be very ably conceived, very well studied out, and which we hasten to make known.

(1.) The system is characterized by the following fundamental points: The up and down tracks, instead of being laid alongside of each other, as in an ordinary railway, are superposed upon two distinct platforms forming a viaduct, which is consequently so arranged as to permit of the laying of one of the tracks at its lower part and of the other at its upper.

(2.) The system of constructing the viaduct is so combined as to be capable of giving passage upon the road to the rolling stock of the large lines during the stoppage of the daily passenger trains.

(3.) The tracks are connected at the extremities by a curve that has the proper incline to compensate for the difference in level between the two, and which has a sufficiently large radius to allow the slope of the track to be kept within the limits admitted. The running of the trains is thus uninterrupted.

(4.) When two lines of different directions bisect one another, a special arrangement permits the passengers from one line to pass to the other by means of what is called a "tangent" station, without the trains of one line crossing the tracks of another, the purpose of which arrangement is to avoid those accidents that would inevitably occur through the crossing of a track by the trains of a transverse line.

(5.) The rolling stock is arranged in a manner that allows the entrance and exit of the passengers to be effected with great promptness.

In ordinary avenues, comprising a roadway and two sidewalks, the elevated railway is placed in the axis of the roadway at a sufficient height to prevent it interfering with the passage of carriages, say 14¾ feet above the surface, while in boulevards or avenues of great width, having *contre-allees*[1] bordered by a double row of trees, it is installed in one of the *contre-allees*.

In the first case (Fig. 1), the viaduct is wholly metallic, while in the second it comprises masonry arches surmounted by a metallic superstructure. The viaduct is formed of independent spans supported by metallic piers that rest upon masonry foundations (Fig. 2).

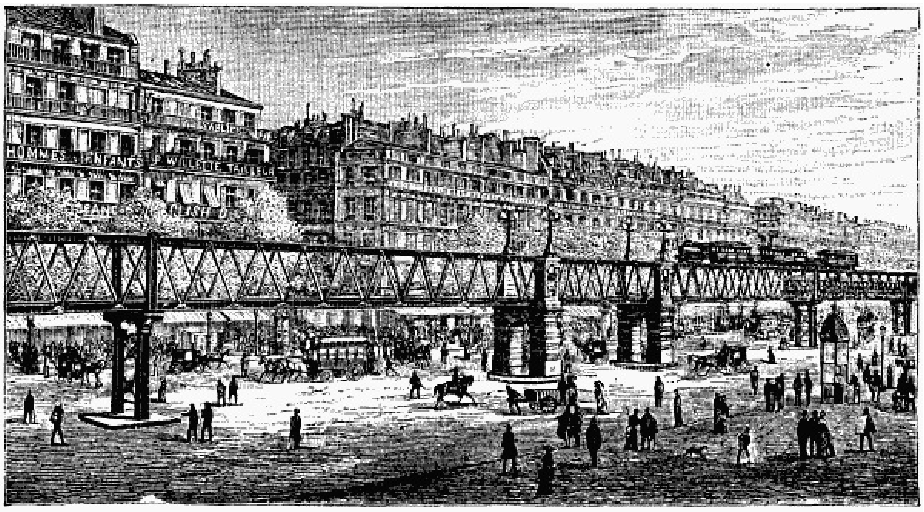


Fig. 1.—PROJECT FOR A PARISIAN ELEVATED RAILWAY.

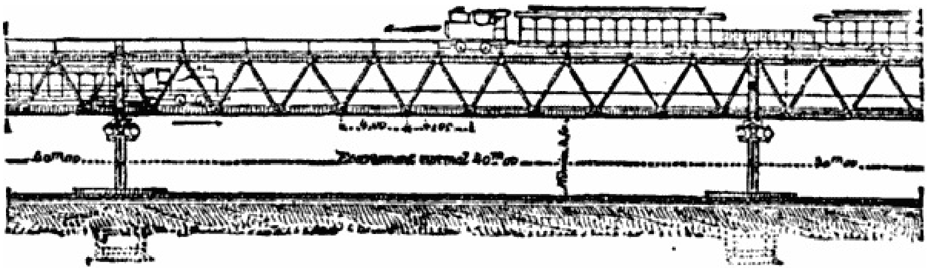


Fig. 2.—LONGITUDINAL ELEVATION.

The line will have three kinds of stations, intermediate, "tangent," and terminal ones. It is at the latter that the two superposed lines are connected by the circular inclined plane.

The waiting platforms of the intermediate stations will be formed simply by the widening of the span corresponding to the station. Access to these platforms will be had by stairs running up from the edge of the sidewalk. The passengers will make their exit by means of corresponding stairs on the opposite side. (Figs 3 and 4.)

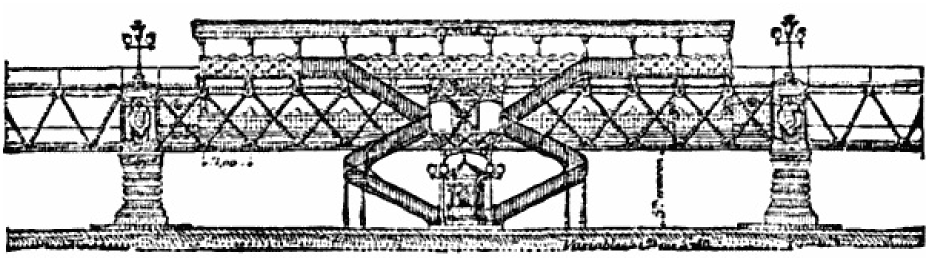


Fig. 3.—A STATION.

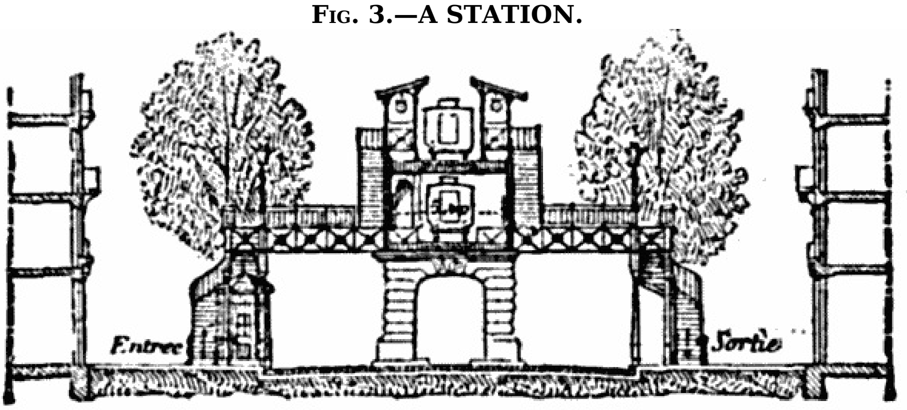


Fig. 4.—TRANSVERSE SECTION OF STATION.

The tangent stations are placed at the meeting point of two lines, which, instead of crossing each other, are bent inward like an X, the two parts of which will be tangent to the central point. Through such arrangements the running of the trains will be continuous, and a traveler reaching one of these stations will be able, upon changing train, to take at his option any one of the three other directions.

As may be seen, Mr. Garnier's project presents conditions which are very favorable to the establishment of an elevated road in the interior of Paris. Far from injuring the aspect of the great arteries of our metropolis, the viaduct, as it has been conceived, will contribute toward giving them a still more imposing look. If the beautiful is, as has been said, the expression of the useful, an elevated railway, well conceived, may be beautiful. The project of a subterranean railway is attended with great drawbacks, not only as regards the great expense that it would necessitate, but also the difficulties of constructing it. And there is a still graver objection to it, and that is that it would oblige travelers to move like moles in dark, cold, and moist tunnels. At Paris, where we are accustomed to a pleasant climate and clear atmosphere, we like plenty of air and broad daylight.—*La Nature.*

[1] Paths parallel with the public walks.

ENGINEERING INVENTIONS SINCE 1862.[1]

By Sir F. J. Bramwell.

I propose to devote the very limited time at my disposal to the consideration of some of the most important of those improvements which are obviously and immediately connected with civil engineering. I am aware of the danger there is of making a serious mistake, when one excludes any matter which at the moment appears to be of but a trivial character. For who knows how speedily some development may show that the judgment which had guided the selection was entirely erroneous, and that that which had been passed over was in truth the germ of a great improvement? Nevertheless, in the interests of time some risk must be run, and a selection must be made; I propose, therefore, to ask your attention while I consider certain of (following the full title of Division I.) "The apparatus, appliances, processes, and products invented or brought into use since 1862." In those matters which may be said to involve the principles of engineering construction, there must of necessity be but little progress to note.

Principles are generally very soon determined, and progress ensues, not by additions to the principles, but by improvement in the methods of giving to those principles a practical shape, or by combining in one structure principles of construction which had been hitherto used apart. Therefore, to avoid the necessity of having a pause, in referring to a work, by finding that one is overstepping the boundary of principle, and trenching within the domain of construction, I think it will be well to treat these two heads together.

If my record had gone back to just before 1851 (the date of the great exhibition), I might have described much progress in the principles of girder construction; for shortly prior to that date, the plain cast-iron beam, with the greater part of the metal in the web, and with but little in the top and bottom flange, was in common use; and even in the preparation of the building for that exhibition, it is recorded that one of the engineers connected therewith had great difficulty in understanding how it was that the form of open work girder, with double diagonals introduced therein (a form which was for years afterward known as the exhibition girder), was any stronger than a girder with open panels separated by uprights, and without any diagonals. But, long before 1862, the Warren and other truss-girders had come into use, and I am inclined to say that, so far as novelty in the principle of girder-construction is concerned, I must confine myself to that combination of principles which is represented by the suspended cantilever, of which the Forth Bridge, only now in course of construction, affords the most notable instance. It is difficult to see how a rigid bridge, with 1,700 foot spans, and with the necessity for so much clear headway below, could have been constructed without the application of this principle.

BRIDGE CONSTRUCTION.

Pursuing this subject of bridge work, the St. Louis Bridge of Mr. Eads may, I think, be fairly said to embody a principle of construction novel since 1862, that of employing for the arch-ribs tubes composed of steel staves hooped together. Further, in suspension bridges there has been introduced that which I think is fairly entitled to rank among principles of construction, the light upper chain, from which are suspended the linked truss-rods, doing the actual work of supporting the load, the rods being maintained in straight lines, and without the flexure at the joints due to their weight. In the East River Bridge, New York, there was also introduced that which I believe was a novelty in the mode of applying the wire cables. These were not made as untwisted cables and then hoisted into place, thereby imposing severe strains upon many of the wires composing the cable through their flexure over the saddles and elsewhere, but the individual wires were led over from side to side, each one having the length appropriate to its position, and all, therefore, when the bridge was erected, having the same initial strain and the same fair play. Within the period we are considering, the employment of testing-machines has come into the daily practice of the engineer; by the use of these he is made experimentally acquainted with the various physical properties of the materials he employs, and is also enabled in the largest of these machines to test the strength and usefulness of these materials, when assembled into forms, to resist strains, as columns or as girders. I of course do not for one moment mean to say that experimental machines were unknown or unused prior to 1862—chain cable testing-machines are of old date, and were employed by our past President, Mr. Barlow, and by others, in their early experiments upon steel; but I speak of it as a matter of congratulation that, in lieu of such machines being used by the few, and at rare intervals upon small specimens, for experimental purposes, they are now employed in daily practice and on a large scale.

In harbor work we have had the principle of construction employed by Mr. Stoney at Dublin, where cement masonry is moulded into the form of the wall for its whole height and thickness, and for such a length forward as can be admitted, having regard to the practical limit of the weight of the block, and then, the block being carried to its place, is lowered on to the bottom, which has been prepared to receive it, and is secured to the work already executed by groove and tongue.

It would not be right, even in this brief notice of such a mode of construction, to omit mention of the very carefully thought out apparatus by which the blocks are raised off the seats whereon they have been made, and are transported to their destination. It is no simple undertaking (even in these days) to raise (otherwise than hydraulically) a weight of 350 tons, which is the weight of the blocks with which Mr. Stoney deals. But he does this by means of pulley-blocks attached to shears built on the vessel which is to transport the block, and he contrives to lift the weight without putting upon his chains the extra strain due to the friction of the numerous pulleys over which they pass. The height of the lift is only the few inches needed to raise the block clear of the quay on which it has been formed, and this is obtained by winding up the chain by steam gear quite taut, so as to take a considerable strain, but not that equal to the weight of the block, and then water is pumped into the opposite end of the vessel to that upon which the shears are carried, this latter end rises, and the block is raised off the seat on which it was formed, without the chains being put to work to do the actual lifting at all. The vessel, with the block suspended to the shear legs and over the bows, is then ready to be removed to the place where the block has to be laid. A word must here be said about an extremely ingenious mode of dealing with the slack chain, to prevent its becoming fouled, and not paying out properly, when the block is being lowered. This is accomplished by reeving the slack of each chain over two fixed sets of multiple sheaves.

A donkey-engine works a little crab having a large drum, the chain from which is connected with the main chain, and draws it round the multiple sheaves so as to take up the slack as fast as the main crab gives it out. The steam is always on the donkey, which is of such limited dimensions that it can do no injury to the chain even when its full power is in vain endeavoring to draw it any further; directly, however, the main crab gives more slack, and the chain between it and the two sets of sheaves falls into a deeper catenary, and one which therefore puts less opposition to the motion of the donkey-engine, that engine goes to work and makes a further haul upon the slack, and in this way, and automatically, the slack is kept clear.

PNEUMATIC FOUNDATIONS.

A noteworthy instance of the use of pneumatic appliances in cylinder sinking for foundations is that in progress at the Forth Bridge. The wrought-iron cylinders are 70 feet in diameter at the cutting-edge, and have a taper of about 1 in 46. They are, however, at a height of 1 foot above low water (that is, at the commencement of the masonry work of the pier) reduced to 60 feet in diameter; at their bottoms there is a roofed chamber, into which the air is pumped, and in which the men work when excavating, this roof being supported by ample main and cross lattice girders. Shafts with air-locks and pipes for admitting water and ejecting silt are provided. The air-locks are fitted with sliding doors, worked by hydraulic rams, or by hand, the doors being interlocked in a manner similar to that in which railway points and signals are interlocked, so that one door cannot be opened until the other is closed. The hoisting of the excavated material is done by a steam engine fixed outside the lock, this engine working a shaft on which there is a drum inside the lock, the shaft passing air-tight through a stuffing box. A separate air-lock, with doors, ladder, etc., complete, is provided to give ingress and egress for the workmen. I have already adverted to one Scotch bridge; I now have to mention another, viz., the Tay Bridge, also now in course of construction. Here the cylinders are sunk, while being guided, through wrought-iron pontoons, which are floated to their berths, and are then secured at the desired spot by the protrusion, hydraulically, of four legs, which bear upon the bottom, and thus, until they are withdrawn, convert the pontoon from a floating into a fixed structure.

SUBAQUEOUS ENGINEERING.

I regret that time will not admit of my giving any description of the modes of "cut and cover" which have been proposed for the performance of subaqueous works; sometimes the proposition has been to do this by means of coffer-dams, and with the work therefore open to the day-light during execution, and sometimes by movable pneumatic appliances. Consideration of subaqueous works necessarily leads the mind to appliances for diving, and although its date is considerably anterior to 1862, I feel tempted, as I believe the construction is known to very few of our members, to say a few words about the diving apparatus known as the "Bateau-plongeur," and used at the "barrage" on the Nile. This consists of a barge fitted with an air-tight cabin provided with an air-lock, and having in the center of its floor a large oval opening, surrounded by a casing standing up above the water-line. In this casing, another casing slides telescopically, the upper part of which is connected to the top of the fixed casing by a leather "sleeve." When it is desired to examine the bottom of the river, the telescopic tube is lowered till it touches the bottom, and then air is pumped into the cabin until the pressure is sufficient to drive out the water, and thus to expose the bottom. This appears to be a very convenient arrangement for shallow draughts of water.

Reverting for a moment to Mr. Stoney's work, I may mention that he uses for the greatest depths he has to deal with, when preparing the bed to receive his blocks, a diving apparatus which (while easily accessible at all times) dispenses with the necessity of raising and lowering, needed in an ordinary diving-bell to allow of the entrance and exit of the workmen. Mr. Stoney employs a bell of adequate size, from the summit of which rises a hollow cylinder, furnished at the top with an air-lock, by which access can be obtained to the submerged bell. Beyond the general improvement in detail and in the mode of manufacture, and with the exception of the application of the telephone, there is probably not much to be said in the way of invention or progress in connection with the ordinary dress of the diver.

THE FLEUSS DIVING APPARATUS.

But one great step has been made in the diver's art by the introduction of the chemical system of respiration, the invention of Mr. Fleuss. He has succeeded in devising a perfectly portable apparatus, containing a chemical filter, by means of which the exhaled breath of the diver is deprived of its carbonic acid; the diver also carries a supply of compressed oxygen from which to add to the remaining nitrogen oxygen, in substitution for that which has been burnt up in the process of respiration. Armed with this apparatus, a diver is enabled to follow his vocation without any air-tube connecting with the surface, indeed without any connections whatever. A notable instance of a most courageous use of this apparatus was afforded by a diver named Lambert, who, during one of the inundations which occurred in the construction of the Severn tunnel, descended into the heading, and proceeding along it for some 330 yards (with the water standing some 35 feet above him), closed a sluice door, through which the water was entering the excavations, and thus enabled the pumps to unwater the tunnel. Altogether, on this occasion, this man was under the water, and without any communication with those above, for one hour and twenty-five minutes. The apparatus has also proved to be of great utility in cases of explosion in collieries, enabling the wearer to safely penetrate the workings, even when they have been filled with the fatal choke-damp, to rescue the injured or to remove the dead.

CONSTRUCTION OF TUNNELS.

With respect to the subject of tunneling thus incidentally introduced, in subaqueous work of this kind, I have already alluded to that which is done by "cut and cover," but where the influx of water is a source of great difficulty, as it was in the old Thames tunnel (though in this case for water one should read silt or mud), I do not know that anything has been devised so ingenious as the Thames tunnel shield; improvement has, however, been made by the application of compressed air.

In the instance of the Hudson River tunnel, the work was done in the manner proposed so long ago as the year 1830 by Lord Cochrane (Earl Dundonald) in that specification of his, No. 6,018, wherein he discloses, not merely the crude idea, but the very details needed for compressed air cylinder-sinking and tunneling, included air-locks and hydraulically-sealed modes for the introduction and extraction of materials. I may, perhaps, be permitted to mention that some few years ago I devised for a tunnel through the water-bearing chalk a mode of excavation by the use of compressed air to hold back the water, and combined with the employment of a tunneling machine. This work, I regret to say, was not carried out. But there are, happily, cases of subaqueous tunneling where the water can be dealt with by ordinary pumping power, more or less extensive, and where the material is capable of being cut by a tunneling machine. This was so in the Mersey tunnel, and would be in the Channel tunnel. In the Mersey tunnel, and in the experimental work of the Channel tunnel, Colonel Beaumont and Major English's tunneling machine has done most admirable work. In the 7 foot 4 inch diameter heading, in the new red sandstone of the Mersey tunnel, a speed of as much as 10 yards forward in twenty-four hours has been averaged, while a maximum of 11-2/3 yards has been attained; while in the 7 foot heading for the Channel tunnel, in the gray chalk, a maximum speed of as much as 24 yards forward in the twenty-four hours has been attained on the English side; and with the later machine put to work at the French end, a maximum speed of as much as 27-1/3 yards forward in the twenty-four hours has been effected. In ordinary land tunneling since 1862 there has been great progress, by the substitution of dynamite and preparations of a similar nature for gunpowder, and by the improvements in the rock-drills worked by compressed air, which are used in making the holes into which the explosive is charged. For boring for water, and for many other purposes, the diamond drill has proved of great service, and most certainly its advent should be welcomed by the geologist, as it has enabled specimens of the stratum passed through to be taken in the natural, unbroken condition, exhibiting not only the material and the very structure of the rock, but the direction and the angle of the dip of the beds.

Closely connected with tunneling machines are the machines for "getting" coal. This "getting," when practiced by manual labor, involves, as we know, the conversion into fragments and dust of a very considerable portion of the underside of the seam of coal, the workman laboring in a confined position, and in peril of the block of coal breaking away and crushing him beneath it. Coal-getting machines, such as those of the late Mr. Firth, worked by compressed air, reduce to a minimum the waste of coal, relieve the workman of a most fatiguing labor in a constrained position, and save him from the danger to which he is exposed in the hand operation. It is a matter of deep regret on many grounds, but especially as showing how little the true principles of political economy are realized by working men, who are usually well informed on many other points, that the commercial failure of these machines is due to their opposition. In connection with colliery work, and indeed in connection with explosives, in the sense of a substitution for them of sources of expansion acting more slowly, mention should be made of the hydraulic wedges. The employment of these in lieu of gunpowder, to force down the block of coal that had been undercut, is one of the means to be looked to for diminishing the explosions in collieries. Another substitute for gunpowder is found in the utilization of the expansion of lime when wetted. This has given birth to the lime cartridge, the merits of which are now universally recognized, but it is feared that trade prejudices may also prevent its introduction. While on this subject of "accidents in mines," it will be well to call attention to the investigations that have been made into the causes of these disasters, and into the probable part played by the minute dust which prevails to so great an extent in dry collieries.

The experiments of our honorary member, Sir Frederick Abel, on this point have been of the most striking and conclusive character, and corroborate investigations of the late Macquorn Rankine into the origin of explosions in flour mills and rice mills, which had previously been so obscure. The name of Mr. Galloway should also be mentioned as one of the earliest workers in this direction. At first sight, pile driving appears to have but little connection with explosives, but it will be well to notice an invention which has been brought into practical use, although not largely (in this country at all events), for driving piles, by allowing the monkey to fall on a cartridge placed in the cavity in the cap on top of the pile; the cartridge is exploded by the fall, and in the act of explosion drives down the pile and raises the monkey; during its ascent, and before the completion of its descent, time is found for the removal of the empty cartridge and the insertion of a new one.

CANALS AND RIVER IMPROVEMENTS.

In the days of Brindley and of Smeaton, and of the other fathers of our profession, whose portraits are on these walls, canals and canalized rivers formed the only mode of internal transit which was less costly than horse traction, and, thanks to their labors, the country has been very well provided with canals; but the introduction of railways proved, in the first instance, a practical bar to the extension of the canal system, and, eventually, a too successful competitor with the canals already made. Frequently the route that had been selected by the canal engineer was found (as was to be expected) a favorable one for the competing railway, and the result was, the towns that had been served by the canal were served by the railway, which was thus in a position to take away even the local traffic of the canal. For some time it looked as though canal and canalized river navigations must come to an end; for although heavy goods could be carried very cheaply on canals, and with respect to the many works and factories erected on the canal banks, or on bases connected therewith, there was with canal navigation no item of expense corresponding to the cost of cartage to the railway stations, yet the smallness of the railway rates for heavy goods, and the greater speed of transit, were found to be more than countervailing advantages. But when private individuals have embarked their capital in an undertaking, they do not calmly see that capital made unproductive, nor do they refrain from efforts to preserve their dividends, and thus canal companies set themselves to work to add to their position of mere owners of water highways, entitled to take toll for the use of those highways, the function of common carriers, thus putting themselves on a par with the railway companies, who, as no doubt is within the recollection of our older members, were in the outset legalized only as mere owners of iron highways, and as the receivers of toll from any persons who might choose to run engines and trains thereon, a condition of things which was altered as soon as it was pointed out that it was utterly incompatible either with punctuality or with safe working. This addition to the legal powers of the canal companies, made by the acts of 1845 and 1847, has had a very beneficial effect upon the value of their property, and has assisted to preserve a mode of transport competing with that afforded by the railways. Further, the canal proprietors have from time to time endeavored to improve the rate of transport, and with this object have introduced steam in lieu of horse haulage, and by structural improvements have diminished the number of lockages. Many years before the period we are considering, there was employed, to save time in the lockages and to economize water, the system of inclined planes, where, either water-borne in a traveling caisson, as on the Monklands incline, or supported on a cradle, as in the incline at Newark, in the State of New Jersey, the barges were transferred from one level to another; but an important improvement on either of these modes of overcoming a great difference of level is the application of direct vertically lifting hydraulic power. A notable instance of this system was brought before the Institution in a paper read on the "Hydraulic Canal Lift at Anderton, on the River Weaver," by S. Duer,[2] and another instance exists on the Canal de New Fosse, at Fontinettes, in France, the engineers being Messrs. Clark and Standfield, who have other lifts in progress. This system reduces the consumption of water and the expenditure of time to a minimum.

With respect to canalized rivers, the difficulty that must always have existed when these rivers (as was mostly the case) were provided with weirs to dam up the water for giving power to mills has been augmented of late years by the change in the character of floods. It has frequently been suggested that in these days of steam motors in lieu of water power, and of railways in lieu of water carriage, the injury done by obstructing the delivery of floods is by no means compensated by the otherwise all but costless power obtained, or by the preservation of a mode of transport competing with railways. It has thereupon been suggested that it would be in the interests of the community to purchase and extinguish both the manufacturing and the navigating rights, so as to enable the weirs to be removed, and free course to be provided for floods. It need hardly be said, however, that if means could be devised for giving full effect to the river channels for flood purposes, while maintaining them for the provision of motive power and of navigation, it is desirable that this should be done. The great step in this direction appears to be the employment of readily or, it may be, of automatically movable weirs. Two very interesting papers on this subject by Messrs. Vernon-Harcourt and E. B. Buckley were read and discussed in the session 1879-1880. These dealt, I fear exclusively, with foreign, notably with French and Indian, examples. I say I fear, not in the way of imputing blame to the authors for not having noticed English weirs, but because the absence of such notice amounts to a confession of backwardness in the adoption of remedial measures on English rivers. An instance, however, of improvement since then has been the construction by Mr. Wiswall, the engineer to the Bridgewater Navigation Company (on the Mersey and Irwell section of that navigation), of the movable Throstle Nest weir at Manchester. It does seem to me that by the adoption of movable weirs, rivers in ordinary times may be dammed up to retain sufficient water to admit of a paying navigation and water for the mills on their banks; while in time of flood they shall allow channels as efficient for relief as if every weir had been swept away.

But the great feature of late years in canal engineering is not the preservation or improvement of the ordinary internal canal, but the provision of canals, such as the completed Suez canal, the Panama canal in course of construction, the contemplated Isthmus of Corinth canal—all for saving circuitous journeys in passing from one sea to another; or in the case nearer home of the Manchester ship canal, for taking ocean steamers many miles inland.

But the old fight between the canal engineer and the railway engineer, or, more properly speaking, between the engineer when he had his canal "stop" on and the same individual when he has his railway "stop"—you will see that I am borrowing a figure, either from Dombey & Son, where Mr. Feeder, B.A., is shown to us with his Herodotus "stop" on, or, as is more likely, I am thinking of the organs to be exhibited in the Second division, "Music," of that exhibition of which I have the honor to be chairman—I am afraid this is a long parenthesis breaking the continuity of my observations, which related to the old rivalry between canal and railway engineering. I was about to say that this rivalry was revived, even in the case of the transporting of ocean vessels from sea to sea, for we know that our distinguished member, Mr. Eads, is proposing to connect the Atlantic and Pacific oceans by means of a ship railway across the Isthmus of Panama. He suggests that the largest vessels should be raised out of the water, in the manner commonly employed in floating docks, and should then be transferred to a truck-like cradle on wheels, fitted with hydraulic bearing blocks (this being, however, not a new proposition as applied to graving docks), so as to obtain practical equality of support for the ship, notwithstanding slight irregularities in the roadway, while he proposes to deal with the question of changes of direction by the avoidance of curves and by the substitution of angles, having at the point of junction of the two sides turntables on which the cradle and ship will be drawn; these can be moved with perfect ease, notwithstanding the heavy load, because the turntable will be floating in water carried in circular tanks.

The question of preserving the level of the turntable, whether unloaded, partially loaded, or loaded, is happily met by an arrangement of water ballast and pumping. I cannot pass away from the mention of Mr. Eads' work without just reminding you of the successful manner in which he has dealt with the mouth of the Mississippi, by which he has caused that river to scour and maintain a channel 30 feet deep at low water, instead of that 8 feet deep which prevailed there before his skillful treatment. Neither can I refrain from mentioning the successful labors of our friend Sir Charles Hartley, in improving the navigation of that great European river, the Danube. I am sure we are all rejoiced to see that one of the lectures of the forthcoming series, that on "Inland Navigation," is to be delivered by him, and I do earnestly trust he will remember it is his duty to the Institution not to leave important and successful works unreferred to because those works happen to be his own.

I regret that time does not admit of my noticing the many improved machines for excavating, to be used either below water or on dry land. I also regret, for similar reasons, I must omit all mention of ship construction, whether for the purpose of commerce or of war, a subject that would naturally follow that of rivers and of ship railways and canals, and would have enabled me to speak of the great debt this branch of civil engineering owes to the labors of our late member, William Froude, and would have enabled me also to deal with the question of material for ships, and with the question of armor plating, in which, and in the construction of ordnance, our past president, Mr. Barlow, and myself, as the two lay members of the Ordnance Committee, are so specially interested.

MILITARY ENGINEERING APPLIANCES.

The mention of armor plates inevitably brings to our minds the consideration of ordnance, but I do not intend to say even a few words on this head of invention and improvement—a topic to which a whole evening might well be devoted—because only three years ago my talented predecessor in this chair, Sir William Armstrong, made it the subject of his inaugural address, and dealt with it in so masterly and exhaustive a style as to render it absolutely impossible for me to usefully add anything to his remarks. I cannot, however, leave this branch of the subject without mentioning, not a piece of ordnance, but a small arm, invented since the date of Sir William's address. I mean the Maxim machine gun. This is not only one of the latest, but is certainly one of the most ingenious pieces of mechanism that has been devised. The single barrel fires the Martini-Henry ammunition; the cartridges are placed in loops upon a belt, and when this belt is introduced to the gun, and some five or six cartridges have been drawn in by as many reciprocations of a handle, the gun is ready to commence firing. After the first shot, which must be fired by the pulling of a trigger in the ordinary way, the gun will automatically continue to send out shot after shot, until the whole of the cartridges on the belt are exhausted; and if care is taken before this happens to link on to the tail of the first belt the head of a second one, and another belt to this, and so on, the firing will be automatically continuous, and at a rate anywhere between one shot per minute and six hundred shots per minute, dependent on the will of the person in charge of the gun, the whole of the operations of loading, firing, and ejecting the cartridge being performed by the energy of the recoil. This perfectly automatic action enables the man who works the gun to devote his whole attention to directing it, and as it is carried on a pivot and can be elevated and depressed, he can, while the gun is firing, aim the bullets to any point he may choose.

Since 1862 the power of defending seaports has been added to by the application of submarine mines, arranged to be fired by impact alone, or to be fired on impact when (under electrical control) the firing arrangement is set for the purpose, or to be fired electrically from the shore by two persons stationed on cross-bearings, both of whom must concur in the act of explosion. These mines are charged with gun-cotton, the development of which owes so much to Sir Frederick Abel, while for purposes of attack the same material, not yet in practical use for shells, is taken as the charge for torpedoes, which are either affixed to a spar or are carried in the head of a submerged cigar-shaped body. By a compressed air or by a direct steam impulse arrangement these weapons are started on their course and are directed, and then the running is taken up by their own engines operating on screw propellers, driven by a magazine of compressed air contained in the body of the torpedo. Means are also provided to maintain the designed level below the water surface. The torpedo may either be projected from the war ship itself or from one of those launches which owe their origin to our member, Mr. John Isaac Thornycroft, who first demonstrated the feasibility of that which was previously considered to be impossible, viz., the obtaining a speed of twenty miles and over from a vessel not more than 80 feet long. Experiments have been carried on in the United States by Captain Ericsson to dispense with the internal machinery of the torpedo, and to rely for its traverse through the water upon the original impulse given to it by a breech-loading gun, carried at the requisite depth below the water level in a torpedo boat. This gun, having a feeble charge of powder at a low gravimetric density, fires the torpedo, and, it is said, succeeds in sending it many yards, and with a sufficient terminal velocity to explode the charge by impact. Also, in the United States, experiments have been made with a compressed air gun of 40 feet in length and 4 inches in diameter (probably by this time replaced by a gun of 8 inches in diameter), to propel a dart through the air, in the front of which dart there is a metallic chamber containing dynamite. Although no doubt the best engineer is the man who does good work with bad materials, yet I presume we should not recommend any member of our profession to select unsuitable materials with the object of showing how skillfully he can employ them. On the contrary, an engineer shows his ability by the choice of those materials which are the very best for his purpose, having regard, however, to the relative facilities of carriage, to the power of supply in sufficiently large quantities, to the ease with which they can be worked up or built in, and to the cost.

USES OF CEMENT.

Probably few materials have been found more generally useful to the civil engineer, in works which are not of metal, than has been Portland cement. It should be noticed that during the last twenty-two years great improvements have been made in the grinding and in the quality of the cement. These have been largely due to the labors in England of our member, Mr. John Grant, to the labors of foreign engineers following in his footsteps, and to the zeal and intelligence with which the manufacturers have followed up the question, from a scientific as well as from a practical point of view, not resting until they were able with certainty to produce a cement such as the engineer needed. I do not know that there is very much to be said in the way of progress (so far as the finished results are concerned) in the materials which Portland cement and other mortars are intended to unite. Clean gravel and ballast and clean sand are, I presume, very much the same in the year 1884 as they were not only in the year 1862, but as they were in the year 1. The same remark applies to stone and to all other natural building materials; and, indeed, even the artificial material brick cannot in these days be said to surpass in quality the bricks used by the Romans in this island nineteen hundred years ago, but as regards the mode of manufacture and the materials employed there is progress to be noted. The brick-making machine and the Hoffmann kiln have economized labor and fuel, while attempts have been made, which I trust may prove successful, for utilizing the clay which is to be found in the form of slate in those enormous mounds of waste which disfigure the landscape in the neighborhood of slate quarries. Certain artificial stones, moreover, appear at last to be made with a uniformity and a power of endurance, and in respect of these qualities compare favorably with the best natural stone, and still more favorably having regard to the fact that they can be made of the desired dimensions and shape, thus being ready for use without labor of preparation.

PRESERVATION OF WOOD.

Reverting to natural materials, there remains to be mentioned that great class, timber. In new countries the engineer is commonly glad to avail himself of this material to an extent which among us is unknown. For here, day by day, owing to the ready adaptability of metals to the uses of the engineer, the employment of wood is decreasing. Far, indeed, are we from the practice of not more than a hundred years ago, when it was not thought improper to make the shell of a steam engine boiler of wooden staves. The engineer of to-day, in a country like England, refrains from using wood. He cannot cast it into form, he cannot weld it. Glue (even if marine) would hardly be looked upon as an efficient substitute for a sound weld; and the fact is, that it is practically impossible to lay hold of timber when employed for tensile purposes so as to obtain anything approaching to the full tensile strength. If it be desired to utilize metals for such a purpose, they can be swollen out into appropriate "eyes" to receive the needed connection; but this cannot be done with wood, for the only way of making an enlarged eye in wood is by taking a piece that is big enough to form the eye, and then cutting away the superfluous portion of the body. Moreover, when too much exposed to the weather, and when too much covered up, wood has an evil habit of rotting, compared with the rapidity of which mode of decay the oxidizing of metals is unimportant. Further, one's daily experience of the way in which a housemaid prepares a fire for lighting is suggestive of the undesirability of the introduction of resinous sticks of timber, even although they may be large sticks, into our buildings. Many attempts, as we know, have been made to render timber proof against these two great defects of rapid decay and of ready combustibility, and, as it appears to me, it is in these directions alone one can look for progress in connection with timber. With respect to the first, it was only at the last meeting of the Institution we presented a Telford medal and a Telford premium to Mr. S. B. Boulton for his paper "On the Antiseptic Treatment of Timber," to which I desire to refer all those who seek information on this point. With respect to the preservation from fire of inflammable building materials, the processes, more or less successful, that have been tried are so numerous that I cannot even pretend to enumerate them. I will, however, just mention one, the asbestos paint, because it is used to coat the wooden structures of the Inventions Exhibition. To the employment of this, I think, it is not too much to say those buildings owed their escape, in last year's very dry summer, from being consumed by a fire that broke out in an exhibitor's stand, destroying every object on that stand, but happily not setting the painted woodwork on fire, although it was charred below the surface. I do not pretend to say that a surface application can enable wood to resist the effects of a continued exposure to fire, but it does appear that it can prevent its ready ignition.

(*To be continued.*)

[1] Address of Sir Frederick Joseph Bramwell, F.R.S., on his election as president of the Institution of Civil Engineers. January 13, 1885.

[2] Minutes of Proceedings Inst. C. E., vol. xlv., p. 107.

THE CATHEDRAL OF THE INCARNATION.

The Cathedral of the Incarnation, at Garden City, N. Y., the memorial of Mrs. Cornelia M. Stewart to her husband, Alexander T. Stewart, was opened April 9, 1885, by impressive religious ceremonies. At precisely 11 o'clock the chimes in the cathedral tower rang out a clear and resonant peal, and the people thronged into the building through its tower and transept entrances.

The effort has been made to reproduce in the cathedral a pure type of the Gothic architecture of the thirteenth century, without its ruder and less refined characteristics. The strained and coarse images designed to illustrate "the world, the flesh, and the devil," which seem so strange and unapt to American visitors to the great Continental cathedrals, are almost entirely omitted in this reproduction. The carving, too, in deference to the more sensitive tastes and better skill of this age, is far more artistic and natural than in the old originals. Flowers in stone are made to resemble flowers, and heads are fashioned after a human pattern, and clusters of figures are modeled in a congruous and modern manner. But aside from changes of this kind, the new and magnificent edifice upon Hempstead Plains is a perfect example of the elaborate and picturesque Gothic structures of mediæval days.

It is built of brown sandstone raised in colossal blocks. The spire, floriated richly and graduated with a precise symmetry, rises to an extreme altitude of 220 feet 6 inches. The extreme length is about 170 ft. The massive oaken front doors are carved handsomely, and contain the arms of the Stewart family, the Clinch family (Mrs. Stewart's maiden name), the Hilton family, and those of Bishop Littlejohn, the Episcopal head of the Long Island Diocese. The porch or tower entrance, which is the main entrance to the building, is paved with white marble. In the center of the floor the Stewart arms are enameled in brass, showing a shield with a white and blue check, supported by the figures of a wild Briton and a lion. The crest is a pelican feeding its young, and the motto is "*Prudentia et Constantia*." These heraldic figures are made a special feature of the main aisle. Directly in the center of the auditorium floor the Stewart and Clinch arms are impaled, enameled in brass. On the floor in the choir the Hilton arms are placed. They bear the patriotic motto "*Ubi libertas ibi patria*," with a deer for a crest. The floor of the ante-chancel presents the arms of the diocese. Its insular character is especially prominent. The shield of barry wavy contains three crosslets, the peculiar sign of the cathedral. It is supported by dolphins. The crest is a ship, and under all is the sacred motto, "I will set his dominion in the sea." The workmanship of all these arms is superb.

By far the most wonderful works of art in the edifice are the windows of stained glass and the musical facilities. Every window presents a theme suggestive of the Incarnation. The windows of the porch present several of the Old Testament characters and events which prefigured the birth of Christ, and over the door leading to the nave are figures of Adam and Eve and of Abraham and Sarah. The four windows on the south side of the nave show the Annunciation, the dream of Joseph, the salutation of Elizabeth, and the refusal of the stable to the parents of the infant Redeemer. In the first window of the transept is presented the inn-keeper's refusal of refuge to Joseph and Mary. The great window of the south transept, in all about thirty feet high, one of the largest windows in the world, shows the family of Jesse, the ancestor of Jesus. Jesse is resting at full length; above him is King David, and all around are figures of his descendants leading up to the Virgin Mary with the Holy Child in her arms. Above all, in the apex of the windows, are the emblems used in prophecies of Christ's coming. The third window of the south transept shows the Nativity, with the Babe in the manger. Two windows in the choir are chosen with special reference to the regular service of the church. The first represents the appearance of the star in the east to the shepherds of Bethlehem, introducing the

"Gloria in Excelsis," and the second shows the presentation of Christ in the temple, suggesting the "Nunc Dimittis," the "Magnificat," and the "Benedictus." Then beautiful representations are given in the north transept windows of the Magi bringing gifts to the infant Saviour, and the wise men before King Herod. The windows of the nave show the flight into Egypt, the massacre of the innocents, and the return to Nazareth.

The north window of the transept is the most magnificent of all. It presents Christ in glory, thus suggesting the "Te Deum." Jesus sits enthroned with the angels and archangels, prophets, apostles and martyrs of the church in all ages bending in adoration before Him, while the heavenly choir are waving palms and chanting music in honor of Heaven's King. The smaller windows under the roof show the hierarchy of heaven indicating by music and dances the joy of the celestial world at the scenes of the Incarnation depicted below. Upon a bright, sunny day the cathedral is made exquisitely beautiful by the mellowed radiance of these windows. They were designed and manufactured by Clayton & Bell, of London, and are esteemed to present the perfection of their work. Their colors, rich and varied, blend in perfect harmony, and the intricacy of the groupings makes each one as interesting as an oil painting.

Six different organs have been built in different parts of the building. The most important of these is the great organ in the north apse. It is furnished with four keyboards and 124 stops, with twenty-four combination stops that admit of more than a million combinations of sound. On either side of the choir is another organ, with a fourth of great power in the crypt, a fifth in the tower, and an echo organ built under the vaulting of the roof. This produces a soft and weird music. All the organs are operated from the keyboard of the great apse organ, which also plays the chimes of thirteen bells in the tower. The choir instruments are made to correspond by means of iron tubes filled with wind by a bellows engine in the crypt of the apse. A second engine in the crypt of the tower operates the bellows that inflate the instruments in the crypt, the tower, and the vaulting. All the organs and the chimes are connected by electric wires, about twenty-six miles of which are employed, supplied with electricity by a motor in the tower engine room. Sublime and grand are the only terms which can suggest the effect of the volume of harmony produced by these instruments in united action. They were made by Hilborne L. Roosevelt, of this city.

The ante-chancel contains the bishop's throne, the dean's seat, and the stalls of the clergy and canons, all of carved mahogany. A superb work of art is the altar, in the chancel, which is separated from the ante-chancel by a heavy bronze railing. The altar is of statuary marble manufactured by Cox & Sons, of London. Its corner columns are of black marble, supported by others of flecked marble, with panels of Sienna and Griote. Between the panels are rich carvings, done in Antwerp, representing the temptation and fall in Eden; Abraham's offering of his son Isaac; Moses raising the brazen serpent in the wilderness; the annunciation to the Virgin; the birth scene in the stable; the Crucifixion and the Resurrection. The slab of the altar is inlaid with five crosslets, representing the five wounds, and the symbol "I. H. S."

None of the cathedral windows are richer than those which circle the chancel. They present Christ as the Good Shepherd and the apostolic college. An excellent piece of chiseling is done by Sibbel, the sculptor of this city, in the panels over the credence. They are figures of the high priest with a slain lamb, the type of the bloody sacrifice, and Christ with sheaves of wheat and clusters of grapes, the unbloody sacrifice. Beneath them is the text, "Thou art a prophet forever after the order of Melchisedec." The chancel is paved with red and yellow Sienna marble as center pieces, flanked with squares of red Griote and white marble, the whole bordered with strips of red and black marble. The ante-chancel is paved with blocks of red Griote and verd antique. Two magnificent pieces of statuary stand on either side of the transept. The first represents Religion holding a little model of the cathedral. The other is an image of Hope. They were done by Park, the Florentine sculptor.

In the south apse is the baptistery, built with a tower furnished with chimes. Its supporting columns are of Languedoc marble clustered with smaller ones of Sienna and verd antique. Six columns support the dome. Each is of a different marble, crowned with sculptured capitals in high relief. The windows are appropriate in theme. They represent Noah with the ark; the building of the ark; Moses holding the tables of the law; the passage of the Red Sea; John the Baptist; the Baptism of the eunuch; St. Philip, the deacon; and the Baptism of Christ. In the center of the room stands the font upon an octagonal base of two steps. Its pedestal and bowl are traced with symbolic carvings. Over it is a canopy of elaborately carved mahogany drawn into a spire bearing a gold crown, studded with rubies and amethysts.

At the foot of the chancel is the pulpit, of bronze, designed by Sibbel. Its base is surrounded by figures representing hearers of the Word. Mr. Sibbel has incorporated an anachronism in one of these figures that will be exceedingly interesting in coming years. It shows the features of Henry G. Harrison, of this city, the architect of the cathedral. The lectern stands on the other side of the ante-chancel, representing Christ blessing little children. Superb bronze columns with brass coronas of natural flowers support the roof of the building. The triforium is carved in the richest style with passion flowers, fuchsias, roses, and lilies.

In the crypt below are the robing rooms of the clergy and the choir and the Sunday-school room. Its windows show the arms of every American diocese. Beneath the choir is the chantry, furnished in carved oak. Adjoining this room is the famous mausoleum erected to the memory of Alexander T. Stewart. It is constructed of statuary marble, and consists of fourteen bays, at the angles of which are triple columns of the most richly colored imported marbles arched above the elegantly carved capitals, with open tracery, through which the headlights of the colored glass are seen. The subjects of the thirteen windows relate to the passion, death, resurrection, and subsequent appearances of Christ, and are executed in admirable design and color. They were made by Heaton, Butler & Bayne, of London. Above the window openings rises a dome-shaped ceiling, in carved marble, with a pendent canopy in the center. The pavement, of black and white marbles, radiates from the center of the sides of this polygonal structure, and a large white urn, delicately draped after Sibbel's designs, stands under the pendent canopy. It bears Mr. Stewart's name. The two entrances to the mausoleum are guarded by open-work bronze gates of elegant design and workmanship.—*N. Y. Tribune.*

MOVABLE MARKET BUILDINGS.

The furnishing of food supplies has always been a question of great importance to cities, and there are few of the latter, great or small, where the establishment of markets is not the order of the day.

At Paris especially, by reason of the massing of the population, which is annually increasing, the multiplicity of the wants to be satisfied renders the solution of this question more and more difficult. The old markets, some of the types of which still exist in various parts of Paris, were built of masonry and wood. They were massive structures into which the air and light penetrated with difficulty, and which consequently formed a dangerous focus of infection for those who occupied them, and for the inhabitants of the neighboring houses. So the introduction of iron into the construction of markets will bring about a genuine revolution whose influence will soon make itself felt in all branches of the builder's art.

The Central Markets were to have been built of masonry, and the work had even been begun, when, under the pressure of public opinion, the architect, Mr. Baltard, was led to use iron. Evidently, the metal that permits of covering vast spaces with the use of distant bearing points that present a small surface in plan, and leaves between them wide openings that the sun and air can enter in quantity, was the only thing that was capable of giving the solution sought. So it has been said, and rightly, that the Central Markets are, as regards the distribution and rational use of materials, the most beautiful of the structures of modern Paris. This system of construction at once met with great success, and the old markets are everywhere gradually disappearing, in order to give place to the new style of buildings.

Notwithstanding their number, the Parisian markets long ago became insufficient, and wants increased with such rapidity that it became impossible to supply them. The municipal administration was therefore obliged, especially in populous quarters, to tolerate perambulating peddlers, who carried their wares in hand carts. This system has the drawback that it interferes considerably with travel, and especially in streets where the latter is most active. Moreover, the merchants and their goods are exposed to the inclemency of the weather. In other places, where large spaces were utilizable, such as squares and avenues, very light structures, that could be easily put together and taken apart, were erected, and markets were opened in these once or twice a week. This method presents serious advantages. Iron markets, in fact, despite the immense progress that they mark, present disadvantages that are inherent to all stationary structures. It is necessary to erect them in populous centers, where land is consequently of great value; and the structure itself is costly.

The result is that the prime cost is very great, and this forces the city to charge the merchants high rents, and the consumer has to pay for it. With movable markets, on the contrary, the city can utilize large areas of unproductive ground, and find new resources, although renting the stalls at a minimum price. The expense connected with the structure itself is very small. In fact, the distinguishing character of such structures is their portability—so that the same shed can be used in any number of different places.

The principal expense, then, will be for carriage; but it is easy to see that there will always be an economy in their use. This is a fact, moreover, that practice has verified, for it is well known that Paris does not get her expenses back from her stationary markets, while the movable ones yield a revenue.

On another hand, as stationary markets are costly, it results that they cannot be multiplied as much as necessary, and so a portion of the inhabitants are daily submitted to a loss of time in reaching the one nearest them.

Finally, from a hygienic standpoint, movable markets present a very great advantage over stationary ones. The latter, in fact, notwithstanding their large open spaces, never get rid of the vitiated air that they contain, and the bad odors that emanate from them are also a source of annoyance and danger to the neighborhood. In movable ones, on the contrary, when the structure is taken apart, the air, sun, and rain disperse all bad odors, and the place is rendered wholesome in an instant.

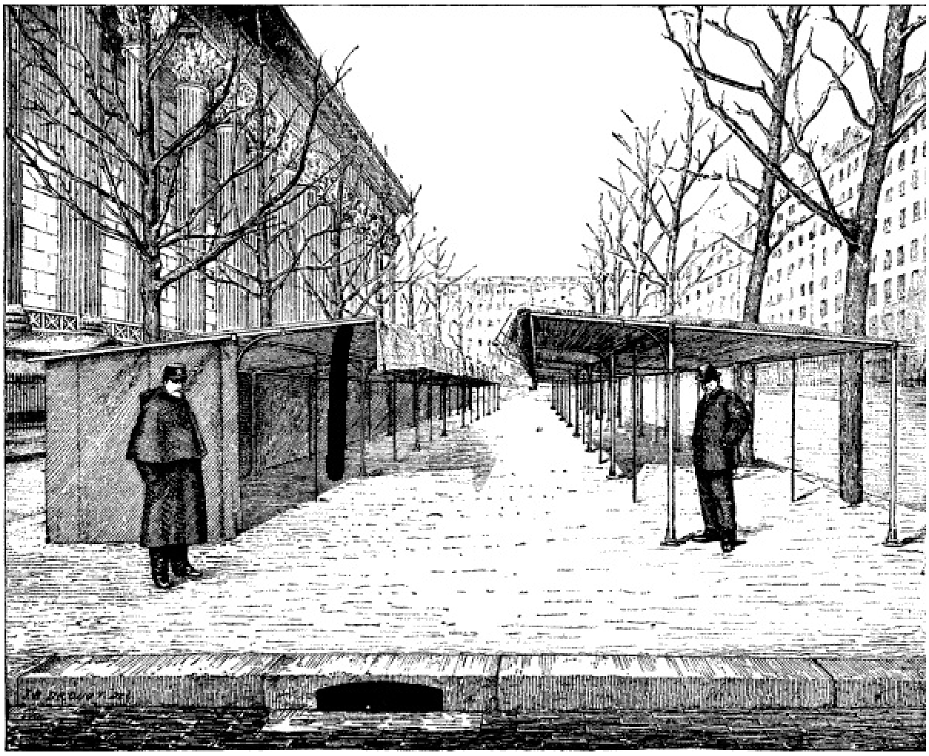
We have now demonstrated what great advantages the city of Paris and her population might derive from the establishing of movable markets.

It is easy to see that well established structures of this kind would render great services in small towns also. They might entirely replace stationary iron markets, the high cost of which often causes municipalities to preserve their old, inconvenient, and unhealthy structures. As a general thing, market is held but once or twice a week in small towns. In the interior the structure could be taken apart, and the place rendered free.

The question, then, is to have a system of construction that shall satisfy the different parts of the programme that we have just laid out, that is to say, strength, lightness, rapidity of erection, and ease of carriage. The shelters that are at present employed for movable markets at Paris are very primitive, and are wanting in solidity and convenience. They consist simply of wooden uprights to which are affixed cross-pieces that support an impermeable canvas.

In order to render it possible to extend the system of movable markets, it became necessary to first find and study the proper material.

During the year 1883 the city of Paris resolved to make some experiments, and the Direction of Municipal Affairs commissioned Mr. Andre, director of the Neuilly works, to submit to him a plan for a structure that could be easily taken apart. The plan finally proposed seemed to meet all the requirements of the case, and a group of ten structures was erected. The trial that was made of these proved entirely satisfactory. The city then made concession to the Neuilly company, for six years, of the market in Boulevard Richard-Lenoir, of those of La Reine Park, and of the Madeleine flower markets. A six months' trial has shown the great resistance of the materials that we are about to describe in detail.



THE MOVABLE MADELEINE FLOWER MARKET AT PARIS.

The structure is supported by cylindrical hollow iron uprights that are firmly connected with the ground as follows: At the places where they are to be fixed, small catches are inserted in the ground so that their upper surface comes flush therewith. These catches consist of two cast iron sides bolted together, and of a bottom and ends formed of flat iron—the end pieces being bent so as to form cramp irons. Each of the sides is provided internally with a projecting piece, and an inclined plane as a wedge. In case the catch becomes filled with dirt, it can be easily cleaned out with a scraper. The iron upright terminates in a malleable cast iron shoe, which is screwed on to it, and which is provided beneath with a projection in the form of a reversed T, the upper part of the horizontal branches of which is beveled off in a direction opposite that of the inclined planes of the catch. This projection enters through the slit and fits into the two wedges, and a simple blow of a hammer suffices to make the adherence perfect.

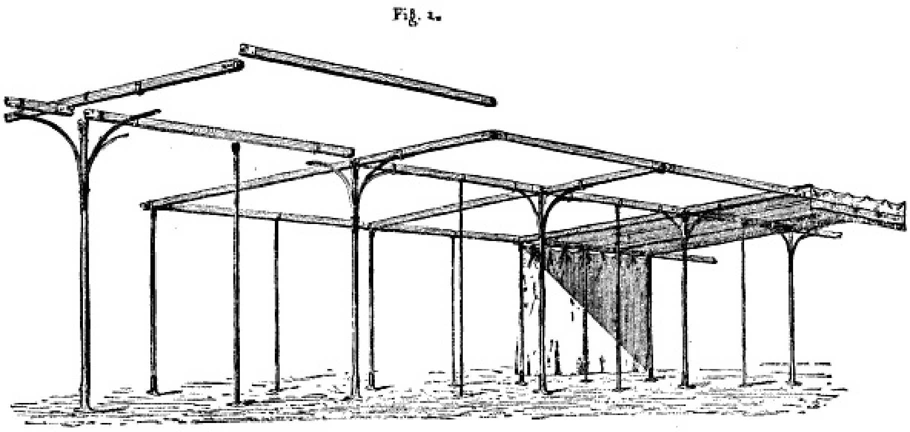


Fig. 1.—General View of a Movable Market.

The front and hind uprights differ only in length, and the roof timbers are joined at their upper extremities. The figures so well show how the parts are fitted together as to render an explanation unnecessary.

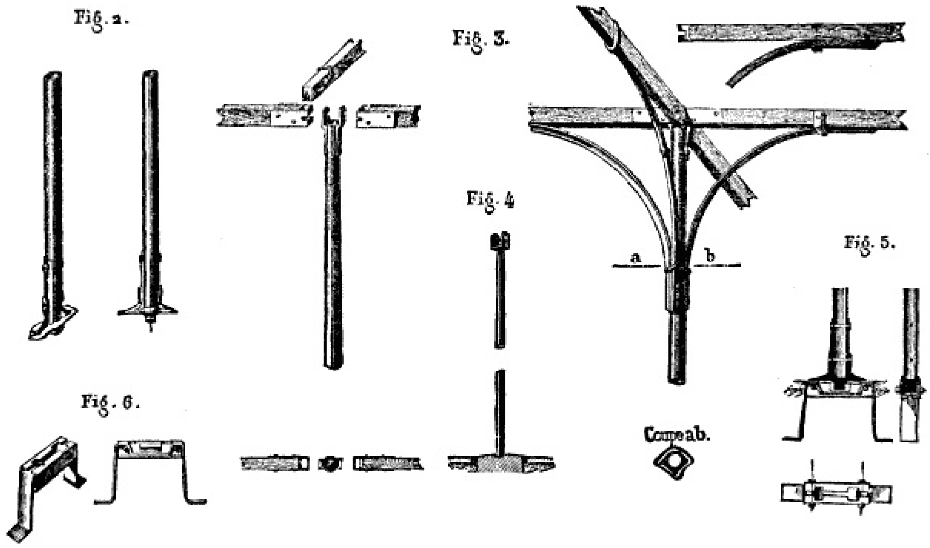


Fig. 2.—Shoes. Fig. 3.—Mode of Joining the Roof Timbers. Fig. 4.—Iron Support. Fig. 5.—Section of a Shoe Inserted in the Catch.— Fig. 6.—Catches.

The dimensions of these structures vary from 6.5 to 5.75 feet in length by 6.5 in width and 6 in height. The rafters are prolonged so as to project 4.25 feet in front, in order to form a protection for the purchaser. This part of the rafters, as well as the longitudinals, is supported by three curved iron braces, which are put in place as follows: The timbers are provided with a ring fixed by a screw, and one extremity of the brace is inserted into this, while the other is held against the upright by a sliding iron socket. The longitudinal timbers are supported between each two uprights by an iron rod that rests upon a block of stone fixed in the ground.

The front ends of the rafters are connected by a longitudinal, 18 feet in length.

The structure is covered with waterproof canvas held in place by wooden rods, to which it is attached.

Fig. 7.—Waterproof Canvas.

The wood employed is pitch pine.

An entire market of 300 stalls can be put up in three hours by one workman and four assistants.—*Le Genie Civil*.

DINOCRATES' PROJECT.

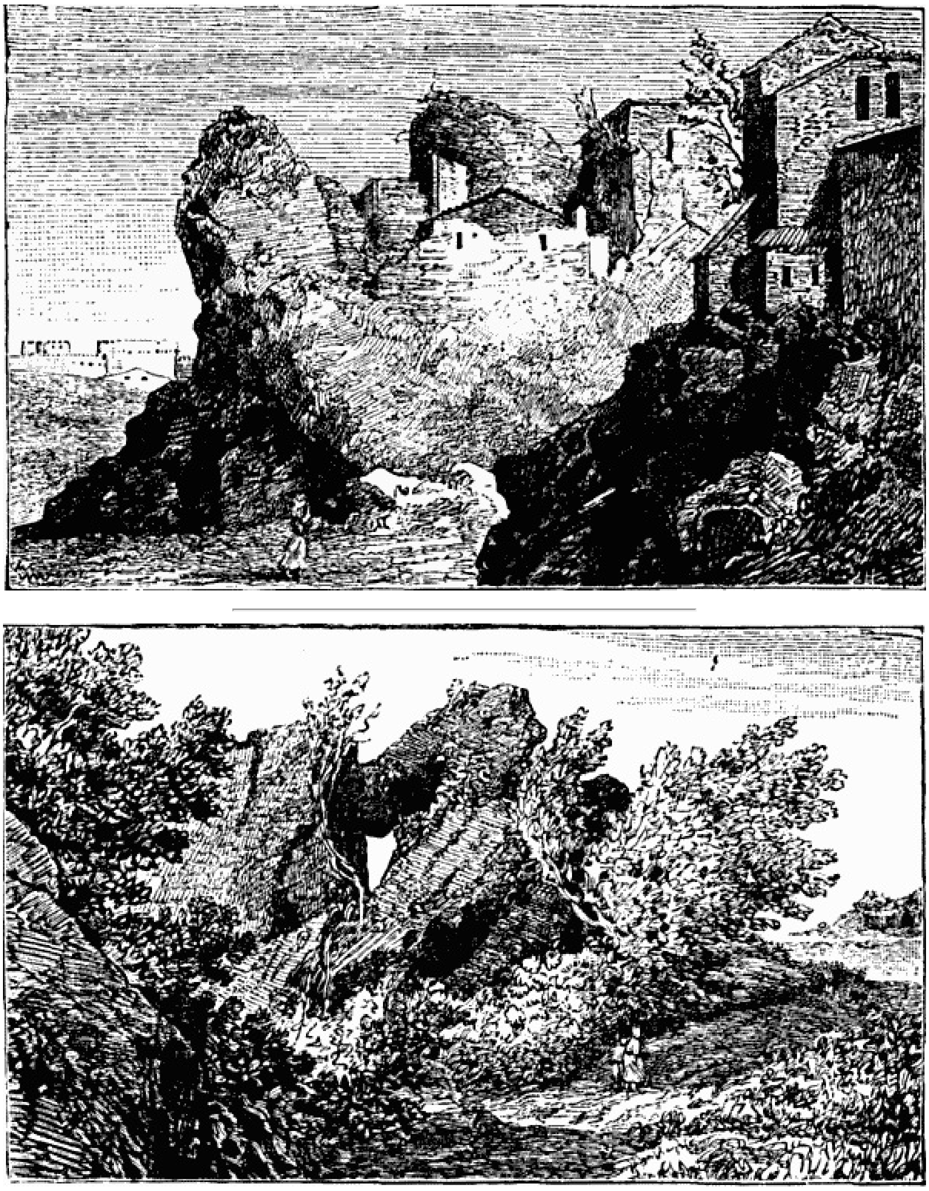
Vitruvius relates that the architect Dinocrates proposed to Alexander the Great to carve Mount Athos in such a way as to give it the shape of a man, whose one hand should support an entire city, and whose other should carry a cup which received all the waters from the mountain, and from which they overflowed into the sea.

Alexander, charmed with the idea, asked him if this city was to be surrounded by land capable of supplying it with the grain necessary for its subsistence. Having ascertained that the provisioning could only be done by sea, Alexander said: "Dinocrates, I grant the beauty of your project; it pleases me, but I think that any one who should take it into his head to establish a colony in the place you propose would run the risk of being taxed with want of foresight; for, just as a child can neither feed nor develop without the milk of a nurse, so a city cannot increase without fertile fields, have a large population without plenty of food, and allow its inhabitants to subsist without rich harvests; so, while giving the originality of your plan my approval, I have to say to you that I disapprove of the place that you have selected for putting it into execution. But I want you to stay near me, because I shall have need of your services."

This gigantic project had doubtless been suggested to the Macedonian architect by the singular forms that certain mountains affect. It is not rare, in fact, to see human profiles delineated upon the sky, and this phenomenon especially happens in countries where the folded limestone strata have been broken up in such a way as to give rise to deep valleys perpendicular to the direction of the chain. If we look at these folds from below in an oblique direction, we shall see them superposed upon one another in such a way as to represent figures that recall a human profile.

Fig. 1. LANDSCAPE BY FATHER KIRCHER.

In the seventeenth century, Father Kircher conceived the idea of taking up Dinocrates' plan upon a small scale, and composed the landscape shown in Fig. 1. The drawing remained engraved for a long time upon a marble tablet set into the wall of Cardinal Montalte's garden at Rome. Later on, artists improved and varied this project, as shown in Figs. 2 and 3. By looking at these cuts from the sides of the page, it will be seen that they form human profiles. Fig. 2 represents an old woman, and Fig. 3 a man whose beard and hair are formed by shrubbery.



Figs. 2 and 3.—LANDSCAPES SHOWING PROFILES OF HUMAN FACE.

We do not think that these conceptions have ever been realized, although Heron in his treatise on Dioptra, and Father Scott in his Parastatic Magic, have described instruments that permit of making the necessary outlines to cause grounds to present a given aspect from a given point. These instruments consist essentially of a vertical transparent frame upon which is drawn a vertical projection of the landscape that it is desired to obtain.

In the island of Goa, near Bombay, there is a singular vegetable called "the sorrowful tree," because it only flourishes in the night. At sunset no flowers are to be seen, and yet after half an hour it is full of them. They yield a sweet smell, but the sun no sooner begins to shine upon them than some of them fall off, and others close up; and thus it continues flowering in the night during the whole year.

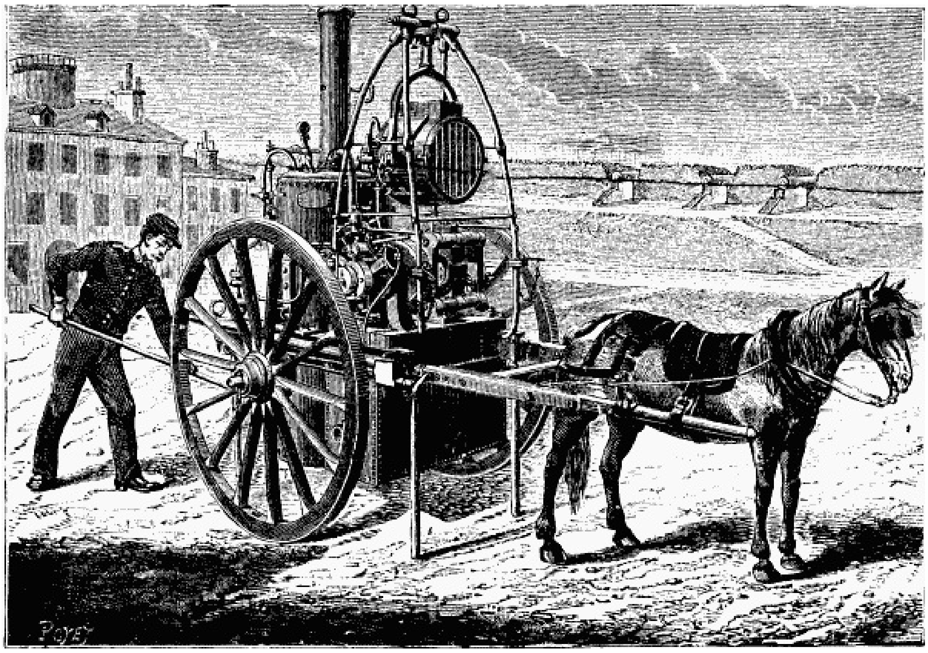
THE CRUTO INCANDESCENT LAMP.

An electrical exhibition on a comparatively small scale was opened in Paris, March 22, 1885, with considerable eclat, the President of the Republic being present. Engines to the extent of 200 H. P. are employed to work the lights. Among the exhibits is the Cruto light. *Engineering* says: At the first glance it presents the same appearance as an Edison lamp, having the same form of globe, and apparently a similar luminous filament. But this latter is made in an entirely different manner. A platinum wire is employed, 1/100 of a millimeter in diameter. This is obtained by the Wollaston process, that is to say, a piece of coarse platinum wire is covered with a stout coating of silver., and drawn down till the outside diameter is 1/10 millimeter. The silver coating is then dissolved in a bath of nitric acid, and the platinum wire is left behind. This wire is then cut into lengths, bent into a U form, and placed in a glass globe, in which circulates a current of bicarbonated hydrogen obtained by the action of sulphuric acid on alcohol. This gas, previously purified, circulates around the platinum filament, through which an electric current is passed sufficient to bring it to a red heat. This decomposes the gas, and a thin coating of absolutely pure carbon is deposited on the wire. The operation is continued until a sufficient thickness of carbon has been deposited for each type of lamp, and the method of regulating the amount of deposit is effected very simply, and, in fact, almost automatically. Indeed, one of the most interesting features of the process is its great simplicity, although it is somewhat more costly than the ordinary methods of producing incandescence lamps. After having been subjected to the action of the gas for two or three hours, the filament is taken from the glass globe, its diameter is carefully measured, the length is calibrated, and it is set on a platinum support, to which it is soldered by a very ingenious process. The filament is then introduced into a second glass globe charged with bicarbonate of hydrogen; it is placed between pincers that hold the carbon near its union with the platinum, and the platinum some millimeters below. These pincers are then thrown into circuit, and a powerful current is passed through the part which is to be soldered. The platinum and carbon become incandescent, the bicarbonate is decomposed, and a fresh deposit of carbon solders the filament to its support. The system thus mounted is placed within the permanent globe, and a vacuum is obtained in the ordinary way, while the testing and finishing details present nothing of special interest. The finished lamp is then photometrically tested, and placed on a support something like the Edison mounting. Upon it are engraved the working constants. As an ordinary practical result, these lamps, working with 50 volts and 1.15 amperes, give a luminous intensity of 20 candles, or the equivalent in luminous spherical intensity of 1.1 Edison A lamps. This result is interesting, especially as the life of the lamp ranges from 900 to 1,100 hours, as was demonstrated by various careful tests made with some 250 lamps; the most valuable trials having taken place at the Turin Exhibition. After prolonged use, a diminution in the fall of potential is produced, to a more marked degree than in the Edison lamp, and the light can be maintained constant by increasing the strength of the current in a proportion that can be determined by means of resistances. The Cruto filament examined under the microscope appears to be uniformly magnetic, and is very regular, except at the curved parts where the diameter is slightly diminished, and it is here that rupture generally takes place. The great structural regularity of the filament probably accounts for its high durability, and from the fact that it may be worked with a higher current than probably any other form of incandescence lamp. M. Desroziers in a series of experiments obtained as much as 250 carcel spherical luminous value per horse-power; this characteristic is one likely to be of great value in electric lighting by incandescence of high intensity. At present only 20-candle lamps are made on the Cruto system. The carbon filament, when properly prepared, is gray in hue and of metallic appearance; it is built up in very fine laminæ indicating the mode of manufacture. The results obtained with these lamps vary as much as 25 per cent., according to the care bestowed in producing the filament. If traces of air exist in the globe, they very quickly manifest themselves by the surface of the glass becoming blackened, while an increased energy is required to maintain the brightness of the light.

In the early days of this lamp it was thought necessary to remove the delicate platinum wire which forms the core of the filament, by raising the strength of the current sufficiently to destroy it in the course of manufacture. This, however, was given up, and the platinum now remains either as a continuous wire or as a series of small separated granules.

ELECTRIC LIGHT APPARATUS FOR MILITARY PURPOSES.

In the first period of the siege of a stronghold it is of very great importance for the besieged to embarrass the first progress of the attack, in order to complete their own armament, and to perform certain operations which are of absolute necessity for the safety of the place, but which are only then possible. In order to retard the completion of the first parallel, and the opening of the fire, it is necessary to try to discover the location of such parallel, as well as that of the artillery, and to ply them with projectiles. But, on their side, the besiegers will do all in their power to hide their works, and those that they are unable to begin behind natural coverts they will execute at night. It will be seen from this how important it is for the besieged to possess at this stage of events an effective means of lighting up the external country. Later on, such means will be of utility to them in the night-firing of long-range rifled guns, as well as for preventing surprises, and also for illuminating the breach and the ditches at the time of an assault, and the entire field of battle at the time of a sortie.



ELECTRIC LIGHT APPARATUS FOR ARMY USE.

On a campaign it will prove none the less useful to be provided with movable apparatus that follow the army. A few years ago. Lieut. A. Cuvelier, in a very remarkable article in the *Revue Militaire Belge*, pointed out the large number of night operations of the war of 1877, and predicted the frequent use of such apparatus in future wars.

The accompanying engraving represents a very fine electric light apparatus, especially designed for military use in mountainous countries. It consists of a two-wheeled carriage, drawn by one horse and carrying all the apparatus necessary for illuminating the works of the enemy. The machine consists of the following parts: (1) A field boiler. (2) A Gramme electric machine, type M, actuated directly by a Brotherhood 3-cylinder motor. (3) A Mangin projector, 12 inches in diameter, suspended for carriage from a movable support. This latter, when the place is reached where the apparatus is to operate, may be removed from the carriage and placed on the ground at a distance of about a hundred yards from the machine, and be connected therewith by a conductor. Col. Mangin's projector consists of a glass mirror with double curvature, silvered upon its convex face. It possesses so remarkable optical properties that it has been adopted by nearly all powers. The fascicle of light that it emits has a perfect concentration. In front of the projector there are two doors. The first of these, which is plane and simple, is used when it is desired to give the fascicle all the concentration possible; the other, which consists of cylindrical lenses, spreads the fascicle horizontally, so as to make it cover a wider space.

The range of the concentrated fascicle is about 86,000 feet. The projector may be pointed in all directions, so as to bring it to bear in succession upon all the points that it is desired to illuminate. The 12-inch projector is the smallest size made for this purpose. The constructors, Messrs. Sautter, Lemonnier & Co., are making more powerful ones, up to 36 inches in diameter, with a corresponding increase in the size of the electric machines, motors, and boilers.

The various powers make use of these apparatus for the defense of fortresses and coasts, for campaign service, etc.

The various parts of the apparatus can be easily taken apart and loaded upon the backs of mules. The only really heavy piece is the boiler, which weighs about 990 pounds.

ELECTRICITY AND MAGNETISM.[1]

Prof. Francis E. Nipher.

It was known six hundred years before Christ that when amber is rubbed it acquires the power of attracting light bodies. The Greek name for amber, *elektron*, was afterward applied to the phenomenon. It was also known to the ancients that a certain kind of iron ore, first found at Magnesia, in Asia Minor, had the property of attracting iron. This phenomenon was called magnetism. This is the history of electricity and magnetism for two thousand years, during which these facts stood alone, like isolated mountain peaks, with summits touched and made visible by the morning sun, while the region surrounding and connecting them lay hidden and unexplored.

In fact, it is only in more recent times that men could be found possessing the necessary mental qualities to insure success in physical investigation. Some of the ancients were acute observers, and made valuable observations in descriptive natural history. They also observed and described phenomena which they saw around them, although often in vague and mystical terms.

They, however, were greatly lacking in power to discriminate between the possible and the absurd, and so old wives' tales, acute speculations, and truthful observations are strangely jumbled together. With rare exceptions they did not contrive new conditions to bring about phenomena which Nature did not spontaneously exhibit—they did not experiment. They attempted to solve the universe in their heads, and made little progress.

In mediæval times intellectual men were busy in trying to set each other right, and in disputing and arguing with those who believed themselves to be right. It was an era of intellectual pugilism, and nothing was done in physics. In fact, this frame of mind is incompatible with any marked success in scientific work.

The physical investigator cannot take up his work in the spirit of controversy; for the phenomena and laws of Nature will not argue with him. He must come as a learner, and the true man of science is content to learn, is content to lay his results before his fellows, and is willing to profit by their criticisms. In so far as he permits himself to assume the mental attitude of one who defends a position, in so far does he reveal a grave disqualification for the most useful scientific work. Scientific truth needs no man's defense, but our individual statements of what we believe to be truth frequently need criticism. It is hardly necessary to remark, also, that critics are of various degrees of excellence, and it seems that those in whom the habit of criticism has become chronic are of comparatively little service to the world.

The great harbinger of the new era was Galileo. There had been prophets before him, and after him came a greater one—Newton. They did nothing of note in electricity and magnetism, but they were filled with the true spirit of science, they introduced proper and reasonable methods of investigation, and by their great ability and distinguished success they have produced a revolution in the intellectual world. Other great men had also appeared, such as Leibnitz and Huyghens; and it became very clear that the methods of investigation which had borne such fruit in the days of Galileo were not disposed of completely by his unwilling recantation; it became very clear that the new civilization which was dawning upon Europe was not destined to the rude fate which had overwhelmed the brilliant scientific achievements of the Spanish Moors of a half century before.

Already in 1580, about the time when Galileo entered Pisa as a student, Borroughs had determined the variation of the magnetic needle at London, and we have upon the screen a view of his instrument, which seems rude enough, in comparison with the elaborate apparatus of our times. The first great work on electricity and magnetism was the "De Magnete" of Gilbert, physician of Queen Elizabeth, published in 1600. Galileo, already famous in Europe, recognized in the methods of investigation used by Gilbert the ones which he had found so fruitful, and wrote of him, "I extremely praise, admire, and envy this author."

Gilbert made many interesting contributions to magnetism, which we shall notice in another lecture, and he also found that sulphur, glass, wax, and other bodies share with amber the property of being electrified by friction. He concluded that many bodies could not be thus electrified. Gray, however, found in 1729 that these bodies were conductors of electricity, and his discoveries and experiments were explained and described to the president of the Royal Society while on his death bed, and only a few hours before his death. If precautions are taken to properly insulate conductors, all bodies which differ in any way, either in structure, in smoothness of surface, or even in temperature, are apparently electrified by friction. In all cases the friction also produces heat, and if the bodies rubbed are exactly alike, heat only is produced.

An electrified body will attract all light bodies. This gutta percha when rubbed with a cat's skin attracts these bits of paper, and this pith ball, and this copper ball; it moves this long lath balanced on its center, and deflects this vertical jet of water into a beautiful curve.

If a conductor is to be electrified, it must be supported by bad conductors. This brass cylinder standing on a glass column has become electrified by friction with cat's-skin. My assistant will stand upon this insulating stool, and by stroking his hand you will observe that with his other hand he can attract this suspended rod of wood, and you will hear a feeble spark when I apply my knuckle to his.

Du Fay, of Paris, discovered what he called two kinds of electricity. He found that a glass rod rubbed with silk will repel another glass rod similarly rubbed, but that the silk would attract a rubbed glass rod. We express the facts in the well-known law that like electricities repel each other, and unlike attract. For a long time the nature of the distinctions between the two electricities was not understood. It was found later that when the two bodies are rubbed together they become oppositely electrified, and that the two electricities are always generated in equal quantity; so that if the two bodies are held in contact after the rubbing has ceased the two electricities come together again and the electrical phenomena disappear. They have been added together, and the result is zero. Franklin proposed to call these electricities positive and negative. These names are well chosen, but we do not know any reason why one should be called positive rather than the other. The electricity generated on glass when rubbed with silk is called positive.

Let us now examine the distinction between positive and negative electricities somewhat more closely, aiding ourselves by two cases which are somewhat analogous.

Two air-tight cylinders, A and B, contain air at ordinary pressure. The cylinders are connected by a tube containing an air-pump in such a way that, when the pump is worked, air is taken from A and forced into B. To use the language of the electricians, we at once generate two kinds of pressure. The vessels have acquired new properties. If we open a cock in the side of either vessel, we hear a hissing sound, if a light body is placed before the opening in A it would be attracted, and before the opening in B it would be repelled. Now this is only roughly analogous to the case of the electrified bodies, but the analogy will nevertheless aid us in our study. If the two vessels are first connected with the air, and then closed up and the pump is set to work, we increase the pressure in B and diminish the pressure in A. To do this requires the expenditure of a quantity of work. If the cylinders are connected by an open tube—a conductor—the difference in pressure disappears by reason of a flow of gas from one vessel to the other.

If we had a pump by means of which we could pump heat from one body into another, starting with two bodies at the same temperature, the temperature of one body would increase and that of the other would diminish. If we knew less than we do of heat, we might well discuss whether the plus sign should be applied to the heat or to the cold, because these names were coined by people who knew very little about the subject except that these bodies produce different sensations when they come in contact with the human body.

Furthermore, we find that whether the hand is applied to a very hot body or to a very cold body, the physiological effect is the same. In each case the tissue is destroyed and a burn is produced. Shall we now say that this burn is produced by an unusual flow of heat from the hot body to the hand, or from the hand to the cold body, or shall we say that it is due to an unusual flow of cold from the cold body to the hand, or from the hand to the hot body?

Logically these expressions are identical; still we have come to prefer one of them. It is because we have learned that in those bodies which our fathers called hot, the particles are vibrating with greater energy than in cold bodies, that we prefer to say that heat is added and not cold subtracted, when a cold body becomes less cold.

Now to come back to our electrified bodies. Let us suppose that this gutta percha, and this cat's-skin are not electrified. That means that their electrical condition is the same as that of surrounding bodies. Let us also suppose that their thermal condition is the same as surrounding bodies, ourselves included—that is, they are neither hot nor cold. We express these conditions in other words by saying that the bodies have the same electrical *potential* and the same temperature.

Temperature in heat is analogous to potential in electricity. As soon as adjacent bodies are at different temperatures, we have the phenomena which reveal to us the existence of heat. As soon as adjacent bodies have different electrical potentials, we have the phenomena which reveal the existence of electricity. As soon as adjacent regions in the air are at different pressures, we have phenomena which reveal the existence of air.

Bodies all tend to preserve the same temperature and also the same electrical potential. Any disturbances in electrical equilibrium are much more quickly obliterated than in case of thermal equilibrium, and we therefore see less of electrical phenomena than of thermal. In thunder storms we see such disturbances, and with delicate instruments we find them going on continuously. Changes in temperature occurring on a large scale in our atmosphere, occurring in these gas jets, in our fires, in the axles of machinery, and in thousands of other places, are so familiar that we have ceased to wonder at them.

If we rub these two bodies together, the potential of the two is no longer the same.

We do not know which one has become greater, and in this respect our knowledge of electricity is less complete than of heat. We assume that the gutta percha has become negative. If we now leave these bodies in contact, the potential of the cat's skin will diminish and that of the gutta percha will increase until they have again reached a common potential—that of the earth. As in the case of heat and cold, we may say either that this has come about by a flow of positive electricity from the cat's skin to the gutta percha, or by a flow of negative electricity in the opposite direction, for these statements are identical.

In case of our gas cylinders, the gas tends to leak out of the vessel where the pressure is great into the vessel where it is small. The heat tends to leak out of a body of high temperature into the colder one, or the cold tends to go in the opposite direction. Similarly, the plus electricity tends to flow from the body having a high potential, to the body having a low potential, or the minus electricity tends to go in the opposite direction.

[1] Introductory to the course of Lectures on Physics at Washington University, St. Louis, Missouri—*Kansas City Review.*

[ENGINEERING.]

THE HYDRODYNAMIC RESEARCHES OF PROFESSOR BJERKNES.

By Conrad W. Cooke.

We have in former articles described the highly interesting series of experimental researches of Dr. C. A. Bjerknes, Professor of Mathematics in the University of Christiania, which formed so attractive a feature in the Electrical Exhibition of Paris in 1881, and which constituted the practical development of a theoretical research which had extended over a previous period of more than twenty years. The experiments which we described in those articles were, as our readers will remember, upon the influence of pulsating and rectilinear vibrating bodies upon one another and upon bodies in their neighborhood, as well as upon the medium in which they are immersed. This medium, in the majority of Professor Bjerknes earlier experiments, was water, although he demonstrated mathematically, and to a small extent experimentally, that the phenomena, which bear so striking an analogy to those of magnetism, may be produced in air.

Our readers will recollect that in the spring of 1882 Mr. Stroh, by means of some very delicate and beautifully designed apparatus, was able to demonstrate a large number of the same phenomena in atmospheric air of the ordinary density; and about the same time Professor Bjerknes, in Christiania, was extending his researches to phenomena produced by a different class of vibrations, namely, those of bodies moving in oscillations of a circular character, such, for example, as a cylinder vibrating about its own axis or a sphere around one of its diameters; some of these experiments were brought by Professor Bjerknes before the Physical Society of London in the following June. Since that time, however, Professor Bjerknes, with the very important assistance of his son, Mr. Vilhelm Bjerknes, has been extending these experimental researches in the same direction, and with the results which it is the object of the present series of articles to describe.

The especial feature of interest in all Professor Bjerknes experiments has been the remarkably close analogy which exists between the phenomena exhibited in his mechanical experiments in water and other media and those of magnetism and of electricity, and it may be of some interest if we here recapitulate some of the more striking of these analogies.

(1.) In the first place, the vibrating or pulsating bodies, by setting the water or other medium in which they are immersed into vibration, set up in their immediate neighborhood a field of mechanical force very closely analogous to the field of magnetic force with which magnetized bodies are surrounded. The lines of vibration have precisely the same directions and form the same figures, while at the same time the decrease of the intensity of vibration by an increase of distance obeys precisely the same law as does that of magnetic intensity at increasing distances from a magnetic body.

(2.) When two or more vibrating bodies are immersed in a fluid, they set up around them fields of vibration, and act and react upon one another in a manner closely analogous to the action and reaction of magnets upon one another, producing the phenomena of attraction and repulsion. In this respect, however, the analogy appears to be inverse, repulsion being produced where, from the magnetic analogy, one would expect to find attraction, and *vice versa*.

(3.) If a neutral body, that is to say a body having no vibration of its own, be immersed in the fluid and within the field of vibration, phenomena are produced exactly analogous to the magnetic and diamagnetic phenomena produced by the action of a magnet upon soft iron or bismuth, its apparently magnetic or diamagnetic properties being determined by the specific gravity of the neutral body as compared to that of the medium in which it is immersed. If the neutral body be lighter than the medium, it exhibits the magnetic induction of iron with respect to polarity, but is nevertheless repelled; while if it be heavier than the medium, its direction is similar to that of diamagnetic bodies such as bismuth, but on the other hand exhibits the phenomena of attraction.

In this way Professor Bjerknes has been able to reproduce analogues of all the phenomena of magnetism and diamagnetism, those phenomena which may be classed as effects of induction being directly reproduced, while those which may be classed as effects of mechanical action, and resulting in change of place, are analogous inversely. This fact has been so much misunderstood both in this country and on the Continent that it will be well, before describing the experiments, to enter more fully into an explanation of these most interesting and instructive phenomena.

For the sake of clearness we will speak of magnetic induction as that property of a magnet by which it is surrounded by a field of force, and by which pieces of iron, within that field, are converted into magnets, and pieces of bismuth into diamagnets, and we will speak of magnetic action as the property of a magnet by which it attracts or repels another magnet, or by which it attacks or repels a piece of iron or bismuth magnetized by magnetic induction.

The corresponding hydrodynamic phenomena may be regarded in a similar manner; thus, when a vibrating or pulsating body immersed in a liquid surrounds itself with a field of vibrations, or communicates vibrations to other immersed bodies within that vibratory field, the phenomena so produced may be looked upon as phenomena of hydrodynamic induction, while on the other hand, when a vibrating or pulsating body attracts or repels another pulsating or vibratory body (whether such vibrations be produced by outside mechanical agency or by hydrodynamical induction), then the phenomena so produced are those of hydrodynamical action, and it is in this way that we shall treat the phenomena throughout this article, using the words *induction* and *direct action* in these somewhat restricted meanings.

In the hydrodynamical experiments of Professor Bjerknes all the phenomena of magnetic induction can be reproduced directly and perfectly, but the phenomena of magnetic action are not so exactly reproduced, that is to say, they are subject to a sort of inversion. Thus when two bodies are pulsating together and in the same phase (*i.e.*, both expanding and both contracting at the same time), they mutually attract each other: but if they are pulsating in opposite phases, repulsion is the result. From this one experiment taken by itself we might be led to infer that bodies pulsating in similar phases are the hydrodynamic analogues of magnets having their opposite poles presented to one another, and that bodies pulsating in opposite phases are analogous to a presentation of similar magnetic poles; but it will be seen at once that this cannot be the case if three magnetic poles or three pulsating bodies be considered instead of only two. It is clear, on the one hand, that three similar magnet poles will all repel one another, while, on the other, of three pulsating bodies, two of them must always attract one another, while a third would be repelled; and, moreover, two similarly pulsating bodies set up around them the same lines of force as two similar magnetic poles, and two oppositely pulsating bodies produce lines of force identically the same as those set up by two magnets of opposite polarity. Thus it will be seen that there is a break in the analogy between the hydrodynamical and the magnetic phenomena (if a uniform inversion of the effects can be called a break, for it is, as far as Professor Bjerknes' experiments go, without an exception); and if by any means this inversion could be reinverted, all the phenomena of magnetism and diamagnetism could be exactly reproduced by hydrodynamical analogues; there would thus be grounds for forming a theory of magnetism on the basis of mechanical phenomena, and a very important link in the chain of the correlation of the physical forces would be supplied.

While the experiments of Professor Bjerknes upon pulsating and rectilinearly vibrating bodies and their influence upon one another illustrate by very close analogies the phenomena of magnetism, those upon circularly vibrating bodies and their mutual influences bear a remarkable analogy to electrical phenomena; and it is a significant fact that exactly as in the case of magnetic illustration, the analogies are direct as regards the phenomena of induction, and inverse in their illustration of direct electrical action.

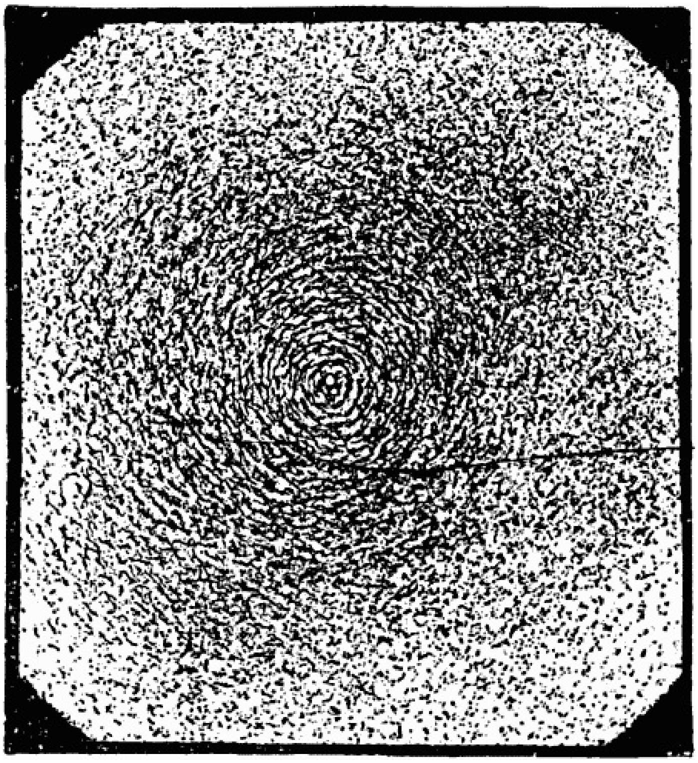


Fig. 1.

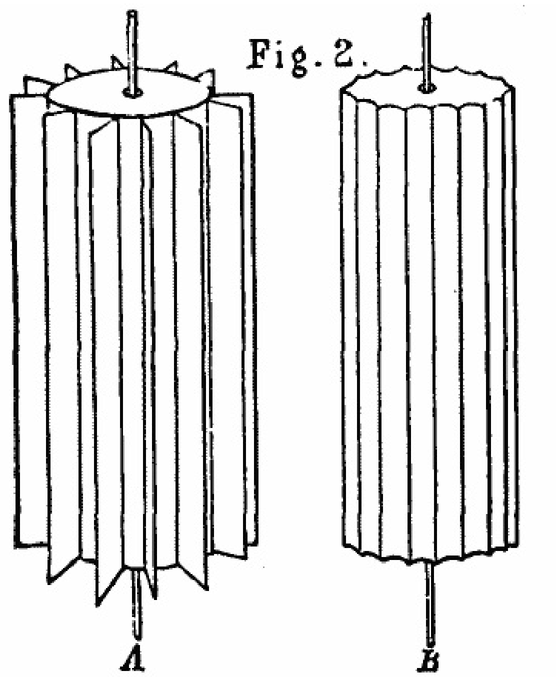


Fig. 2.

If we examine the figure produced by the field of force surrounding a conductor through which a current of electricity is being transmitted (see Fig. 1), we see that iron filings within that field arrange themselves in more or less concentric circles around the conductor conveying the current. From this fact Professor Bjerknes and his son, reasoning that, to produce a similar field of energy around a vibrating body, the vibrations of that body must partake of a circular or rotary character, constructed apparatus for producing the hydrodynamic analogue of electric currents, in which a conductor transmitting a current of electricity is represented by a cylinder to which oscillations in circles around its axis are given by suitable mechanical means, so as to cause the enveloping medium to follow its motion and make similar rotative vibrations. In some of the earlier experiments in this direction, cylinders carrying radial veins (A, Fig. 2) or fluted longitudinally around their surfaces (B, Fig. 2) were employed with the object of giving the vibrating cylinder a greater hold of the liquid in which they were immersed; but it was found that these vanes or flutings had but little or no effect upon water or liquids of similar viscosity, and Professor Bjerkes was led to adopt highly viscous fluids, such as Glycerin or maize sirup, both of which substances are well adapted for the experiments, being at the same time both highly viscous and perfectly transparent and colorless. In seeking, for the purpose of this research, a fluid medium which shall possess analogous properties to the luminiferous ether, or whatever may be the medium whose vibrations render manifest certain physical phenomena, it might be considered at first sight that substances so dense as glycerin and sirup could have but little in common with the ether, and that an analogy between experiments made within it and phenomena associated with ethereal vibrations would be of a very feeble description: but Professor Bjerknes has shown that the chief requisite in such a medium is that its viscosity should be great, not absolutely, but large only in proportion to its density, and if the density be small, the necessary viscosity may be small also. Neither is it necessary for the fluid medium to possess great internal friction, but what is necessary to the experiments is that the medium shall be one which is readily set into vibration by the action of the circularly vibrating cylinder; this property appears to be possessed exclusively by the more viscous fluids, and is, moreover, in complete accord with what is known of the luminiferous ether according to the theory of light.

The property is rather a kind of elasticity, which ordinary fluids do not possess, but which facilitates the propagation of transverse vibrations.

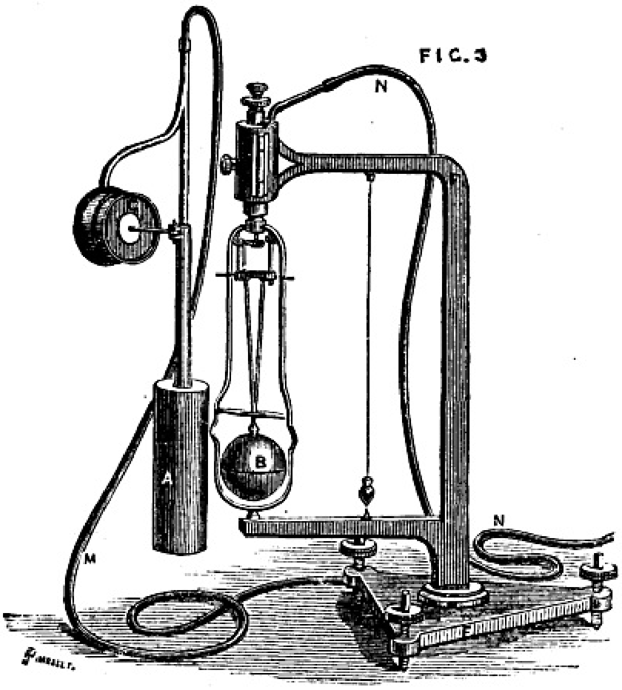


FIG. 3.

One form of apparatus for the propagation of rotative oscillations is shown to the left of Fig. 3, and consists of a cylinder, A, mounted on a tubular spindle, and which is set into circular oscillations around its axis by the little vibrating membrane, C, which is attached to the axis of the cylinder by a little crank and connecting rod shown in detail in Fig. 4. This membrane is set into vibration by a rapidly pulsating column of air contained in a flexible tube M. by which apparatus is connected to the pulsation pump which was employed by Professor Bjerknes in his earlier experiments. In Fig. 5, a somewhat similar apparatus for producing horizontal vibrations is shown, and marked N H C, the only difference between them being one of mechanical detail necessitated by the change in the position of axis of vibration from the vertical to the horizontal.

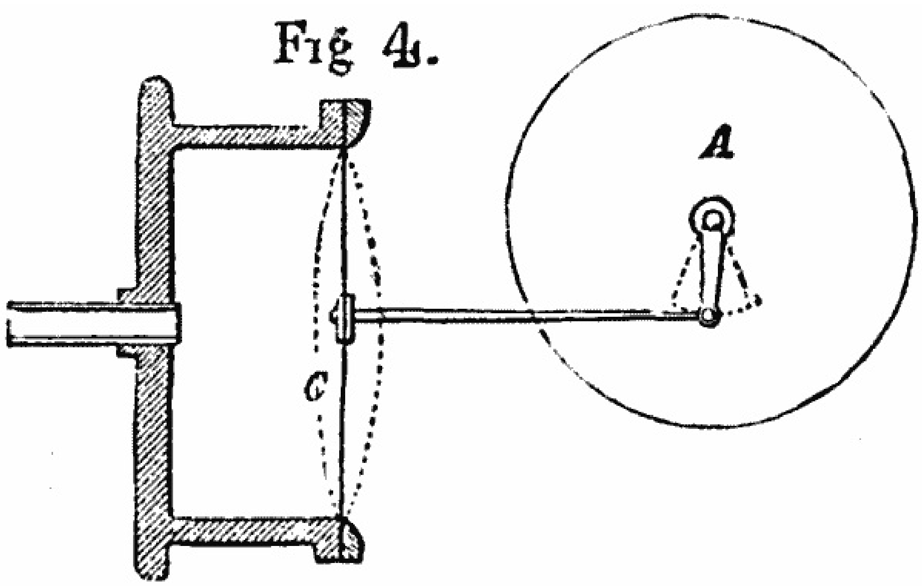


FIG. 4.

If circularly vibrating cylinders, such as we have described, be immersed in a viscous fluid and set into action, the following phenomena may be observed: 1. The effect upon the fluid itself, setting up therein a field of vibration, and corresponding by analogy with the production of a field of force around a wire conveying an electric current. 2. The effect upon other circularly vibrating bodies within that field of force corresponding to the action and reaction of electric currents upon one another. 3. The effect on pulsating and oscillating bodies similarly immersed, illustrating the mutual effects upon one another of magnets and electric currents. The first of these effects is one of induction, and, from what has been said from an earlier part of this article, it will be understood that the analogy between the hydrodynamic and the electric phenomena is direct and complete. The effects classified under the second and third heads, being phenomena of direct action (in the restricted use of the word), are uniformly analogous to the magnetic and electric phenomena which they illustrate.

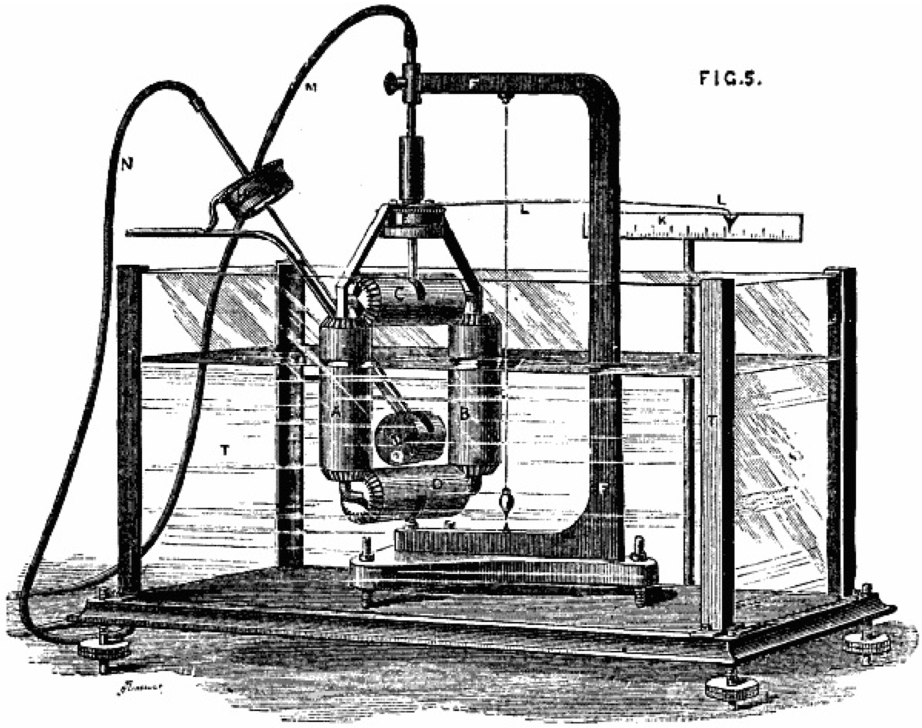


Fig. 5.

(*To be continued.*)

THE XYLOPHONE.

Like most musical instruments, the xylophone, had its origin in very remote times. The Hebrews and Greeks had instruments from which the one of to-day was derived, although the latter has naturally undergone many transformations. Along about 1742 we find it widely in use in Sicily under the name of *Xylonganum*. The Russians, Cossacks, and Tartars, and especially the mountain population of the Carpathians and Ural, played much upon an instrument of the same nature that they called *Diereva* and *Saloma*.

Fig. 1.—METHOD OF PLAYING UPON THE XYLOPHONE.

It appears that the xylophone was played in Germany as early as the beginning of the 16th century. After this epoch it was in use for quite a long period, but gradually fell into oblivion until the beginning of the present century. It was toward 1830 that the celebrated Russian Gussikow undertook a grand artistic voyage through Europe, and gained a certain renown and received many honors due to his truly original productions. Gussikow possessed a remarkable *technique* that permitted the musical instrument which he brought into fashion to be appreciated for all its worth.

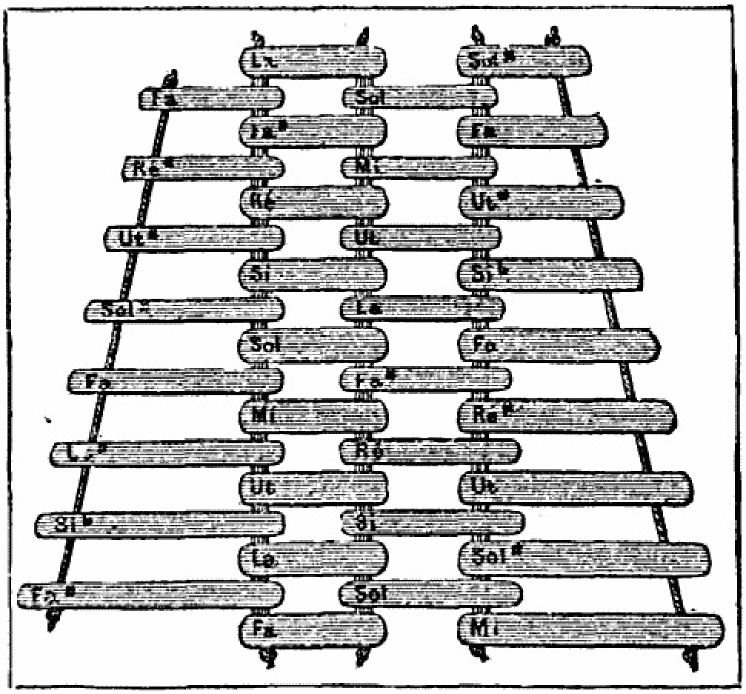


Fig. 2.—PLAN VIEW OF THE XYLOPHONE.

As the name, "instrument of wood and straw," indicates, the xylophone (which Fig. 1 shows the mode of using) consists of small pieces of wood of varying length, and narrow or wide according to the tone that it is desired to get from them. These pieces of wood are connected with each other by cords so as to form a triangular figure (Fig. 2) that may be managed without fear of displacing the parts. The whole is laid upon bands of straw designed to bring out the sounds and render them stronger and purer. The sounds are produced by striking the pieces of wood with a couple of small hammers. They are short and jerky, and, as they cannot be prolonged, nothing but pieces possessing a quick rhythm can be executed upon the instrument. Dances, marches, variations, etc., are played upon it by preference, and with the best effect.

The popularity of this instrument is making rapid progress, and it is beginning to be played in orchestras in France [as it has been in America for many years]. A method of using it has just been published, as well as pieces of music adapted to it, with piano, violin, orchestra, etc., accompaniment.

ELECTROTYPING.

This eminently useful application of the art of electrotyping originated with Volta, Cruickshank, and Wollaston about 1800 or 1801. In 1838, Spencer, of London, made casts of coins, and cast in intaglio from the matrices thus formed; in the same year Jacobi, of Dorpat, in Russia, made casts by electro deposit, which caused him to be put in charge of the work of gilding the dome of St. Isaac at St. Petersburg.

Electrotyping for the purposes of printing originated with Mr. Joseph A. Adams, a wood-engraver of New York, who made casts (1839-41) from wood-cuts, some engravings being printed from electrotype plates in the latter year. Many improvements in detail have been added since, in the processes as well as the appliances. Robert Murray introduced graphite as a coating for the form moulds. He first communicated his discovery to the Royal Institution of London, and afterward received a silver medal from the Society of Arts.

BLACKLEADING THE FORM.

The process of electrotyping is as follows: The form is locked up very tightly, and is then coated with a surface of graphite, commonly known as blacklead, but it is a misnomer. This is put on with a brush, and may be done very evenly and speedily by a machine in which the brush is reciprocated over the type by hand-wheel, crank, and pitman. A soft brush and very finely powdered graphite are used; the superfluous powder being removed, and the face of the type cleaned by the palm of the hand.

TAKING THE MOULD.

A shallow pan, known as a moulding pan, is then filled with melted yellow wax, making a smooth, even surface, which is blackleaded. The pan is then secured to the head of the press, and the form placed on the bed, which is then raised, delivering an impression of the type upon the wax.

The pan is removed from the head of the press, placed on a table, and then built up, as it is termed. This consists in running wax upon the portions where large spaces occur between type, in order that corresponding portions in the electrotype may not be touched by the inking roller, or touched by the sagging down of the paper in printing.

MAKING THE DEPOSIT.

The wax mould being built, is ready for blackleading, to give it a conducting surface upon which the metal may be deposited in the bath, superfluous blacklead being removed with a bellows. Blacklead, being nearly pure carbon, is a poor conductor, and a part of the metal of the pan is scraped clean, to form a place for the commencement of the deposit. The back of the moulding is waxed, to prevent deposit of copper thereon, and the face of the matrix is wetted to drive away all films or bubbles of air which may otherwise he attached to the blackleaded surface of the type.

The mould is then placed in the bath, containing a solution of sulphate of copper, and is made a part of an electric circuit, in which is also included the zinc element in the sulphuric-acid solution in the other bath. A film of copper is deposited on the blacklead surface of the mould; and when this shell is sufficiently thick, it is taken from the bath, the wax removed, the shell trimmed, the back tinned, straightened, backed with an alloy of type-metal, then shaved to a thickness, and mounted on a block to make it type-high.

A RECENT IMPROVEMENT

has been introduced in which there is added finely pulverized tin to the graphite for facing the wax mould; the effect in the sulphate of copper bath is to cause a rapid deposition of copper by the substitution of copper for the tin, the latter being seized by the oxygen, while the copper is deposited upon the graphite. The film is after increased by the usual means. Knight's expeditious process consists in dusting fine iron filings on the wet graphite surface of the wax mould, and then pouring upon it a solution of sulphate of copper. Stirring with a brush expedites the contact, and a decomposition takes place; the acid leaves the copper and forms with the iron sulphate a solution which floats off, while the copper is freed and deposited in a pure metallic form upon the graphite. The black surface takes on a muddy tinge with marvelous rapidity. The electric-connection gripper is designed to hold and sustain the moulding pan and make an electric connection with the prepared conducting pan of the mould only, while the metallic pan itself is out of the current of electricity, and receives no deposit.

BACKING-UP.

The thin copper-plate, when removed from the wax mould, is just as minutely correct in the lines and points as was the wax mould, and the original page of type. But it is obvious that the copper sheet is no use to get a print from. You must have something as solid as the type itself before it can be reproduced on paper. So a basis of metal is affixed to the copper film, and this again is backed up with wood thick enough to make the whole type-high. To get this, a man melts some tinfoil in a shallow iron tray, which he places on the surface of molten lead, kept to that heat in square tanks over ordinary fires. The tinfoil sticks to the back of the copper, and on the back of this is poured melted type-metal, until a solid plate has been formed, the surface of which is the copper facsimile and the body white metal. The electro metal plate, copper colored and bright on its surface, has now to go to the

FINISHING ROOM.

Here are two departments. In one the plates are shaved and trimmed down to fit the wood blocks, which are made in the other department. Some of these operations are done by hand, but it is very interesting to see self-working machines planing the sheets of metal to precisely the required thinness with mathematical exactness. A pointed tool is set to a certain pitch, and the plate of metal is made to revolve in such a way that one continuous curl shaving falls until the whole surface (back) has been planed perfectly true. The wood blocks are treated in the same way, after being sawn into the required sizes by a number of circular saws. Another set of workmen fit and join the metal to the wood, trim the edges, and turn the blocks out type-high and ready for working on the printing press.

A WET BLACKLEADING PROCESS.

In Messrs. Harper's establishment in New York, an improved wet process of blackleading is adopted. The wax mould is laid face upward on the floor of an inclosed box, and a torrent of finely pulverized graphite suspended in water is poured upon it by means of a rotary pump, a hose, and a distributing nozzle which dashes the liquid equally over the whole surface of the mould. Superfluous graphite is then removed by copious washing, an extremely fine film of graphite adhering to the wax. This answers a triple purpose; it coats the mould with graphite, wets it ready for the bath, and expels air bubbles from the letters. This process prevents entirely the circulation of blacklead in the air, which has heretofore been so objectionable in the process of electrotyping.

A NEW FOREIGN PROCESS.

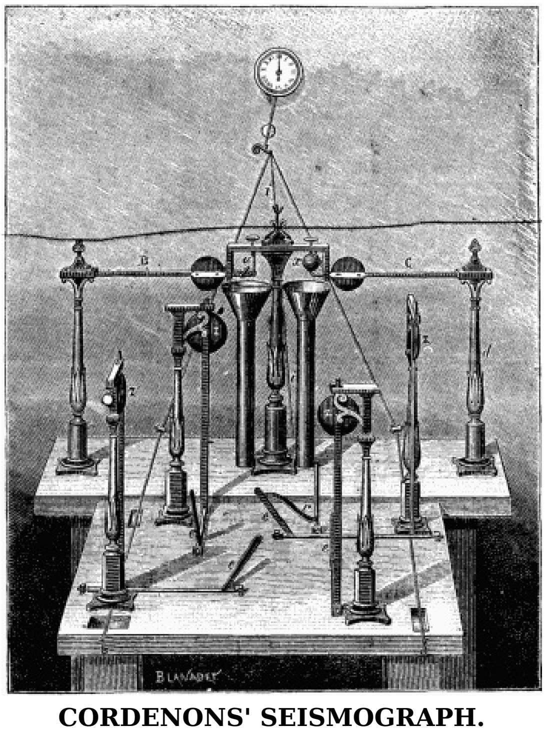
The galvanoplastic process of M. Coblence for obtaining electrotypes of wood-engravings is as follows: A frame is laid upon a marble block, and then covered with a solution of wax, colophane, and turpentine. This mixture on the frame, after cooling, becomes hard, and presents a smooth, even surface. An engraved wooden block is then placed upon the surface of the frame, and subjected to a strong pressure. The imprint on matrix in cameo, having been coated with graphite, is then placed vertically in a galvanoplastic bath, and a cast, an exact reproduction of the wood-engraving, is obtained. The shell is then backed with type metal and finished in the usual way.—*Printer and Stationer.*

A NEW SEISMOGRAPH.

All the seismographs that have hitherto been employed have two grave disadvantages: they are either too simple, so that their indications are valueless, or too complicated, so that their high cost and delicacy, and the difficulty of mounting them and keeping them in order, tend to prevent them from being generally used.

Seismology will not be able to make any serious progress until it has at its disposal very certain and very numerous data as to telluric movements registered at a large number of points at once by accurate instruments. I have endeavored to construct a simple apparatus capable of automatically registering such facts as it is most necessary to know in scientific researches on the movements of the earth. After numerous experiments I believe that I have succeeded in solving this delicate problem, since my apparatus, put to the test of experience, has given me satisfactory results. I have consequently decided to submit it to the approval of men of science.

My seismograph is capable of registering (1) vertical shocks, (2) horizontal ones, (3) the order in which all the shocks manifest themselves, (4) their direction, and (5) the hour of the first movement.



CORDENONS' SEISMOGRAPH.

The apparatus is represented in the accompanying cut. The horizontal shocks are indicated by the front portion of the system, and the vertical ones by the back portion. The hour of the first shock is indicated as follows: The elastic strip of steel, C, is fixed by one of its extremities to a stationary support, *d.* When, as a consequence of a vertical motion, the free extremity of this strip oscillates, the leaden ball, *x,* drops into the tube, *c,* and, on reaching the bottom of this, acts by its shock upon a cord, *i,* which actuates the pendulum of a clock that has previously been stopped at 12. The other strip, B, is very similar to the one just described, but, instead of carrying a ball, it holds a small metallic cylinder, *u*, so balanced that a vertical shock in an upward direction causes it to drop forward into the anterior half of the tube to the left. A second vertical shock in a downward direction causes it to drop into the other half. The cylinder, *u*, and the ball, *x*, are regulated in their positions by means of screws affixed to a stationary support.

The portion of the apparatus designed to register horizontal (undulatory) motions consists of four vertical pendulums, *z z z z*, each of which is capable of moving in but one direction, since, in the other, it rests against a fixed column.

Telluric waves, according to modern observations, almost invariably in every region follow two directions that cross each other at right angles. When the seismograph has been arranged according to such directions, no matter from what part the first horizontal shock comes, one of the four pendulums will be set in motion. If, after the first undulation in one direction, another occurs in the opposite, the pendulum facing the first will in its turn begin to move; and if other undulations make themselves felt in diametrically opposite directions, the other pendulums will begin to act. These pendulums, in their motion, carry along the appendages, *e e e e*, which are so arranged as to fall in the center of the marble or iron table, one upon another, and thus show the order according to which the telluric waves manifested themselves. The part of the apparatus that records vertical shocks has a winch, *r*, which falls at the same place when the lead ball drops.

The apparatus as a whole may be inclosed in a case. When it is desired to employ it, it should be mounted in a cellar, while the clock that is connected with it can be located in one of the upper stories of the house.—*F. Cordenons, in La Nature*.

NOTES ON THREE NEW CHINESE FIXED OILS.[1]

By Robert H. Davies, F.I.C., F.C.S., General Superintendent of Apothecaries' Hall.

The three oils that form the subject of the examination detailed in this paper were consigned to a London broker, with a view to their being regularly exported from China if a market could be found for them here: it was, therefore, necessary to ascertain what commercial oils they resembled in character, so as to estimate to what uses they might be applied.

TEA OIL (*Camellia oleifera*).

In color, transparency, and mobility, this oil considerably resembles olive oil. The odor and taste, though characteristic, are not easy to describe.

(1.) *Specific Gravity.*—The specific gravity at 60° F. is 917.5), water at 60° F. being taken as 1,000.

(2.) *Action of Cold.*—On subjecting to the cold produced by a mixture of pounded ice and salt, some solid fatty matter, probably stearine, separates, adhering to the side of the tube. It takes a longer exposure and a lower temperature than is necessary with olive oil. I did not succeed in solidifying it, but only in causing some deposit. Olive oil became solid, while almond and castor oil on the other hand did not deposit at all under similar circumstances. The lowest temperature observed was -13.3° C. (8° F.), the thermometer bulb being immersed in the oil.

A few qualitative tests, viz., the action of sulphuric acid, nitric acid (sp. gr. 1.42), and digestion, with more dilute nitric acid (1.2 sp. gr.) and a globule of mercury, were first tried.

When one drop of sulphuric acid is added to eight or ten drops of tea oil on a white plate, the change of color observed is more like that when almond oil is similarly treated than with any other oil, olive oil coming next in order of similarity.

When a few drops of tea oil are boiled with thirty drops or so of nitric acid in a small tube, the layer of oily matter, when the brisk action has moderated, is of a light yellow color, similar in tint to that produced from almond and olive oil under similar circumstances. When the oil is digested with an equal volume of nitric acid (1.2 sp. gr.), and a globule of mercury added, the whole becomes converted into a mass of elaidin in about two hours, of the same tint as that produced from almond oil when similarly treated.

These tests point to the fact that the oil may be considered as resembling almond or olive oil in composition, a conclusion which is borne out by the subsequent experiments.

(3.) *Free Acidity of Oil.*—The oil was found to contain free acid in small quantity, which was estimated by agitating a weighed quantity with alcohol, in which the free acid dissolves while the neutral fat does not, and titrating the alcoholic liquid with decinormal alkali, using solution of phenol-phthalein as an indicator.

It was thus found that 100 grammes of the oil require 0.34 gramme of caustic potash to neutralize the free acid. Mr. W. H. Deering (*Journ. Soc. of Chem. Industry*, Nov., 1884) states that in seven samples of olive oil examined by him, the minimum number for acidity was 0.86 per cent., and the maximum 1.64 per cent., the mean being 1.28 per cent. Tea oil compares favorably with olive oil, therefore, in respect of acidity, a quality of which note has to be taken when considering the employment of oil as a lubricating agent.

(4.) *Saponification of the Oil.*—Considerable light is thrown on the composition of a fixed oil by ascertaining how much alkali is required to saponify it. In order to estimate this, a known excess of alcoholic solution of potash is added to a weighed quantity of the oil, contained in a stout, well-closed bottle (an India-rubber stopper is the most convenient), which is then heated in a water oven until the liquid is clear, no oil bubbles being visible. Phenol-phthalein solution being added, the excess of potash is estimated by carefully titrating with standard hydrochloric acid solution.

It was thus found that 1,000 grammes of oil would require 195.5 grammes of caustic potash to convert it entirely into potash soap.

Koettstorfer, to whom this method of analysis is due, gives 191.8, and Messrs. F.W. and A.F. Stoddart the numbers 191 to 196, as the amounts of caustic potash required by 1,000 parts of olive oil. The numbers given by niger seed, cotton seed, and linseed oils are very similar to these. These oils differ from olive and tea oil, however, in having a higher specific gravity, and in the property they possess of drying to a greater or less extent on exposure to air.

(5.) *The Fatty Acids Produced.*—A solution of the potash soap was treated with excess of hydrochloric acid, and after being well washed with hot water, the cake of fatty acids was dried thoroughly and weighed. These, insoluble in water, amounted to 93.94 per cent, of the fat taken. The proportion dissolved in the water used for washing was estimated by titration with alkali; the quantity of KOH required was insignificant, equaling O.71 per cent, of the fat originally used. This portion was not further examined.

The insoluble fatty acids amounted, as last stated, to 93.94 per cent. Pure olein, supposing none of the liberated acid to be dissolved in water, would yield 95.7 per cent. of fatty acid.

The acid was evidently a mixture, and had no definite melting point. It was solid at 9° C., and sufficiently soft to flow at 12° C., but did not entirely liquefy under 22° C. To test its neutralizing power, 0.9575 gramme dissolved in alcohol was titrated with decinormal alkali; it required 34.05 c.c. This amount of pure oleic acid would require 33.95 c.c.; of pure stearic acid, which has almost the same molecular weight as oleic acid, 33.71 c.c.; or of pure palmitic acid, 37.4 c.c. This, taken in conjunction with the way in which the acid melted, makes it extremely probable that it is a mixture of oleic and stearic acids.

Additional evidence of the large proportion of oleic acid was furnished by forming the lead salt, and treating with ether, in which lead oleate is soluble, the stearate and palmitate being insoluble. In this way it was found that the oleic acid obtained from the ethereal solution of the lead salt amounted to 83.15 per cent. of the oil.

This acid was proved to be oleic, by its saturating power and its melting point, which were fairly concordant with those of the pure acid.

CABBAGE OIL (*Brassica, sp.*).

Appearance, etc.—The sample was of a deep brown color, of a fluidity intermediate between olive and castor oil, and possessed a strong, rather disagreeable odor.

The Specific Gravity at 60° Fahr., 914.0.—The specific gravity of rape oil and colza oil, both of which are obtained from species of the genius *Brassica*, varies from 913.6 to 916.

Exposure to Cold.—This oil by exposure to a temperature of -12° C. (10° F.) becomes solidified in course of an hour, a bright orange-yellow mass resulting.

Qualitative Examination.—The three reagents before indicated were applied to this oil.

(a.) Sulphuric Acid.—The color produced was very marked and characteristic; it

differed considerably from any of the others simultaneously tested, the nearest to it being olive end rape oil.

(b.) Strong Nitric Acid.—The reaction was more violent than before, the stratum of oil after cooling being darker in color than in the three cases before mentioned. The reaction with rape oil was similar in all respects.

(c.) Elaidin Test.—The solid mass of elaidin formed was of a darker color than that from olive, almond, and tea oil, but closely resembled that from rape oil.

Free Acidity.—This was estimated as above described. 100 grammes of oil would require 0.125 gramme caustic potash. The samples of rape oil examined by Deering (*loc. cit.*) were found to require from 0.21 to 0.78 KOH per 100 grammes oil.

Saponification of the Oil.—Upon saponifying with alcoholic potash, it was found that 1,000 grammes of oil required 175.2 grammes of potash for complete saponification.

The number obtained by Koettstorfer for colza was 178.7, by Messrs. Stoddart for rape oil, 175-179, and by Deering for rape oil, 170.8-175.5. The only other oil of which I can find figures resembling these is castor oil, which requires 176-178 grammes per kilo (Messrs. Stoddart). The difference in specific gravity between this (cabbage) oil and castor oil and the solubility of the latter in alcohol point to a wide distinction between them. Hence I think the numbers above given conclusively demonstrate the resemblance between this oil and rape oil in composition.

The Fatty Acids.—The acids produced by adding HCl to the potash soap were almost entirely insoluble in water. The actual amount of potash required to neutralize the acid in the wash water equaled 0.20 per cent. of the oil originally taken.

The insoluble fatty acid amounted to 95.315 per cent. of the oil taken. It was evidently a mixture of two or more fatty acids. On trying to take its melting point, I found that it commenced to soften at 17° C., was distinctly liquid at 19°, but not completely melted until 22° C.

According to O. Bach (Year Book Pharm., 1884, p. 250), the fatty acids from rape seed oil melt at 20.7° C., which is fairly concordant with the result obtained for cabbage oil acids.

The neutralizing power of these acids was then tested. 0.698 gramme dissolved in alcohol required 20.52 c.c. decinormal alkali. It is a singular coincidence that brassic acid ($C_{22}H_{42}O_2$), which is a characteristic acid of colza and rape oils, would have required almost exactly this quantity of alkali for neutralization, O.698 brassic acid theoretically saturating 20.69 c.c. of decinormal alkali. I am disposed to regard this as a coincidence, since a subsequent experiment showed that the lead salts formed were partially soluble in ether, whereas the lead salt of brassic acid is said to be insoluble in this liquid.

WOOD OIL (*Elæococcus cordata*).

Appearance, etc.—This oil has a decided brown color and a persistent and disagreeable odor. It is rather more fluid than castor oil. Glass vessels containing it soon show a film of apparently resinous material, which forms whenever a portion of the oil flows from the lip or edge down the outside of the vessel, and is thus exposed to the air in a thin stream. This drying power is one of its most prominent characters. If a few drops be exposed in a flat dish, in the water oven, the oil dries rapidly, so that in two hours the gain in weight will be appreciable, and in four hours the whole will have become solid.

The Specific Gravity at 60° Fahr., 940.15.—This is an unusually high gravity for a fixed oil. The only two which exceed it are castor oil, which is 960, about, and croton oil, which is very similar to this, 942 to 943 (A. H. Allen). It is interesting to note that both these oils are yielded by plants of the natural order *Euphorbiaceæ*, to which the plant yielding so-called wood oil belongs.

Exposure to Cold.—This oil is apparently unaffected by exposure to a temperature of -13.3° C. (8° F).

Qualitative Examination.—The action of sulphuric acid is remarkable. When a drop comes in contact with the oil, the latter apparently solidifies round the drop of acid, forming a black envelope which grows in size and gradually absorbs and acts upon so much of the surrounding oil as to assume the appearance of a large dried currant of somewhat irregular shape.

When a drop of the oil is added to nitric acid, it solidifies, and on heating very readily changes into an orange yellow solid, which appears to soften, though not to liquefy, at the temperature of boiling water. This substance is readily soluble in hot solution of potash or soda, producing a deep brown liquid, from which it is again deposited in flocks on acidifying. I have not yet found any solvent for it. The action of nitric acid with linseed oil is more similar to this than that with any other oil I have tried, but the nitro products of the two, if I may so call them, are quite different from one another. That from linseed oil produced as indicated remains liquid at ordinary temperatures, as does the oil upon its addition to the acid.

Elaidin Test.—By the action of nitric acid in presence of mercury, a semi-solid mass is produced of a much deeper color than in the preceding cases. A portion of the oil remains in the liquid state, as is usually the case with drying oils.

Free Acidity.—By the method indicated, it was found that 100 grammes of oil required 0.39 grammes caustic potash to neutralize the acid occurring in a free state.

Saponification of the Oil.—The oil saponifies readily on being heated with potash in presence of alcohol, and the amount required to convert it entirely into potash soap was 211 grammes of caustic potash per thousand grammes of oil. There are no saponification numbers for oils that can be considered close to this. I can find no record of any having been obtained between 197 and 221, so that the further examination on which I am now engaged may show this unusual number to be due to this oil containing some new fatty acid in combination.

The Fatty Acid.—The acids produced by adding acid to the potash soap formed in this case a cake on cooling, of a much deeper color than I have before obtained. After washing well they amounted to 94.10 per cent. of the oil. The amount dissolved by the water in washing was in this case also very small, the potash required for neutralizing equaling 1.02 per cent. of the weight of oil.

I found that the cakes of acids were solid at 36° C., and were completely melted at 39°.

On solution in alcohol, and digestion for two days with animal charcoal, the color was much diminished, and on the liquid being filtered and cooled to 0° C., an abundance of small white crystalline plates separated out, which, when dried, melted at 67° C.

The crude fatty acids turn black with sulphuric acid, as the oil does, and yield a similar substance with nitric acid. It is similar in appearance, but differs in that it melts at about 50° C., and is soluble in glacial acetic acid, which is not the case with the substance from the oil.

These fatty acids crystallize on cooling, in a most characteristic and beautiful way, forming wavy circular plates totally unlike any that I have seen before.

The above experiments may, I think, be taken as conclusive as to the nature of tea oil and cabbage oil. The former may certainly be considered a useful lubricating agent for the finer kinds of machinery. The work upon wood oil is not yet sufficiently complete to show us the nature of its proximate constituents. I am continuing the examination of this oil. Perhaps I need scarcely add that there is no connection between this "wood oil" and the Gurgun balsam, the product of *Dipterocarpus turbinatus*, which is also known as "wood oil."

[1] Read at an evening meeting of the Pharmaceutical Society of Great Britain, Feb, 4, 1885.

THE OTOSCOPE.

Prof. Leon Le Fort has recently presented to the Academy of Medicine, in the name of Dr. Rattel, a new otoscope, which we illustrate herewith.

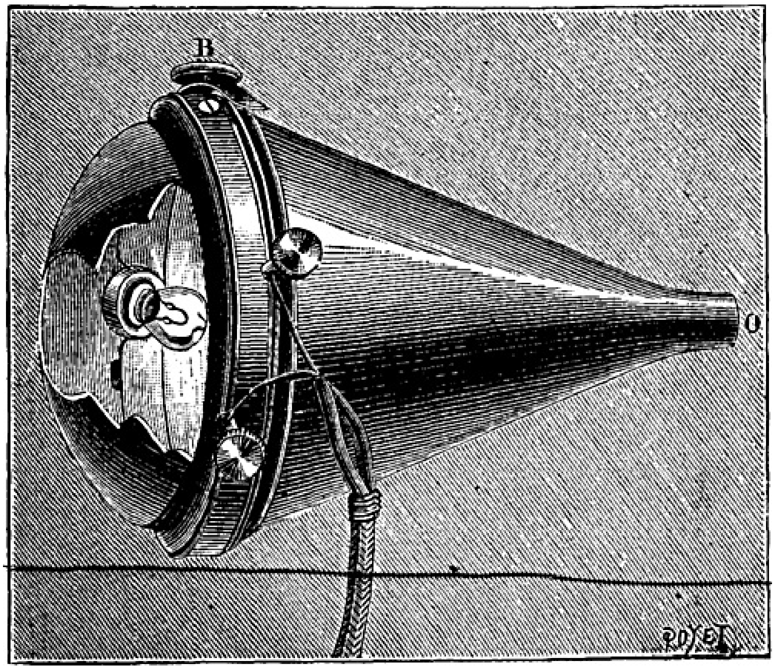
The first person to whom the idea occurred to illuminate the ear was Fabricius d'Acquapendentus (1600). To do this he placed the patient in front of a window in such a way as to cause the luminous rays to enter the external auditory canal. It was he likewise who conceived the idea of placing a light behind a bottle filled with water, and of projecting its concentrated rays into the ear.

In 1585 Fabricius de Hilden invented the speculum auris. This instrument was employed by him for the first time under the following circumstances: A girl ten years of age had in playing introduced a small glass ball into her left ear, and four surgeons, called in successively and at different times, had been unable to extract it. Meanwhile the little patient was suffering from an earache that extended over almost the entire head, and that increased at night and especially in cold and damp weather. To these symptoms were added strokes of epilepsy and an atrophy of the left arm. Finally, in November, 1595, De Hilden, being called in, acquainted himself with the cause of the trouble, and decided to remove the foreign body. To do this, he selected, as he tells us, "a well lighted place, caused the solar light to enter the ailing ear, lubricated the sides of the auditory canal with oil of almonds, and introduced his apparatus." Then, passing a scoop with some violence between the side of the auditory canal and the glass ball, he succeeded in extracting the latter.

At the beginning of the 17th century, then, physicians had at their disposal all that was necessary for making an examination of the ear, viz.: (1) a luminous source; (2) a means of concentrating the light; and (3) an instrument which, entering the auditory canal, held its sides apart.

The improvements which succeeded were connected with each of these three points. To solar light, an artificial one has been preferred. D'Acquapendentus' bottle has given way to the convex lens, and to concave, spherical, and parabolic mirrors, etc. De Hilden's speculum has been replaced by cylindrical, conical, bivalve, and other forms of the instrument.

The apparatus that we illustrate herewith offers some arrangements that are all its own as regards the process of concentrating the light. It is lighted, in fact, by a small incandescent lamp of 2 candle-power, placed within the apparatus and supplied by an accumulator. The reflector is represented by a portion of an ellipse so calculated that one of the foci corresponds to the lamp and the other to the extremity of the instrument. A commutator, B, permits of establishing or interrupting the current at will. A rheostat added to the accumulator makes it possible to graduate the light at one's leisure and cause it to pass through all the shades comprised between cherry-red and incandescence. Finally, the orifice through which the observer looks is of such dimensions that it gives passage to all the instruments necessary for treating complaints of the middle and internal ear.



RATTEL'S OTOSCOPE.

This mode of lighting and reflection may be adapted to a Brunton otoscope, utilized for examining other natural cavities, such as the nose, pharynx, etc. Elliptical reflectors do not appear to have been employed up to the present.

STATE PROVISION FOR THE INSANE.[1]

By C. H. Hughes, M.D.

We live in an age when every uttered sentiment of charity toward the insane is applauded to its remotest echo; an age in which the chains and locks and bars and dismal dungeon cells and flagellations and manifold tortures of the less humane and less enlightened past are justly abhorrent; an age which measures its magnificent philanthropy by munificent millions, bestowed without stint upon monumental mansions for the indwelling of the most pitiable and afflicted of the children of men, safe from the pitiless storms of adverse environment without which are so harshly violent to the morbidly sensitive and unstable insane mind; an age in which he who strikes a needless shackle from human form or heart, or removes a cause of human torture, psychical or physical, is regarded as a greater moral hero than he who, by storm or strategy of war taketh a resisting fortress; an age when the Chiarugis and Pinels, the Yorks and Tukes, of not remotely past history, and the Florence

Nightingales and Dorothea Dixes of our own time, are enshrined in the hearts of a philanthropic world with greater than monumental memory.

Noble, Christlike sentiment of human charity! Let it be cherished and fostered still, toward the least of the children of affliction and misfortune, as man in his immortal aspirations moves nearer and nearer to the loving, charitable heart of God, imaging in his work the example of the divinely incarnate Master!

But let us always couple this exalted sentimentality with the stern logic of fact, and never misdirect or misapply it in any of our charitable work. Imperfect knowledge perverts the noblest sentiments; widened and perfected knowledge strengthens their power. A truly philanthropic sentiment is most potent for good in the power of knowledge, and may be made most powerful for evil through misconception of or inadequate comprehension of facts. As we grow in aspirations after the highest welfare of the insane, let us *widen our knowledge of the real nature of insanity and the necessities for its amelioration, prevention, and cure*.

It is a long time since Grotius wrote, "The study of the human mind is the noblest branch of medicine;" and we realize to-day that it is the noblest study of man, regardless of vocation. Aye! it is the imperative study of our generation and of those who are to follow us, if we would continue, as we wish to be, the conservators of the good and great, and promoters of advancing capability for great and good deeds in our humanity.

One known and acknowledged insane person to every five hundred sane persons, and among those are unreckoned numbers of unstably endowed and too mildly mannered lunatics to require public restraint, but none the less dangerous to the perpetuation of the mental stability of the race, is an appalling picture of fact for philanthropic conservators of the race to contemplate.

The insane temperament and its pathological twin brother, the neuropathic diathesis, roams at large unrestrained from without or that self-restraint which, bred of adequate self-knowledge, might come from within, and contaminates with neurotic and mental instability the innocent unborn, furnishing histogenic factors which the future will formulate in minds dethroned to become helpless wards of the state or family.

The insane temperament is more enduringly fatal to the welfare of humanity than the deadly *comma bacillus* which is supposed to convey the scourge of Asia to our shores. The latter comes at stated periods, and disappears after a season or two of devastation, in which the least fit to survive of our population, by reason of feeble organic resisting power, are destroyed; while resisting tolerance is established in the remainder. But *this* scourge is with us always, transmitting weakness unto coming generations.

It is the insanity in chronic form which escapes asylum care and custody except in its exacerbations; it is the insanity of organism which gives so much of the erratic and unstable to society, in its manifestations of mind and morals; it is the form of unstable mental organism which, like an unstrung instrument jangling out of tune and harsh, when touched in a manner to elicit in men of stable organisms only concord of sweet, harmonious sounds; it is the form of mental organism out of which, by slight exciting causes largely imaginary, the Guiteaus and Joan d'Arcs of history are made, the Hawisons and Passanantis and Freemans, and names innumerable, whose deeds of blood have stained the pages of history, and whose doings in our day contribute so largely to the awful calendar of crime which blackens and spreads with gore the pages of our public press.

We may cherish the sentiment that it were base cowardice to lay hand upon the lunatic save in kindness; and yet restrain him from himself and the community from him. We may couple his restraints with the largest liberty compatible with his welfare and ours; we may not always abolish the bolts and bars, indeed we cannot, either to his absolute personal liberty in asylums or to his entire moral freedom without their walls, yet we may keep them largely out of sight. Let him be *manacled when he must and only when he must*, and then only with silken cords bound by affectionate hands, and not by chains. We may not open all the doors, indeed we cannot, but we can and do, thanks to the humanitarian spirit of the age in which we live, open many of them and so shut them, when it must need be done, that they close for *his* welfare and ours only; that he may not feel that hope is gone or humanity barred out with the shutting of the door that separates him from the world.

We may not always swing the door of the lunatic as facilely outward as inward—the nature of his malady will not always admit of this—but we should do it whenever we can, and never, when we must, should we close it harshly. And while we must needs narrow his liberty among ourselves, we should enlarge it in the community to which his affliction assigns him, to the fullest extent permissible by the nature of his malady.

Liberty need not necessarily be denied him; and to the glory of our age it is not in the majority of American asylums for the insane, because the conditions under which he may safely enjoy liberty, to his own and the community's welfare, are changed by disease. The free sunlight and the fresh air belong as much to him in his changed mental estate as to you or me, and more, because his affliction needs their invigorating power, and the man who would chain, in this enlightened age, an insane man in a dungeon, because he is diseased and troublesome or dangerous, would be unworthy the name of human. Effective restraint may be employed without the use of either iron manacles or dismal light and air excluding dungeons.

The insane man is one of our comrades who has fallen mentally maimed in the battle of life. It may be our turn next to follow him to the rear; but because we must carry him from the battlefield, where he may have fought even more valiantly than ourselves, we need not forget or neglect him. The duty is all the more imperative that we care for him, and in such a manner that he may, if possible, be restored. Simple sequestration of the insane man is an outrage upon him and upon our humanity. "Whatsoever ye would that men should do unto you, do ye even so to them," is the divine precept, which, if we follow it as we ought, will lead us to search for our fallen comrades in the alms-houses and penal institutions and reformatories, and sometimes in the outhouses or cellars of private homes, to our shame, where errors of judgment or cruelty have placed them, and to transfer them to places of larger liberty and hopes of happiness and recovery. The chronic insane are entitled to our care, not to our neglect, and to all the comforts they earned while battling with us, when in their best mental estate, for their common welfare and ours.

Almshouses and neglected outhouses are not proper places for them. They are entitled to our protection and to be so cared for, if we cannot cure them, as that they may not do those things, to their own harm or the harm of the race, which they would not do if they were sound in mind. Society must be protected against the spread of hereditary insanity, hence such kindly surveillance, coupled with the largest possible liberty, should be exercised over them as will save posterity, so far as practicable, from the entailment of a heritage more fatal than cancer or consumption.

The insane man is a changed man, and his life is more or less delusional. In view of this fact, we should endeavor always to so surround him that his environments may not augment the morbid change in him and intensify his perverted, delusioned character.

Realizing the fact that mind in insanity is rather perverted than lost, we should so deport ourselves toward the victims of this disease as in no wise to intensify or augment the malady, but always, if possible, so as to ameliorate or remove it.

Realizing that the insane man in his best estate may have walked the earth a king, and in this free country of ours have been an honored sovereign weighted with the welfare of his people, and contributing of his substance toward our charities, we should, with unstinting hand, cater to his comfort when this affliction comes upon him.

We should give him a home worthy of our own sovereign selves, and such as would suit us were we providing for ourselves, with the knowledge we have of the needs of this affliction, pending its approach to us.

That his home should be as unirritating and restful to him as possible it should be unprison-like always, and only be an imprisonment when the violent phases of his malady imperatively demand restraint. An hour of maniacal excitement does not justify a month of chains. Mechanical restraint is a remedy of easy resort, but the fettered man frets away strength essential to his recovery. Outside of asylums direct restraint is often a stern necessity. It is sometimes so in them, but in many of them and outside of all of them it may be greatly diminished, and asylums may be so constructed as to make the reduction of direct restraint practicable to the smallest minimum. Direct mechanical restraint for the insane, save to avert an act of violence not otherwise preventable, is never justifiable. The hand should never be manacled if the head can be so influenced as to stay it, and we should try to stay the hand through steadying the head.

Every place for these unfortunates should provide for them ample room and congenial employment, whether profitable to the State or not, and the labor should be induced, not enforced, and always timed and suited to their malady. A variety of interesting occupations tends to divert from delusional introspection.

Most institutions attempt to give their patients some occupation, but State policy should be liberal in this direction.

Deductions are obvious: Every insane community of mixed recent and long standing cases, or of chronic cases exclusively, should be a home, and not a mere place of detention. It should be as unprison-like and attractive as any residence for the non-criminal. It should have for any considerable number of insane persons at least a section (640 acres) of ground. It should be in the country, of course, but accessible to the supplies of a large city. It should have a central main building, as architecturally beautiful and substantial as the State may choose to make it, provided with places of security for such as require them in times of excitement, with a chapel, amusement hall, and hospital in easy covered reach of the feeble and decrepit, and accessible, without risk to health, in bad weather.

Outhouses should be built with rooms attached, and set apart from the residence of trustworthy patients, for farmer, gardener, dairyman, herdsman, shepherd, and engineer, that those who desired to be employed with them, and might safely be intrusted, and were physically able, could have opportunity of work.

Cottages should be scattered about the ground for the use and benefit of such as might enjoy a segregate life, which could be used for isolation in case of epidemic visitation. Recreation, games, drives, and walks should be liberally provided.

A perfect, but not direct and offensive, surveillance should be exercised over all the patients, with a view to securing them the largest possible liberty compatible with the singular nature of their malady.

In short, the hospital home for the chronic insane, or when acute and chronic insane are domiciled together, should be a colonial home, with the living arrangements as nearly those which would be most congenial to a large body of sane people as the condition of the insane, changed by disease, will allow.

It is as obvious as that experience demonstrates it, that the reigning head or heads of such a community should be medical, and not that medical mediocrity either which covets and accepts political preferment without medical qualifications.

The largest personal liberty to the chronic insane may be best secured to them by provision for the sexes in widely separated establishments.

It is plain that the whole duty of man is not discharged toward his fallen insane brother when he has accomplished his sequestration from society at large, or fed and housed him well. The study of the needs of the insane and of the duty of the State in regard to them is as important and imperative a study as any subject of political economy.

[1] Remarks following "Definition of Insanity." published in the October number of *The Alienist and Neurologist*. and read before the Association of Charities and Corrections at St. Louis, Oct. 15, 1884.

THE COURAGE OF ORIGINALITY.

Most of us are at times conscious of hearing from the lips of another, or reading from the printed page, thoughts that have existed previously in our own minds. They may have been vague and unarranged, but still they were our own, and we recognize them as old friends, though dressed in a more fitting and expressive costume than we ever gave them. Sometimes an invention or a discovery dawns upon the world to bless and improve it, and while all are engaged in extolling it some persons feel that they have had its germs floating in their minds, though from the lack of favorable conditions, or some other cause, they never took root or became vital. An act of heroism is performed, and a bystander is conscious that he has that within him by which he could have taken the same step, although he did not. Some one steps forward and practically opposes a social custom that is admitted to be evil, yet maintained, and by his influence lays the ax to its root and commences its destruction; while many, commending his courage, wonder why they had not taken the same course long ago. In numberless instances we are conscious of having had the same perceptions, the same ideas, the same powers, and the same desires to put them into practice that are shown by the one who has so successfully expressed them; yet they have, for some reason, lain dormant and inoperative within us.

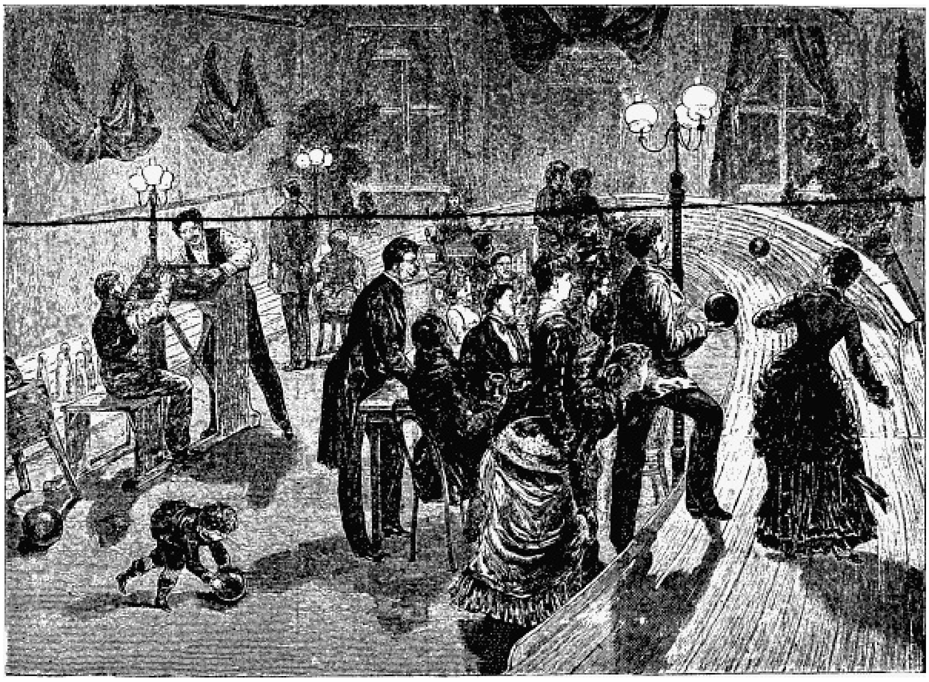
When we consider the waste of human power that this involves, we may well search for its cause. Doubtless it sometimes results from the absorption (more or less needful) of each one is his individual pursuit. No one can give voice to all he thinks, or accomplish all that he sees to be desirable, while striving, as he should, to gain excellence in his own chosen work. Conscious of his own limitations, he will rejoice to see many of his vague ideas, hopes, and aspirations reached and carried out by others. But the same consciousness that reconciles him to this also reveals much that he *might* have said or done without violating any other obligation, but which he has allowed to slip from his hands to those of another, perhaps through lack of energy, or indolence, or procrastination. The cause, however, most operative in this direction is a strange disloyalty to our own convictions. We look to others, especially to what we call great men, for thoughts, suggestions, and opinions, and gladly adopt them on their authority. But our own thoughts we ignore or treat with indifference. We admire and honor originality in others, but we value it not in ourselves. On the contrary, we are satisfied to make poor imitations of those we revere, missing the only resemblance that is worth anything, that of a simple and sincere independent life.

We would not undervalue modesty or recommend self-sufficiency. We should always be learners, gladly welcoming every help, and respecting every personality. But we should also respect our own, and bear in mind, that "though the wide universe is full of good, no kernel of nourishing corn can come to us but through our toil bestowed on that plot of ground which is given to us to till." To undervalue our own thought because it is ours, to depreciate our own powers or faculties because some one else's are more vigorous, to shrink from doing what we can because we think we can do so little, is to hinder our own development and the progress of the world. For it is only by exercise that any faculty is strengthened, and only by each one putting his shoulder to the wheel that the world moves and humanity advances.

There is nothing more insidious than the spirit of conformity, and nothing more quickly paralyzes the best parts of a man. A gleam of truth illuminates his mind, and forthwith he proceeds to compare it with the prevailing tone of his community or his set. If it agree not with that, he distrusts and perhaps disowns it; it is left to perish, and he to that extent perishes with it. By and by, when some one more independent, more truth-loving, more courageous than himself arises to proclaim and urge the same thing that he was half ashamed to acknowledge, he will regret his inglorious fear of being in the minority. We are accustomed to think that greatness always denotes exceptional powers, yet most of the world's great men have rather been distinguished by an invincible determination to work out the best that was within them. They have acted, spoken, or thought according to their own natures and judgment, without any wavering hesitation as to the probable verdict of the world. They were loyal to the truth that was in them, and had faith in its ultimate triumph; they had a mission to fulfill, and it did not occur to them to pause or to falter. How many more great men should we have were this spirit universal, and how much greater would each one of us be if, in a simple straightforward manner, we frankly said and did the best that we knew, without fear or favor? Soon would be found gifts that none had dreamed of, powers that none had imagined, and heroism that was thought impossible. As Emerson well says, "He who knows that power is inborn, that he is weak because he has looked for good out of him and elsewhere, and so perceiving throws himself unhesitatingly on his thought, instantly rights himself, stands in the erect position, commands his limbs, works miracles, just as a man who stands on his feet is stronger than a man who stands on his head."—*Phil. Ledger*.

A CIRCULAR BOWLING ALLEY.

The arcades under the elevated railroad which runs transversely through Berlin are used as storehouses, stores, saloons, restaurants, etc., and are a source of considerable income to the railway company. The owner of one of the restaurants in the arcades decided to provide his place with a bowling alley, but found that he could not command the requisite length, 75 ft., and so he had to arrange it in some other way. A civil engineer named Kiebitz constructed a circular bowling alley for him, which is shown in the annexed cut taken from the *Illustrirte Zeitung*. The alley is built in the shape of a horse-shoe, and the bottom or bed on which the balls roll is hollowed out on a curved line, the outer edge of the bed being raised to prevent the balls from being thrown off the alley by centrifugal force.



A CIRCULAR BOWLING ALLEY.

The balls are rolled from one end of the alley, describe a curved line, and then strike the pins placed at the opposite end of the alley. No return track for the balls is required, and all that is necessary is to roll the balls from one end of the alley to the other. A recording slate, the tables for the guests, etc., are arranged between the two shanks or legs of the alley.

It is evident that a person cannot play as accurately on an alley of this kind as on a straight alley; but if a ball is thrown with more or less force, it will roll along the inner or outer edge of the alley and strike the group of pins a greater or less distance from the middle. A room 36 ft. in length is of sufficient size for one of these alleys.

PATENT OFFICE EXAMINATION OF INVENTIONS.

To the Editor of the Scientific American:

It is with considerable surprise that the writer has just perused the editorial article in your issue of March the 28th—"Patent Office Examinations of Novelty of Inventions". It seems to me that the ground taken therein is diametrically opposed to the views heretofore promulgated in your journal on this subject, and no less so to the interests of American inventors; and it appears difficult to understand why the abolition of examinations for novelty by the Patent Office should be recommended in face of the fact that the acknowledged small fees now exacted from inventors are sufficient to provide a much greater force of examiners than are now employed on that work. If inventors were asking the government to appropriate money for this purpose, the case would be quite different; although it may be shown, I think, that Congress would be fully justified in disposing of no inconsiderable portion of the public money in this way, should it ever become necessary.

Recognizing the fact that the patent records of all countries, as well as cognate publications, are rapidly on the increase—and particularly in this country—making an examination for novelty a continuously increasing task, and that the time must come when such an examination cannot be made at all conclusively without a vastly increased amount of labor, from the very magnitude of the operation, it is nevertheless true that this difficulty menaces the inventor to a much greater extent, if imposed upon him to make, than it can ever possibly do an institution like the Patent Office.

Dividing and subdividing patent subjects into classes and sub-classes, and systematizing examinations to the extent it may be made to reach in the Patent Office, may, for a very long time to come, place this matter within the possibility of a reasonably good and conclusive search being made without additional cost to the inventor, provided what he now pays is all devoted to the furtherance of the Patent Office business. If, however, we hereafter make no examinations for novelty, an inventor is obliged to either make such a search for himself—with all the disadvantages of unfamiliarity with the best methods, inaccessibility to records, and incurring immensely more work than is required of the Patent Office examiner, who has everything pertaining thereto at his fingers' ends—or blindly pay his fees and take his patent under the impression that he is the first inventor, and run every risk of being beaten in the courts should any one essay to contest his claims; the probabilities of his being so beaten increasing in proportion as the number of inventions increase.

The inventor pays to have this work done for him at the Patent Office in the only feasible way it can be thoroughly done; and the average inventor would, or should, be willing to have the present fees very largely increased, if necessary, rather than have the examinations for novelty abolished at the Patent Office; for, in the event of their abolition, it would cost him immensely more money to secure himself, as before the courts, by his own unaided and best attainable methods.

The inventor now, however, pays to the Patent Office, as you well know, a good deal more money every year than the present cost of examinations, including of course all other Patent Office business; seeing a part of what he pays yearly covered into the Treasury as surplus, while his application is unreasonably delayed for the lack of examiner force in the Patent Office.

Let the government first apply all the moneys received at the Patent Office to its legitimate purpose, including the making of these examinations, and, when this proves insufficient, you may depend that every inventor will cheerfully consent to the increase of fees, sufficient to insure the continuance of thorough examinations for novelty, rather than attempt to do this work himself or take the chances of his having reinvented some old device (which it is very well known occurs over and over again every day), and being beaten upon the very first contest in the courts, after, perhaps, investing large amounts of money, time, and anxiety over something which he thus discovers was invented, perhaps, before he was born.

For an inventor to obtain a patent worth having, and one that is not more likely to be a source of expenditure than income to him, if contested, it goes without saying that examination for novelty must be made either by himself or some competent person or persons for him; and it is strictly proper and just that the inventor should pay for it; and it is too self-evident a proposition to admit of argument that the organized and systematized methods of the Patent Office can do it at a tithe of the expense which would be incurred in doing it in any other way; in point of fact, it would be impossible to do it by any other means so effectually or so well within any reasonable amount of cost.

Your summing up of the case should, instead of the way you put it, read: The Commissioner of Patents attempts to perform for two-thirds the sum paid as fees by inventors what he is paid three-thirds to accomplish, so that one-third of it may go to swell the surplus of the United States Treasury, and finds it an impracticable task to ascertain the novelty of an invention in a reasonable time for such a sum. To perform it, however imperfectly, he feels authorized to delay the granting; of patents, sometimes for several months, simply because Congress will not allow him to apply the moneys paid by inventors to their legitimate purpose.

I have had, for several years, always more or less applications on file at the Patent Office for inventions in my particular line, and now have several pending; and probably there are few, if any, who have suffered more from the great delays lately obtaining at that institution than myself, particularly in connection with taking out foreign patents for the same inventions, and so timing the issue of them here and abroad as not to prejudice either one. But great as the annoyance and cost have been in consequence of these delays, I would infinitely prefer that it were ten times as great, rather than see the examinations for novelty abolished by the United States Patent Office; and, so far as I know and believe, in this preference I most completely voice that of inventors in general.

JOHN T. HAWKINS.
Taunton, Mass., March 28th, 1885.

The writer of the above communication gives a very clear statement of our original premises. He sees as we do the difficulty, every year on the increase, of making satisfactory searches in the matter of novelty. But his deductions vary from ours. To us it appears on its face an impossibility for satisfactory searches to be made in the case of every individual patent by the Patent Office. The examinations have repeatedly been proved valueless. We know by our own and others' experience that the searches as at present conducted are of comparatively little accuracy. Patents are declared to be anticipated continually by our courts. The awarding of a patent in fact weighs for nothing in a judge's mind as proving its originality. The Commissioner of Patents is really exhausting the energies of the Office employees over a multitude of searches that have no standing whatever in court, and that no lawyer would accept as any guarantee of novelty of invention. If every inventor would search the records for his own benefit, we should then have twenty thousand examiners instead of the present small number. This would be something. But if it be advanced that the inventor is not a competent searcher, then he can engage an expert to do it for him. Every day, searches of equal value to the Patent Office ones are executed for but a fraction of the government fees on granting a patent.

Our correspondent speaks of an evil that he thinks would be incidental to the system we proposed in our article criticised by him, namely, that were the Patent Office to make no search an inventor would "run every risk of being beaten in the courts should any one essay to contest his claims." The fact is that in spite of the Office examination for novelty this risk always has to be encountered, and forms a criterion by which to judge of the exact value of that examination. Furthermore, we take decided issue with our correspondent when he says that the present is the only feasible way of executing these searches thoroughly. They are not so executed as a matter of fact, and could be done better and cheaper by private individuals, experts, or lawyers, engaged for the purpose by inventors.

We agree that all money received by the Patent Office should be applied to its legitimate end. It seems to us a great injustice to make one generation of patentees accumulate money in the Treasury for the benefit of some coming generation. Application of the whole of each year's fees to the expediting of that year's business would be simple justice. But we do not lose sight of our main point, that were the inventor unable to make a satisfactory search, it could be done for him by private parties better and cheaper than it is now done in the Office.

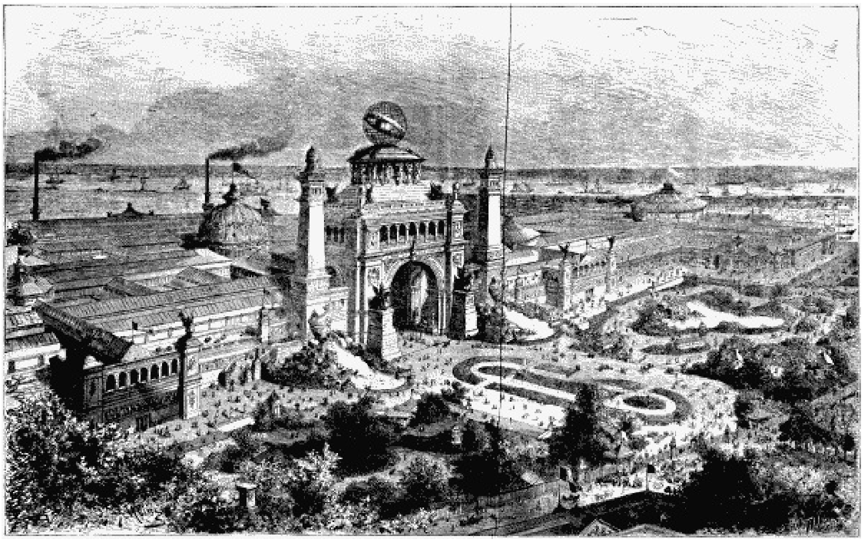
We are very glad to have the question so intelligently discussed as by our correspondent, and we feel that it is one well worthy of consideration. The future will, we are sure, bring about some change, by which inventors will be induced to bestow more personal care on their patents, at least to the extent of securing searches for novelty to be made by their own attorneys, and even at a little additional expense to abandon any blind dependence on the Patent Office as a prover of novelty.—Ed. Sc. Am.

THE UNIVERSAL EXPOSITION AT ANTWERP (ANVERS), BELGIUM.

Never before was there so striking and remarkable an example of what can be accomplished by private enterprise when applied to a great and useful object. Last year some prominent citizens of Antwerp—justly proud of the rapid and marvelous progress made by their city—conceived the idea of inviting the civilized world to come and admire the transformation which, in half a century, had converted the commercial metropolis of Belgium into the first port of the European continent. This audacious project has been carried into execution, and the buildings of the Universal Exposition, including the Hall of Industry, the Gallery of Machinery, and the innumerable annexes, cover 2,368,055 sq. ft. of ground. Even this large space has proved too limited. These buildings are shown in the accompanying cut.

All nations have responded to the call of the citizens of Antwerp, who are supported by the patronage of a sovereign devoted to progress, Leopold II., King of the Belgians. Among the countries represented in the exposition, France takes the first rank. She is represented by over 2,000 exhibits, and her products occupy one-fifth part of the Hall of Industry and the Gallery of Machinery. The pavilion of the French Colonies is an exact representation of a palace of Cochin China.

Belgium is represented by 2,400 exhibits. The French and Belgian compartments together occupy one-half of the Hall of Industry and the Gallery of Machinery. This latter building represents a grand spectacle, especially in the evening, when it is lighted by electricity. In excavating under this gallery, ruins were brought to light which proved to be the foundations of the citadel of the Duke d'Albe, the terrible lieutenant of Philip II. of Spain. Thus, on the same site where once stood this monument of oppression and torture, electricity, that bright star of modern times, will illuminate the most wonderful inventions of human progress.—*L'Illustration*.



Bird's-Eye View of the Universal Exposition at D'Anvers, Belgium.

THE STONE PINE.
(PINUS PINEA.)

Although not such an important tree in this country as many other conifers, the Stone pine possesses a peculiar interest beyond that of any other European conifer. From the earliest periods it has been the theme of classical writers. Ovid and Pliny describe it; Virgil alludes to it as a most beautiful ornament; and Horace mentions a pine agreeing in character with the Stone pine; while in Pompeii and Herculaneum we find figures of pine cones in drawings and on the arabesques; and even kernels of charred pines have been discovered. The Pinaster of the ancients does not appear to be the same as that of the moderns; the former was said to be of extraordinary height, while the latter is almost as low as the Stone pine. No forest is fraught with more poetical and classical interest than the pine wood of Ravenna, the glories of which have been especially sung by Dante, Boccacio, Dryden and Byron, and it is still known as the "Vicolo de' Poeti."

The Stone pine is found in a wild state on the sandy coasts and hills of Tuscany, to the west of the Apennines, and on the hills of Genoa, usually accompanied by, and frequently forming forests with, the Pinus pinaster. It is generally cultivated throughout the whole of Italy, from the foot of the Alps to Sicily. It is not commonly found higher than from 1,000 feet to 1,500 feet, but it occurs in the south of Italy as high as 2,000 feet. It is found, according to Sibthorp, on the sandy coasts of the Western Peloponnesus, in the same conditions, probably, as in the middle of Italy; it is also met with in the island of Melida. Cultivated, it is found on all the shores of the Mediterranean. In northern Europe, and especially in England, its general appearance is certainly that of a low-growing tree, its densely clothed branches forming almost a spherical mass; but in the sunny south it attains a height of 75 feet to 100 feet, losing, as it ascends, all its branches, except those toward the summit, which, in maturity, assume a mushroom form.

Seen in the soft clime of Italy in all its native vigor, the Stone pine is always majestic and strangely impressive to a northern eye, whether in dense forests, as near Florence, in more open masses, as at Ravenna, in picturesque groups, as about Rome, or in occasional single trees, such as may be seen throughout the country, but rather more frequently toward the coast. In these isolated trees their imposing character can be best appreciated, the great trunk carrying the massive head perfectly poised, an interesting example of ponderous weight gracefully balanced. The solid, weighty appearance of the head of the tree is increased by its even and generally symmetrical outline, this especially in the examples near the coast, the mass of foliage being so close and dense that it looks like velvet, and in color a warm rich olive green, strangely different from the blue greens and black greens of our northern pines. The lofty or normal type with the umbrella-formed top is almost peculiar to Central and Southern Italy. In other parts of the south of Europe, though often attaining large dimensions, it remains more dwarf and rotund in shape.

THE STONE PINE (PINUS PINEA) AT CASTEL GANDOLFO, IN ITALY.

This pine has not been much planted in this country, owing, no doubt, to its slow growth and want of hardiness in a young state. Consequently there are not many large specimens, and certainly none to compare with those of Italy for size or picturesque beauty. Mr. A. D. Webster, the forester at Penrhyn Castle, North Wales, who has kindly sent us a fine cone of this pine, writes thus respecting it: "A fair-sized specimen of this pine stands on the sloping ground to the southwest of Penrhyn Castle. It shows off to advantage the peculiar outline of this pine, which is so marked a characteristic of those grown in the Mediterranean region. The trunk, which is about 4½ feet in girth at a yard up, rises for three-fourths its height without branches, after which it divides into a number of limbs, the extremities of which are well covered with foliage, thus giving to the tree a bushy, well-formed, and, I might almost add, rounded appearance. At a casual glance the whole tree might readily be mistaken for the pinaster, but the leaves are shorter, less tufted, and always more erect. The bark of the Stone pine is somewhat rough and uneven, of a dull gray color, unless between the furrows, which is of a bright brown. That on the branches is more smooth and of a light reddish brown color. When closely examined, there is something remarkably pleasing and distinct from the generality of pines in the appearance of this tree, the leaves, which are of a deep olive-green, being, from their regularity and usual closeness, when seen in good light, like the finest network."

There is a moderately large specimen in the arboretum at Kew, and if this is the tree which Loudon in his "Arboretum" alluded to as a "mere bush," it has made good growth during the past thirty years. According to Veitch's "Manual of Coniferæ," a fine specimen, one of the largest in the country, is at Glenthorn, in North Devon. It is 33 feet high, and has a spread of branches some 22 feet, while the trunk is clear of branches for 15 feet. Loudon enumerates several fine trees in these islands at that date (1854), only one of which was 45 feet high. This one was at Ballyleady, in County Down, and had been planted about 60 years. Even where planted in the most favored localities, we can never expect the Stone pine to assume its true character, and that is the reason why so few plant it.

As a timber tree it is of not much value. Mr. Webster says, "The wood is worthless except for very ordinary purposes. The timber grown here (Penrhyn) is, from the few specimens I have had the chance of examining, very clean, light, from the small quantity of resin it contains, and in color very nearly approaches the yellow pine of commerce. It cuts clean and works well under the tools of the carpenter. In its native country the wood has been used for boat-building, but is now, I believe, almost entirely discarded." This pine thrives best on a soil that is deep, sandy, and dry. It should be well sheltered and nursed, as it is rather tender while in its young state. It is best to keep the seedlings under glass, though they may be planted out in the open air after their fourth or fifth year.

The cones of this pine supply the "pignoli" of commerce. The Italian cooks use these seeds in their soups and ragouts, and in the Maritozzi buns of Rome. Sometimes the Italians roast the barely ripe cone, dashing it on the ground to break it open, but the ripe seeds of the older cone when it naturally opens are better worth eating. They are soft and rich, and have a slightly resinous flavor. The empty cones are used by the Italians for fire lighting, and being full of resinous matter they burn rapidly and emit a delightful fragrance.

Description.—Pinus pinea belongs to the Pinaster section of the genus. In the south of Europe it is a lofty tree, with a spreading head forming a kind of parasol, and a trunk 50 feet or 60 feet high, clear of branches. The bark of the trunk is reddish and sometimes cracked, but the general surface of the bark is smooth except on the smaller branches, where it long retains the marks of the fallen leaves, in the shape of bristly scales. The leaves are of a dull green, but not quite so dark as those of the Pinaster; they are semi-cylindrical, 6 inches or 7 inches long and one-twelfth of an inch broad, two in a sheath, and disposed in such a manner as to form a triple spiral round the branches.

The catkins of the male flowers are yellowish; and being placed on slender shoots of the current year, near the extremity, twenty or thirty together, they form bundles, surmounted by some scarcely developed leaves. Each catkin is not more than half an inch long, on a very short peduncle, and with a rounded denticulated crest. The female catkins are whitish, and are situated two or three together, at the extremity of the strongest and most vigorous shoots. Each female catkin has a separate peduncle, charged with reddish, scarious, lanceolate scales, and is surrounded at its base with a double row of the same scales, which served to envelop it before it expanded; its form is perfectly oval, and its total length about half an inch. The scales which form the female catkin are of a whitish green; the bractea on the back is slightly reddish on its upper side; and the stigma, which has two points, is of a bright red. After fertilization, the scales augment in thickness; and, becoming firmly pressed against each other, they form by their aggregation a fruit, which is three years before it ripens. During the first year it is scarcely larger than the female catkin; and during the second year it becomes globular, and about the size of a walnut. The third year the cones increase rapidly in size; the scales lose their reddish tinge, and become of a beautiful green, the point alone remaining red; and at last, about the end of the third year, they attain maturity. At this period the cones are about four inches long and three inches in diameter, and they have assumed a general reddish hue. The convex part of the scales forms a depressed pyramid, with rounded angles, the summit of which is umbilical. Each scale is hollow at its base; and in its interior are two cavities, each containing a seed much larger than that of any other kind of European pine, but the wing of which is, on the contrary, much shorter. The woody shell which envelops the kernel is hard and difficult to break in the common kind, but in the variety fragilis it is tender, and easily broken by the fingers. In both the kernel is white, sweet, and agreeable to the taste. The taproot of the stone pine is nearly as strong as that of P. pinaster; and, like that species, the trees, when transplanted, generally lean to one side, from the head not being correctly balanced. Hence, in full-grown trees of the Stone pine there is often a similar curvature at the base of the trunk to that of the pinaster. The palmate form of the cotyledons of the genus Pinus is particularly conspicuous in those of P. pinea. When one of the ripe kernels is split in two, the cotyledons separate, so as to represent roughly the form of a hand; and this, in some parts of France, the country people call *la main de Dieu*, and believed to be a remedy in cases of intermittent fever if swallowed in uneven numbers, such as 3, 5, or 7. The duration of the tree is much greater than that of the pinaster, and the timber is whiter and somewhat more durable. In the climate of London trees of from fifteen to twenty years' growth produce cones.

There are no well-marked varieties of the Stone pine, though in its native districts geographical forms may occur. For instance, Loudon describes a variety cretica, which is said to have larger cones and more slender leaves. Duhamel also describes a variety fragilis, having thinner shells to the seeds or kernels. Neither of these varieties is in this country, so far as we are aware. There are various synonyms for P. pinea. the chief being P. sativa of Bauhin, P. aracanensis of Knight, P. domestica, P. chinensis of Knight, and P. tarentina of Manetti.—*The Garden.*

THE ART OF BREEDING.

From a paper read by C. M. Winslow, Brandon, Vt., before the Ayrshire Breeders, at their annual meeting, in Boston, Feb. 4, 1885:

Sometimes we meet with breeders whose only aim in their stock seem to be to produce animals that shall be entitled to registry. To such I have little to say, as their work is comparatively easy, and has but few hindrances to success; but to those breeders who are possessed of an ideal type of perfection, which they are striving to impress upon their stock, I have a few words to say upon the hindrances they may find in the way of satisfactory results. It is a law of nature that the offspring resembles some one or more of its ancestors, not only in the outward appearance, but in the construction of the vital organism and mental peculiarities, and is simply a reproduction, with the accidental or intentional additions that from time to time are accumulating as the stock passes through the hands of more or less skillful breeders.

The aim of the breeder is to not only produce an animal which shall in its own person possess the highest type of excellence sought, but shall have the power to transmit to its offspring those qualities of value possessed by himself. A breeder may, by chance, produce a superior animal, or it may be the result of carefully laid plans and artfully controlling the forces of nature and subjecting them to his will.

It is comparatively easy to accidentally produce an animal of value, but to steadily breed to one type is the test of the skill of the breeder and the value of his stock. However well he may lay his plans, or however desirable his stock may appear, his ability to perpetuate their desirable qualities will depend upon the prepotence of the animals, and this prepotence depends, to a great extent, upon the length of the line in which the stock has been bred with one definite end in view. A man may, in his efforts to breed stock excelling in a certain line, produce stock that shows excellence in other qualities, but this will not compensate for a deficiency in the qualification he is attempting to impress, nor is it safe to breed from any animal that does not show, in a marked degree, those desired qualities.

There is one qualification without which there can be no success, and that is a sound, healthy constitution, with good vital organs and vigorous digestion; and any amount of success in other directions will not compensate for lack of constitution, and disappointment is always sure to attend the breeder who does not guard this, the foundation of all success....

The very finest type of breeding and surest plans of success may be entirely defeated by improper feed and care. A valuable herd may be entirely ruined by a change of food and care; for those conditions which have conspired to produce a certain type must be continued, or the type changes, it may be for the better or it may be for the worse, since stock very readily adapt themselves to their surroundings; and it is just here that so many are disappointed in buying blood stock from a successful breeder; for a successful breeder is necessarily a good feeder and a kind handler, and stock may give good results in his hands, and, if removed to starvation and harshness, quickly degenerate. So, too, stock that has been bred on poor pasturage will readily improve if transplanted to richer pastures and milder climate.

Therefore he who would prove himself an artist in moulding his herd at will, must not only bring together into his herd many choice lines of goodness, but must ever seek, by kind treatment and good care, to change their qualities for the better, and by right selection and careful breeding so impress these changes for the better as to make them hereditary. If this course is persistently adhered to, the stock will gradually improve, retaining the good qualities of the ancestry, and developing new ones, generation by generation, under the hand of the artist breeder.

THE BABYLONIAN PALACE.

In a recent lecture on "Babylonian and Assyrian Antiquities," at the British Museum by Mr. W. St. Chad Boscawen, the architecture and ornaments of a typical palace were described. The palace, next to the local temple, was, the lecturer said, the most important edifice in the ancient city, and the explorations conducted by Sir Henry Layard, Mr. Rassam, M. Botta, and others, had resulted in the discovery of the ruins of many of the most famous of royal residences in Nineveh and Babylon. The palace was called in the inscriptions the "great house," as the temple was "God's house," though in later times it was also named "the abode of royalty," "the dwelling-place of kings," while the great palace of Nebuchadnezzar at Babylon, the ruins of which are marked by the Kasr mound, was called "the wonder of the earth." The arrangement of the palace was one which varied but little in ancient and modern times, the same grouping of quadrangles, with intermural gardens, being alike common to the Assyrian palace and the Turkish serai.

The earliest of the Assyrian palaces were those built in Assur, which dated probably from the nineteenth century before the Christian era; but the seat of royalty was at an early period transferred from Assur to Calah, the site of which is marked by the great mounds of Nimroud at the junction of the greater Lab and the Tigris. Here large palaces were erected by the kings of the Middle Assyrian Empire, the most lavish of royal builders being Assur-nazir-pal and Shalmanisar; while a third palace was built by Tiglath Pileser II. (B. C. 742). Mr. Boscawen described the explorations carried out by Sir Henry Layard on this site.

The most important chamber in the building was the long gallery or saloon, which had been called the "Hall of Assembly." The various parts of this palace included the royal apartments, the harem, and the temple, with its great seven-stage tower or observatory. The very extensive and systematic explorations carried out by the French explorer M. Botta had restored the remains of one of the most beautiful of the Assyrian palaces. The usurpation of the Assyrian throne by Sargon the Tartar in B. C. 721 placed in power a new dynasty, who were lavish patrons of the arts and who made Nineveh a city of palaces. Probably on account of his violent seizure of the throne, Sargon was afraid to reside in any of the existing places at Nineveh—though he appears for a short time to have occupied the old palace; he built for himself Calah, at a short distance to the northeast of Nineveh, the palace town of Dun Sargina, "the fort of Sargon," one of the most luxurious palaces—the Versailles of Nineveh. The ruins of this palace were buried beneath the mound of Korsabad, and were explored by M. Botta on behalf of the French Government, and the sculptures and inscriptions are now deposited in the Louvre. Compared with all the Assyrian palaces, later or earlier, this royal abode of Sargon stands alone. The sculptures were more magnificent, while warmth and color were obtained by the extensive use of colored bricks. Some of the cornices and friezes of painted bricks, of which Mr. Boscawen exhibited drawings, were most rich in ornament. The chief colors employed were blue and yellow, and sometimes red and green. Having described the general construction of this remarkable building, Mr. Boscawen proceeded to speak of the character of Assyrian art during the golden age (B.C. 721-625), and he illustrated his remarks by the exhibition of several large drawings. One of the most elaborate of these was the embroidery on the royal robe. The pectoral was covered with scenes taken from Babylonian myths. On the upper part was Isdubar or Nimrod struggling with the lion; below this a splendid representation of Merodach, as the warrior of the gods armed for combat against the demon of evil, while the lower part was covered with representations of the worship of the sacred tree. The general character of Assyrian art, its attention to detail, and the wonderful skill in representing animal life, as exhibited in the hunting scenes, was next spoken of, and Mr. Boscawen concluded by a brief description of the royal library, a most important part of the great palace at Nineveh.

Munn & Co., 361 Broadway, New York.
Branch Office, cor. F and 7th Sts., Washington, D. C.