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AMERICAN PERMANENT WAY.

BY JOSEPH M. WILSON, A.M., C.E.

Mem. Inst. Civ. Engrs, London, England; Mem. American Soc. Civ. Engrs.; Mem. Engrs. Club of Philadelphia Fellow Amer. Inst. Architects; Mem. Amer. Philosophical Soc.; Mem. Franklin Institute etc. etc.

The word "American" covers a very wide field, including not only Canada and the United States, but the whole continent; a vast extent of country with all varying conditions of climate, of constructive material, and of railway requirements.

When therefore American Permanent Way comes to be considered, the subject must necessarily involve a considerable variety of constructions, depending upon location and other conditions. Thus the form of construction required for a railroad in the Northern United States or in Canada, built to resist the severe winters of these latitudes, might be unnecessarily expensive for the mild climate of the south; also roads with heavy traffic require a more solid and substantial construction that those having only a light service; then again, the materials of construction available in places geographically far apart are often very different, and the engineer must adapt himself to circumstances, using what materials he can best obtain at a reasonable cost.

Permanent Way, or Railway Superstructure, as it is sometimes called, is that portion of a railway which directly receives the weight of the moving trains and transmits it to the road bed below. It comprises the rails, the cross ties or sleepers to which these are attached, and the distributing material in which the ties or sleepers are bedded. The object of the Permanent Way, no matter how constructed, is in all cases the same; to provide a way for the running equipment of the road to move upon, and to so transmit and distribute the weight from this to the sub-structure, that the latter, which is usually a soft material, as earth, may be able to sustain the load without settlement.

American Permanent Way only differs from that of other countries, in the adaptation of the materials available for the construction of the work, taking into consideration their relative abundance and value, and displaying, perhaps, some of the aptness for which Americans have a reputation.

It is necessary for a first-class perfect track to have good surface, good drainage, true line, accurate gauge and tight joints.

Rails have been made of wood, iron and steel. Wood is so soft a substance and so perishable, that it can only be employed for very light and temporary service, such as is sometimes required in lumber regions. It has been so employed, and may be considered as essentially "American." Iron and steel are the materials used throughout the world for railway service proper, and the cost of steel in late years has so nearly approached that of iron, that with its vastly superior qualities it is rapidly driving iron out of use; in fact the use of iron may already be said to be of the past. The shape and weight of the rail is governed by several conditions. Its section must be so formed at the top as to properly carry the wheels of the moving load with the least amount of wear, and at the bottom so that it may be securely attached to the supports upon which it rests, at the same time transmitting the load effectively to them. It must be designed with the greatest possible economy in weight, to carry with safety its load between the points of support, acting as a continuous girder of a span equal to the distance of the points of support apart, or rather twice that distance, so that in case any one should fail or give way, the rail would still be able to carry over the increased span with safety. Theory therefore points to a deep rail having a comparatively thin web, with upper and lower flanges, the upper flange being rounded to the proper shape to receive the wheels of the moving load, allowing sufficient width of bearing surface to prevent crushing under the action of the wheels, but not more than necessary, as the friction would otherwise be increased; and the lower flange shaped to adapt it to the mode of support adopted. In England, where iron chairs of peculiar kind are used to carry the rail the lower flange is made of a similar form to the upper, while on the continent of Europe and in America, the lower flange is made flat, to rest on a timber tie or sleeper. The width of this flange should be such that the load will not cause the rail to sink into the timber. The web of the rail must be sufficiently thick to give stiffness sideways and prevent the load bending the top of the rail over and crushing it. The section of the rail is made symmetrical about a vertical axis, allowing of reversal , if desired, when the inner edge has become seriously worn by the wheels.

As to the proper depth and weight of the rail, it will readily be seen that this depends upon the distance that the supports are placed apart, and the load carried. The loads carried on first class American railways are no lighter than those carried on European railways. Class K Engine, as used on the Pennsylvania Railroad, has a total weight in working order of 92,700 pounds, distributed on a wheel base of 22 feet 7½ inches, and a weight on the first pair of drivers of 33,600 pounds. Class L Engine, on the same road, has a total weight of 124,100 pounds, on a wheel base of 31 feet 4 inches, with a load on the main pair of drivers of 32,500 pounds. Class M Engine has a total weight of 87,500 pounds on a wheel base of only 10 feet 8 inches, and a weight on the first pair of drivers of 33,400 pounds. But in Europe, where timber is expensive, the ties or sleepers are placed farther apart than they are in America and therefore heavier rails are required. So long as timber is cheap in this country light rails will be used, but there is a tendency on some lines to heavier rails.

In assuming the proper load to be used in calculating the proportions and weight of a rail, it is not sufficient to take the static weight from the heaviest wheel, but an amount must be added to this on account of the load being a live or moving load, and also for impact, the tendency of a rapidly moving train, particularly with the driving wheels of the engine, being to pound down, as it were, upon the track making sudden applications of heavy loads. The percentages of addition thus required to the dead load cannot be determined theoretically, but must be assumed more or less empirically, depending upon the results of practical experience. The rails, when fastened firmly to their supports, must also possess sufficient lateral stiffness to resist all deflection sideways from the swinging motion of the train, centrifugal force on curves, etc.

The author is indebted to the courtesy of the Cambria Iron Company, Johnstown, Penn., for the standard sections of steel rails shown on plate I, as adopted and in use on a number of American roads. These will represent pretty fairly the general practice throughout the country. In comparing these it must be borne in mind that the service on some lines is not so severe as on others, also that the same railroad company uses lighter sections on its branch lines than on its main stem, on account of the difference in service. Sections that are quite suitable in one case are not so in others.

The numbers by which the several sections are designated are those of the Cambria Iron Iron Co. Where the roads using any section are noted, and the date is given, it simply means that this section was rolled for that railroad at that date. It does not follow that the railroad in question may not have changed its section, at some other mill since then, but this is a matter that could not be ascertained and its probability is not very great.

The Grand Trunk Railway of Canada uses the Sandberg pattern of T rail, weight 65 pounds per yards.

The Chicago & North Western Railway Co. is using 30 feet rails, the weight on main lines since 1882 being 65 pounds per yard, on less important lines 60 pounds per yard, and some 56 and 50 pound rails on branches.

The material of which rails are formed requires great care in selection. It must be sufficiently strong to sustain as a girder, tough to avoid all brittleness and danger of breaking under sudden shocks, and at the same time compact in texture and having hardness in the top to resist wearing action under service. With iron rails it is sought to arrange for these qualities in the packing or building up of the masses of iron from which the rails are rolled, taking advantage of the well-known principle that the different parts of the mass keep their same relative positions in the section of the bar when rolled out as in the original pile. Harder material is put in the top of the pile and softer in the bottom. Steel rails however are rolled from solid ingots and as a consequence they are of a homogeneous texture throughout. They do not split like iron rails, which sometimes show the result of imperfect welding between the separate pieces of which the original pile, from which the rail was rolled, was formed.

Rails are rolled to a certain maximum length, 30 feet being the usual standard on American roads, but there is always a certain proportion of shorter rails allowed, which, however, must conform to regular specified lengths, these being generally arranged to conform to the standard spacings of the cross ties.

The following specification of the Pennsylvania Railroad Company for steel rails, adopted January 27th, 1879, may be regarded as a standard for first class manufacture.

"As it is the desire of the Pennsylvania Railroad Company to have on the roads under their control none but first-class tracks in every respect, and as the rails laid down on these tracks form an important part in the achievement of this result, the Pennsylvania Railroad Company have found it necessary to make certain demands in regard to the manufacture of their steel rails, with which the different rolling mills and rail inspectors will be required to comply.

1. The steel used for rails shall be in accordance with the 'pneumatic,' or 'the open hearth' process, and contain not less than thirty, nor more than fifty one hundredths of one per cent. of carbon.

2. The result of the carbon test of each charge, of which the Pennsylvania Railroad Company is to receive rails, and of which an official record is kept at each mill, is to be exhibited to the rail inspector.

3. A test bar three-quarters of an inch wide and about ten inches long, is to be taken from a web of rail made from each charge.

4. The number of the charge and place and year of manufacture shall be marked in plain figures and letters on the side of the web of each rail.

5. The sections of the rails rolled shall correspond with the respective templates issued by the Pennsylvania Railroad Company showing the shape and dimensions of the different rails adopted as their standard.

6. The space between the web of the rails and template representing the splice bar shall not be less than one-quarter of an inch, nor more than three-eighths of an inch.

7. The weight of rails shall be kept as near to the standard weights as can be demanded, after complying with section No. 5.

8. Circular holes, one inch in diameter, shall be drilled through the web in the centre thereof, at equal distances from the upper surface of the flange and lower surface of the head, and three and fifteen sixteenths inches from the end of the rail to the centre of the first hole, and of five inches from the centre of the first hole to the centre of the second hole,

9. The lengths of rails at sixty degrees Fahrenheit shall be kept within one quarter of an inch of the standard lengths, which are thirty feet, twenty-seven and one-half feet, and twenty-five feet. That not more than ten per cent. of the shorter lengths, not more than five per cent. of No. 2 rails, will be accepted on any one contract.

10. The rough edges produced at the ends of the rails by the saw shall be well trimmed off and filed.

11. All rails are to be straightened in order to insure a perfectly straight track.

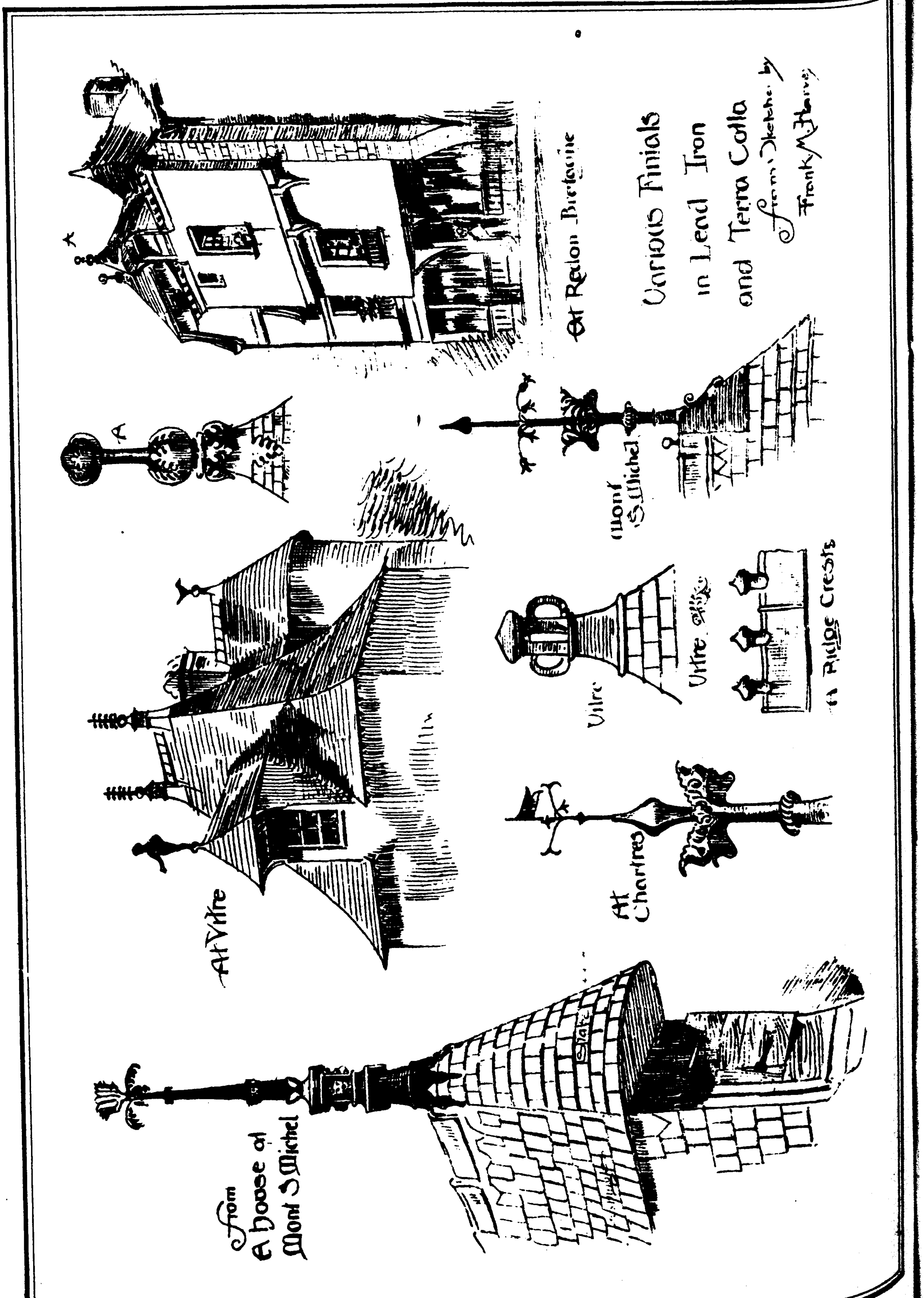
12. The causes for temporary rejection of the rails are:

1. Crooked rails.
2. Imperfect ends (which, after being cut off, would give a perfect rail of one of the standard short lengths).
3. Missing test reports.
4. A variation of more than one-quarter of an inch from the standard lengths.

13. The causes for the permanent rejection of a rail, as a No. 1 rail, are:

1. A bad test report, showing a deficiency or excess of carbon.
2. The presence of a flaw of one-quarter of an inch in depth in any part of the rail.
3 A greater variation beteen the rail and splice bar than is allowed in paragraph No. 6.
4. The presence of such other imperfections as may involve a possibility of the rail breaking in the track."

In the construction of a railroad, the rails should be accurately laid to line and level stakes as given by the engineer. On straight lines, the two rails of a track must be laid to the same level, but on curves the outer rail is elevated according to the degree of curvature, the elevation commencing at each end back of the point of curvature, by a distance also depending upon the sharpness of the curve, and increasing to the curve itself, around which the full elevation is carried uniformly. The amount of elevation varies on different roads, and, indeed, on the branches and main stem of the same road, depending upon the velocity at which trains are intended to be run. If one rides at a rapid rate over a road adapted in this respect for slow speeds, he will soon discover the want of elevation to the curves. John B. Henck, an American Civil Engineer of great reputation for his "Field-book for Railroad Engineers," published many years ago, gives the following table for elevation of the outer rail on curves, based on the question of centrifugal force tending to throw the car against the outer rail and the elevation of the same above the inner one to counteract it. Practical use of this table has demonstrated its correctness. M in the middle represents the speed of train in miles per hour, and the elevation is given in decimals of a foot for the degree of curvature and the speed of train M.


Various Finials
in Lead Iron
and Terra Cotta
from Sketches by
Frank M. Harvey
At Redon Bretagne
Mont S. Michel
Vitre
Vitre
A Ridge Crests
At Chartres
At Vitre
From
A House at
Mont S. Michel
Slate

ELEVATION OF OUTER RAIL ON CURVES.*

John B. Henck, M.A., C.E.

Degree.	M=15	M=20	M=25	M=30	M=40	M=50
1	.012	.022	.034	.049	.088	.137
2	.025	.044	.068	.099	.175	.274
3	.037	.066	.103	.148	.263	.411
4	.049	.088	.137	.197	.351	.548
5	.062	.110	.171	.247	.438	.685
6	.074	.131	.205	.296	.526	.822
7	.086	.153	.240	.345	.613	.958
8	.099	.175	.274	.394	.701	1.095
9	.111	.197	.308	.443	.788	1.232
10	.123	.219	.342	.493	.876	1.368

The Atlantic & Pacific Railroad Company elevate the curve one-half inch per degree up to a ten degree curve, which has an elevation of five inches, and all sharper curves are kept at this same elevation. This corresponds very nearly with Henck's table for 30 miles per hour. The elevation of outer rail is run off, onto straight track, a distance of ten feet per degree of curvature. Thus, for a 2 degree curve, the distance on the tangent is 20 feet, and for a 10 degree cuvre it is 100 feet.

(To be continued.)

*Of course some of these figures are merely theoretical and out of the question practically. No one would expect to go around a 10 degree curve at 50 miles per hour, but would reduce speed.

NOTES ON ELECTRICITY AND MAGNETISM.

BY PROF. W. GARNETT.

(*Continued from page* 231.)

When a number of battery cells are connected in multiple arc, or, as it is sometimes expressed, in parallel circuit, so that the conductivity of the battery is the sum of the conductivities of the several cells, while the electromotive force of the whole battery is simply that of one cell, the battery is sometimes said to be arranged *"for quantity."* This is because the battery is capable of sending a very great current through a short thick wire of very small resistance, for though the E. M. F. is only that of one cell the circuit possesses such a small resistance that the current is very great. The whole arrangement is analogous to a very large channel which is capable of delivering a very great quantity of water per minute, though the head of water may be very small.

When the cells of a battery are connected in series so that the resistance of the battery is the sum of the resistances of the several cells, while the E. M. F. of the battery is the sum of the electromotive forces of the cells, the battery is sometimes said to be arranged *"for intensity."* Such an arrangement is adapted for sending a current through a conductor of great resistance, as for example, a long telegraph line; but a battery arranged in this way is not capable of sending so great a current through a wire of very small resistance as when the cells are arranged in "multiple arc." If we wish to pump a stream of water through a very great length of very fine tube, a pump with very small suction and delivery valves and worked at very high pressure, will be best suited to our purpose; but if we wish to pump a great body of water through a comparatively short length of pipe of great diameter, we must select a pump with very large valves, though the pressure at which it is worked may be much less than in the former case, otherwise the "internal resistance" of the pumps will prevent our obtaining more than a very small stream of water notwithstanding the low resistance of the pipes. As before stated, a given number of battery cells will produce the greatest current in a given conductor when the cells are so arranged that the "internal resistance" of the battery is equal to the resistance of the external conductor.

Though we may speak of a battery arranged "for quantity" or "for intensity," we must avoid the error of speaking of "quantity currents" and "intensity currents." A current is completely defined by the number of units of electricity which pass across any section of the conducting circuit in a second, and two currents can differ from one another only in this respect. The one current may be produced by a high electromotive force in a circuit of great resistance, and the other by a comparatively low electromotive force in a circuit of correspondingly low resistance, but if the total quantity of electricity passing per second in each circuit is the same the currents are equal. If in some parts of the circuit the conductor is very thin and at other parts very thick, the amount of current *per unit area of the section of the conductor* will differ in different parts, and we may regard the current as more *intense* when the section of the conductor is smaller, but using the word in this sense the same current may have a high intensity in one part of the circuit and a low intensity in another. This is not the sense in which the phrases "intensity currents" and "quantity currents" have been erroneously employed.

In electric lighting installations, where incandescent lamps are employed, it is desirable that all the lamps should be placed in "parallel circuit" or "multiple arc," so that any lamp can be extinguished without affecting others, and without wasting the energy of the current. Hence, if the installation comprise 40,000 lamps, each having a resistance of 160 ohms, the resistance of all the lamps together will be only $\frac{160}{40,000}$ ohm, or ·004 ohm. As we shall learn shortly, it is important on the score of economy, that the resistance of the whole of the rest of the circuit, including the dynamo, which takes the place of a battery, should be small compared with this. Hence, the necessity for copper conductors of very great section, and for dynamo machines of very large dimensions.

Electrical resistance, like all other physical quantities, must be measured in terms of a unit of its own kind. The unit generally adopted is called an ohm. It was originally determined by a Committee appointed by the British Association for the Advancement of Science, and was based on certain theoretical principles, which will be explained nnder the head of Electro-magnetism. For the present it is sufficient to know that the ohm is the resistance of a certain coil of wire, measured at a particular temperature. The electrical resistance of all metals increases as the temperature is raised, the increase in the case of pure metals being greater than in the case of alloys. The British Association Committee, constructed a number of standard "ohms," of different alloys, and marked upon them the temperatures at which they were correct, but, after the lapse of twenty years, it appears that the resistances of these standards have somewhat changed, and they are not all consistent with one another. In addition to this, it has been found that the original determination of the absolute unit is considerably in error, and the International Committee have recommended that that the standard ohm should be the resistance of a column of pure mercury, one square millimetre in section, and of a length to be determined in accordance with the electro-magnetic principles above referred to. This length will be between 104 and 105 centimetres.

Boxes containing sets of resistance coils are constructed, and by means of such resistance boxes, as they are called, any desired resistance can be introduced into a circuit. These coils are made to represent multiples (or fractions) of an ohm, and are generally arranged on the same principle as a set of weights. Thus, it is usual to construct resistance boxes capable of furnishing any multiple of an ohm, from 1 ohm to 10,000 ohms. Such boxes usually contain sixteen coils, which, expressed in ohms, are as follows:—1, 2, 2, 5, 10, 10, 20, 50, 100, 100, 200, 500, 1,000, 1,000, 2,000, 5,000. It will be seen that, from this set, any number of ohms, from 1 to 10,000, can be obtained. The coils are so connected that any coil can be introduced into the circuit by removing a brass plug.

If one end of the wire is connected to the positive terminal of a battery and maintained at potential V while the other end is connected to the negative terminal and also to the earth, and so kept at potential zero, the potential of the wire will diminish uniformly from one end of the wire to the other as the current flows along it; that is to say, there will be the same fall of potential between any two points on the wire, the resistance between which is the same. In order to raise the wire to this potential the surface of the wire must receive from the battery a statical charge corresponding at every point to the potential to which it is raised. In the case of a submarine cable we have a copper conductor surrounded by an insulator, and this again surrounded by iron sheathing, or by sea water. Such an arrangement possesses all the characteristics of a condenser, and possesses a very great capacity. Hence, a large quantity of electricity must be provided by the battery in order to charge the surface of the wire before a "steady current" can be maintained in the circuit. This behaviour of the cable, (ressembling that of a Leyden jar) limits the "speed of signalling," which can be obtained through long sub-marine cables. The charge taken up by the cable when employed in transmitting a current with its far end to earth is one half that which would enter the cable if the remote end were insulated and the whole cable raised to the same potential. V, as the end formerly connected with the battery. The reason of this is that when one end of the cable is "put to earth" the average potential to which the cable is raised is only $\frac{1}{2}$ V.

There are great many different method of measuring the resistance of the wire. For example, the wire may be introduced into a battery circuit along with a galvanometer, and the deflection of the galvanometer, which measures the strength of the current, noticed: The wire may then be removed, and replaced by resistance coils until the galvanometer shews the same deflection. The resistance of the coils will then be equal to that of the wire, provided that the battery has experienced no change.

But, both the electromotive force, and the resistance of a battery, are liable to undergo considerable change, when the current flowing through the battery is altered even for a short time. Hence it is desirable that a comparison of the wire and coils should be made by a current flowing through both at the same instant, and not by two observations made in succession. The best arrangement for this purpose, is known as "Wheatstone's Bridge." The method depends upon the fact, that the potential diminishes uniformly per unit resistance along a wire in which a current is flowing.

Suppose two canals to be cut from a mountain lake to the sea, and, for the sake of illustration, we may suppose one canal to be long and winding, and the other short and straight. Since the difference of level between the extremities is the same, it follows that the slope of the first canal will be gentle, and that of the other steep; for simplicity, suppose that the slope of each is the same throughout its whole length. Now, let a cross canal be cut, so as to join one point on one canal, and one point on the other. There will be a flow of water in this canal, unless it is horizontal, in which case the water in the cross canal will remain stationary. The condition that the cross canal may be horizontal is that the points selected on the two canals may be distant from the top of each canal, by the same fraction of the length of the canal, since the level falls uniformly along each canal. Thus, if the point selected on the long canal is one third the way down, the point on the short canal must be also one third the way down. The existence or non-existence of a current in the cross canal will determine whether this condition is fulfilled or not.

Now suppose two conductors, a and b, to be joined end to end, so as to form one conductor, and let the extremities of this conductor be connected with the terminals of a battery. Suppose two other conductors, c and d, to be similarly connected together and to the battery, so that the battery current divides itself between the two compound conductors $a \div b$ and $c \div d$. Now let the terminals of the galvanometer be connected with points of junction of a with b and of c with d. Then no current will flow in this conductor, when, and only when, these points of junction are at the same potential. But the potential falls uniformly per unit of resistance along each conductor, from the positive pole to the negative pole of the battery. Hence, the condition that the points should be at the same potential, is analagous to the condition that the ends of the cross canal may be at the same level, and it may be expressed, thus:—

Resistance of a : Resistance of b :: Resistance of c : Resistance of d. Hence, denoting these resistances by P, Q, R, and S respectively, if there is no current in the galvanometer, we know that

$$P : Q :: R : S.$$

if a, b, and c consist of coils of known resistance, the resistance of c being changed until there is no current in the galvanometer, then P, Q, and R are known, and the unknown resistance, S, of the conductor d can be found from the above proportion. *(To be Continued.)*

A CORK GRINDING MACHINE.

The new material "linoleum" required the invention of a new machine for pulverizing the cork, of which it is chiefly made. This machine is described by the *Manufacturer and Builder* as follows: The machine consists of a series of cast steel disks (18 or 20 in number), with serrated edges like a saw. These disks are alternately seven and nine inches in diameter, and one-half inch in thickness, and are mounted in close contact with each other, side by side upon a shaft, to which they are keyed. Closely adjoining, and fitting in between these disks, with just space enough left between their edges and the periphery of the disks to permit of the feeding of the cork to be reduced, are a series of steel plates with similar serrated eggs. These plates are held firmly in juxtaposition by bolts, which serve also to attach them firmly to the frame of the machine. The toothed disks are rotated at about 180 revolutions per minute, and the cork is reduced by the machine to the size of a pea. These fragments are further reduced to powder by ordinary horizontal mills resembling those used for grinding corn. From the millstones the cork powder is carried by a screw elevator to a sieve by which the coarse and fine fragments are separated into several grades for the production of several qualities of linoleum. If any of the material is too coarse, it is returned to the mill. The very fine powder is treated with the suitable mixture of oxidized linseed oil, and after the product is finished, makes a floor cloth that is susceptible of a very high finish; the coarser material, on the other hand, makes a more elastic linoleum.

ELECTRICITY AS THE MOTIVE POWER FOR STREET RAILWAYS.

The announcement, which has been extensively circulated, that electricity has been successfully used as a motive power on street railways in the city of Cleveland, may be designated as "important, if true." Should the facts, as narrated in the daily newspapers, prove to be only partially true, the circumstance may still be regarded as one of the very highest interest.

There is a sort of superstitious confidence in the future possibilities of electricity, which is not without a basis of sound common sense to rest upon. The rapid strides that have been made within the past decade in its domain, and the unexpected and wonderful things that have been accomplished in applying it to useful purposes, cause even conservative men of science to ponder long and seriously before pronouncing anything that is alleged to be done in its name to be impossible. The telephone, the microphone, the multiplex telegraph, and other electric marvels, are of too recent date to encourage skepticism respecting even greater achievements; and beside these the alleged electric railway of Cleveland appears commonplace.

In the absence of the necessary details to inform us of the system of operation, we prefer to withhold any opinion of the practical merits of the Cleveland experiment; but these will doubtless be shortly forthcoming. The probability of the success of the experiment, it may be added, is made strong, not only by the very general admissions of the daily press, but by the fact, as all our readers know, that electrical railways of various forms have been, and are now, in actual operation in several European localities. If, however, the Cleveland experiment should turn out to be as satisfactory as report makes it, it will have the distinction of being the first successful application of electricity as a motive power for street cars in cities, and it will always remain a notable event. We trust it may prove to be so.

We may add, finally, that there is no more promising field for the inventor than in the direction of applying electricity as a motive power. It is in this field that most valuable results may be anticipated.—*New York Manufacturer and Builder.*

THE MIGRATION OF SALMON.

During the last ten years some exceedingly interesting researches have been effected by German, Finnish, Swedish, and Norwegian ichthyologists as to the migration of salmon on their respective coasts. Thus, by careful researches, some Swedish and Finnish *savants* have proved that the salmon, which in the summer are caught in the rivers of the upper gulf of the Baltic, have at another season, most probably in the winter, paid a visit to the shores and rivers of Northern Germany. This has been conclusively proved by salmon caught in the Swedish and Finnish rivers having German-made hooks in their gills and stomach. From this it is therefore apparent that, in the Baltic, salmon are in the habit of quitting the rivers of Northern Sweden and Finland in the autumn in order to visit the shores of Northern Germany during the winter, and return to their haunts in the spring. That the fish should be capable of performing the enormous journey across the Baltic—from the upper gulf to the Pomeranian coast—and back every year may indeed seem incredible, but that it is impossible is fully disproved by the experiments with salmon and trout effected by the late Mr. Frank Buckland on the coasts of Scotland and England in the same direction.

In March 1872 Profs. Virchow and Hansen were commissioned by the German Fishery Association to "mark" some of the salmon which has been hatched artificially near Hameln, in order to ascertain whether they were in the habit of returning to the river. The fish then in the hatching reservoirs were one year old, and mostly seven centimetres in length, although some were twice the size. Having tried cutting off various parts of the fins, it was found that it was most suitable for the object in view and the health of the fish to cut the so-called "fat" fin right away, particularly as the fish would retain this mark even when full grown.

On March 23 and 24, 1872, a thousand salmon marked in this manner were let out into the Weser. The marking was effected by taking the fish in the left hand, and then cutting the fin away with a pair of scissors, whereby the fish were perfectly uninjured. The little fat fin, which is mostly found on Salmonidæ only, contains no nerves of any importance, and has no particular function, so that its removal does not impair the fish in the least.

Ever since that year the fishermen between Bremen and Hameln have been on the look out for the marked fish, but not until a month ago a fish was caught, weighing 30 lbs., at Osterdeich, just above Bremen. The fat fin, which, on the fish one metre long, ought to have been six centimetres, was entirely absent; and, when the well-healed cut was felt, the hard membrane indicated that an operation had at one time or another been performed at this spot. The fish which was marked as a grilse in 1872, was then thirteen years old—an age which in every respect corresponds with the age fixed by the fisherman. According to general observation, it has been demonstrated that the salmon in the Weser is, when one year old, from five to twelve centimetres long. In the second year it has been proved that the salmon go into the sea, and when they re-enter the river at four years of age they weigh from eight to twelve pounds, and in the fifth year from twelve to fifteen pounds. From that age upwards the weight increases rapidly.

The results of the artificial hatching in the Weser are exceedingly promising. Thus the salmon fisheries at Hameln have been doubled in consequence during the last ten years, the tax at present paid to this town alone by the salmon fisheries being more than a thousand pounds.

In Norway, too, efforts have been made in the same direction during the last few years. Thus in 1883 the Storthing granted a sum of money for this purpose, and with this amount the Chief Inspector of Fisheries, Herr A. Landmark, has effected the marking of several hundreds of salmon and trout, chiefly on the west coast of Norway, during last autumn and winter. The marking here is effected by means of a tiny bit of platinum, 7 mm. long, and 4 mm. broad, being thus about the size of the nail on the little finger, which is attached by a very fine platinum wire to the fat fin of the big fish and the tail of the smaller ones. The piece has a number stamped on it, which corresponds with one in a "log" giving all the particulars as to the date the fish was marked, its weight, size, &c.

In order to encourage fishermen to be on the look out for these marked fish, the inspector offers a reward of two shillings and sixpence for each mark forwarded to him, if accompanied with precise information as to the spot and date when it was taken, the length and breadth of the fish, and its weight.

As these researches will tend greatly to ascertain the habits and migrations of *Salmonidack*, the result will be watched with interest.—*Nature.*

SEATS IN RAILWAY CARRIAGES.—*Nature.*

In a recent article in *Science et Nature* the writer, after animadverting on the lateness of the day at which shoemakers have at length begun, though still very imperfectly, to take account of the osseous framework of the human foot, proceeds to investigate the relation between the structure of the human trunk and that of the seat, more particularly in railway carriages, designed for its accommodation. In a sitting posture the pelvis has for its sole function the support of the upper part of the

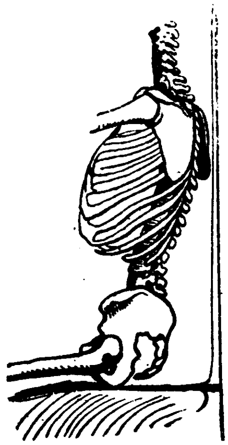


Fig. 1.

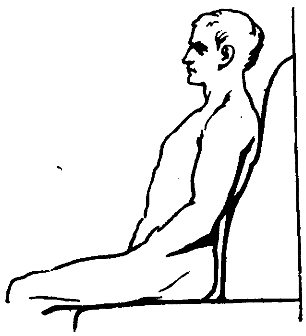


Fig. 2.

body. The spinal column, however, is inserted in the pelvis, not in the form of a straight line but of a curve (Fig. 1). This inflection on the part of the backbone, while adding to the mobility of the trunk, imposes on it

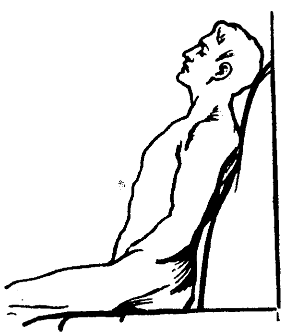


Fig. 3.

Fig. 4.

the necessity of a continual balancing movement, the centre of gravity being shifted every time the head and thorax sway to one side or the other. Such balancing

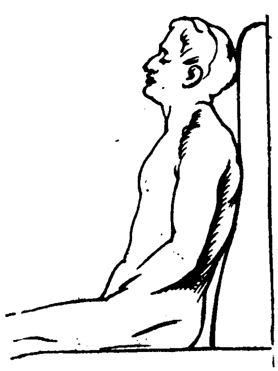


Fig. 5.

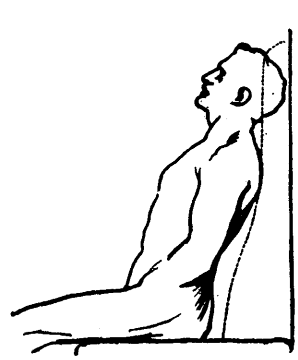


Fig. 6.

movement is necessarily also attended by a certain expenditure of energy. To allow the upper part of the body to remain comfortably at rest there must be supports for the back, the shoulders, and the head. So far as these are wanting, the body will tend of itself, unless counteracted by an effort of will and nervous force, to bend forward, till at last the forehead finds the knees to lean on. The position of the body in sitting is all the easier, and its rest all the more complete, the more decided is the inclination of the back of the seat and the more obtuse is the angle formed by the trunk and

Fig. 7.

the thighs. Seats such as the *dormeuses* realise the most favourable conditions in this respect.

Fig. 2 represents a man comfortably seated and propped. The back of the seat supports him principally under the shoulder-blades, offers the chest a depression to sink in, and altogether keeps the upper part of the body in a free and easy position. Fig. 3 shows the same person in a similar position, but with his head resting

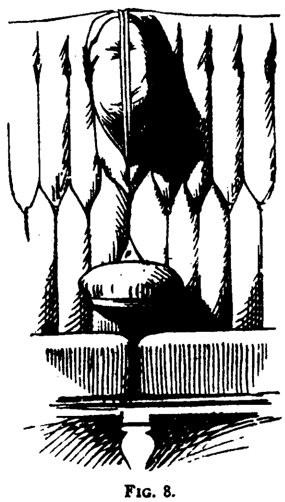


Fig. 8.

behind. In both these figures the back of the seat is seen exactly in profile, and to the writer of the article such seems the construction which is most convenient in railway carriages.

Fig. 4, on the other hand, represents the profile of a man seated as passengers are in many of our actual first-class carriages. His position is perceived to be a forced one in contrast with that just noticed, and altogether disagreeable. Fig. 5 shows exactly the stiff attitude the head is compelled to take in order to rest.

Finally, Fig. 6 reproduces the comfortable position indicated in Fig. 3, and at the same time represents the profile of the back of the seat actually in use in our railway carriages. On comparing this profile with the position of the man comfortably supported, the following defects in the back of the seat are observed :—

1. It is too vertical.

2. It allows an empty space between the lumbar vertebræ and the lower extremity of the shoulder-blade exactly at the place where one is in the habit of putting a cushion "behind the back," as it is called.

3. It is at least half a foot too high, and so makes it impossible for the head to rest behind. It is customary to make the back of the seat tally with the height of a man of average size seated bolt upright.

Under the actual conditions, such as they have been

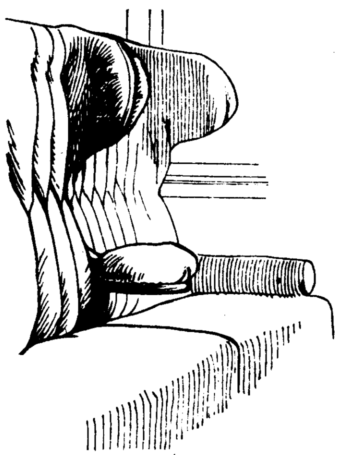


Fig. 6.

described, what becomes of the traveller when sleep at length overtakes him? Little by little he slides down on his seat till the lower extremity of his shoulder-blades, which has most need of support, finds the most sensible projection, which, as the backs of our railway carriages actually are, is precisely where it is least serviceable—at a point, namely, on a level with the region of the pelvis. Lastly, the head inclines forward or to the side, if it does not bury itself in the breast (Fig. 7).

Fig. 8 gives a front view of the face of the bench serving as the back of the seat. In the centre is seen a stuffed projection, on each side of which a passenger may rest his cheek. The shoulder, getting no separate support, must contrive to lodge itself between this stuffed projection and a kind of plateau fixed in the side of the back of the seat, and which, situated about a hand's breadth above the seat, offers a resting-place to the elbow (Figs. 8 and 9).

IMPERMEABLE CONSTRUCTION IN REFERENCE TO VENTILATION AND WARMING.*

BY E. C. ROBINS, F.S.A.

The enclosing walls of every house are an important factor in considering its sanitary condition ; so also is the roof covering, which, together with the walls, constitutes its power of resistance to the winds and weather of our inclement climate. Until late years, however, the site covered by the walls and roof of any building has been thought to be sufficiently protected by them, and the existence of such a thing as "ground air" has been ignored in constructing the lowest ground or basement floors of buildings.

Having myself witnessed Dr. Renk's experiments at the Hygienic Institute at Munich, which he has been for years carrying on under the supervision of Dr. Pettenkofer, I am able to speak from ocular demonstration concerning the penetrability by air and water of the materials commonly used in the construction of buildings both public and private.

There are circumstances under which it may be desirable that the air should find its way through walls ; for example, wherever no other means are provided for the change of the air in dwellings. Indeed, were it not for the flimsy construction of the houses of the poor, and the passage of the air through the outer walls, and through the crevices about door and window openings and basement floors, the air of the rooms would become perfectly stagnant, and be much more unhealthy than it is. But in the construction of the houses of the future upon sound sanitary principles, it is of course presupposed that nothing comes by chance, that the providence of the designer anticipates and provides for every contingency, and thus puts under the control of the occupier the means of warming, ventilating, and maintainining in healthful condition the house he inhabits. To attain this end, it is obvious that in the first place it must be possible to insure that the basement floor shall be impervious to ground air and moisture.

But what is ground air? It is the superincumbent pressure of the external atmosphere which passes through the earth subjected to its pressure to find its escape in the direction of the least resistance, which direction is commonly that forming the site of a house. The resistance to this external pressure is much reduced by the temperature of the air within the house, which is usually much higher, and consequently much lighter ; so that there is every inducement from natural causes for a stream of ground air to be continually passing through the basement, or lowest floor from without, unless steps are taken to construct an impervious flooring, the resistance to the passage of the air through which shall be greater than the pressure.

When the earth is clean and the house is pure there may be no great harm in allowing this process to go on, but for one consideration, viz., the humidity of the air so passing during wet seasons. But in populous places, where the earth is fouled by innumerable accumulations of refuse of all kinds, and where defective drainage has rendered pestiferous the very soil upon which the house stands, and leaky gas-pipes have rendered the external soil black and reeking with gaseous deposits, &c., I say under these circumstances it becomes a matter of enormous moment that the house itself shall not be made the safety-valve for the reception and accumulation of all these abominable impurities in the form of imperceptible "ground air."

IMPERMEABLE BASEMENT FLOORS.

There are two ways of overcoming this evil. The one is by forming an impervious flooring as before mentioned, and the othes is by constructing channels under the floor leading to the kitchen chimney flue. These channels should be of porous materials, and should be 6 ft. apart ; and by being carried to the kitchen chimney, the ground air will be drawn off with the heated air and smoke of the chimney, and tend to increase the draught in the flue at one and the same time. This was accidentally discovered by Dr. Renk during his experiments at Munich ; for, being unable to account for the difference of ground air pressure in different parts of the basement upon which he was operating, he excavated the floor, and found that one of the air flues from the chemical laboratory passed under the basement floor to the foul air extract shaft, drawing with it the ground air in its immediate vicinity, thus relieving the pressure upon a certain area, and giving the confirmatory exception to the rule he was formulating.

The ordinary materials for paving basement floors are all of a very porous character, and where boarded floors are provided no attempt used to be made to cover the soil at all, till the last amendment of the Act governing these matters required a thin layer of lime concrete to be laid over the earth under the floors generally.

The experiments made on various materials show that hydraulic cement is always impermeable, and a layer of cement concrete covered with pure cement, or an asphalt surface, or concrete formed of Portland cement mixed with granite or slag chippings, and finished with a smooth surface, will answer the purpose desired. But, for the sake of comfort and warmth to the feet, it is often desirable that wood should be the covering. This is equally well secured by the adoption of one or other of the many excellent wood block floorings exhibited in this great International Health Exhibition, to be laid on 6 in. of cement

*A paper read at the Conference of Architects at the International Health Exhibition.

concrete. The blocks need not be more than 2 in. thick and 6 in. long by 3 in. wide. They should be dovetail grooved at the bottom, burnetized before using, and bedded in cement. Powdered cement should be brushed into the interstices after the laying is complete, and the surface well washed with pure water and left clean.

Deal, pine, pitch pine, oak, walnut, teak—most kinds of wood will do, which may be planed or polished, and laid in any variety of pattern, equivalent in beauty to a parquet floor. Where there are no basements it would be better that all the rooms should be thus paved, the difference in the purpose of the rooms being expressed by the character of the design and the quality of the material used. Vitreous porcelain tiles are best for passages, being both impermeable and not slippery on the surface. But excellent tiles of every kind are now available for the purpose, and are most easily kept clean.

IMPERMEABLE WALL CONSTRUCTION.

In the second place, let us consider briefly the case of the enclosing walls of a building. Nothing but the observation of carefully conducted experiments will enable you fairly to realize the remarkable porousness of the ordinary building materials used for the external walls of dwelling houses.

The impermeable qualities of terra-cotta, give to it a foremost place in the decorative construction desirable in all buildings. Mr. Waterhouse has proved its value as a material for use in the metropolis. The Natural History Museum has the exceptional advantage of being, as it were, cased in terra-cotta. In the erection of buildings of the ordinary porous materials, however, precautions may be taken to achieve a similar result. There are a variety of systems for forming hollow walls, the inner and outer casing being connected with strips of bent iron galvanized. But hollow walls are not always efficient, and are rarely perfectly well done, and, of course, leave a space into which bad air can accumulate, and vermin may some day find their way and be unable to get out and die, and thus fumigate the building. The system is costly too, and covers a larger area than solid walls.

There is another system which makes a wall at once air and water proof so far as it extends, leaving nothing but the crevices in the ill-fitting of the joiner's work of doors and windows which only good workmanship can eliminate. It consists of an asphalt bond between the inner and outer casing, applied in the following manner. Let us suppose a 14½ in. wall, on one side 9 in. of brickwork, on the other 4½ in., with 1 in. division between, the opposite joints being left free of mortar for about three quarters of an inch each. At every two or three courses the heated asphalte is poured in, and the crevices all filled up with this impervious material, and the result is a wall much stronger than the ordinary wall, occupying no more space, and perfectly wind and weather proof. Impermeable water tanks may thus be constructed, an example of which may be seen in the Parkes Museum.

In facing with stonework, this will be found a valuable accessory, but the preservation of the face of the stone will not be secured, and another and a wider question is opened up as to the best kind of preserving solution for treating stone and other porous facing materials, and preserving it from the action of the weather and disintegrating gases afloat in the atmosphere, and found to be so destructive in London, and the manufacturing towns of the provinces. But before discussing this question, let us return to the impervious walling, to observe that there is still a weak point not rendered impregnable to damp air.

DAMP COURSES.

The asphalte must not only be applied vertically but also horizontally at the foot of the wall and at the level of the lowest floor adjoining. In fact, the asphalte may be continued at the level of the underside of the wood block basement flooring, and so seal up the walls and floor.

The horizontal course in walls is called a damp course, and is usually applied, but when it is absent the result is that damp rises in the walls forced up by the pressure of the ground air by the variations of temperature, by capillary attraction, &c., and the plaster becomes demoralized and falls off the walls, and considerable discomfort and expense is the consequence.

PRESERVING SOLUTIONS.

This was the subject of an interesting discussion at the Institute many years ago, under the presidency of the late Sir Wm. Tite, and in the Transactions of the Institute the whole matter was very carefully reported. I invariably specify that the stonework shall receive when in a dry state, two coats of a solution, the effect of which is to render the surface of the stone comparatively impermeable, at all events, till such a time as the stone has had time to weather and form its own skin and natural protector from the weather. In fact, wax and gum are dissolved in a spirit, and the solution is applied with a brush on dry stonework; the spirit volatilizes, and the congealing of the rest forms a skin as thick as the stone is impregnated; two coats are usually sufficient.

At Hanover Church, Regent Street, may be seen three different processes, none of which have as yet shown signs of failure. The building had become perfectly black, but very few signs of decay had taken place except in the towers, and I was desirous of removing the soot without taking away the weathered surface of the stone, and this I achieved by the use of the wet steam jet. I also discovered that the portions which had been treated with linseed oil when first erected fifty years ago had not decayed to any extent, while the rest was so far gone that the greater part of the stones had to be replaced.

Of course a great deal of the defective stone we see arises from injudicious selection; there is good and bad stone of every kind, and unless pains are taken not only to select the quarry itself, but to mark the approved stones at the quarry, and then to see that they lie in the building on the same bed that they lay in the quarry, disappointment must ensue whatever the solution you employ. Solutions should only be used to preserve good stone, not to make bad stones pass muster.*

THE ROOF.

A very few words must suffice to dispose of this subject, having regard to our limitations as to time. It is not my intention to speak of flat roofs of fireproof construction, and covered with impermeable materials of various kinds; obviously they are rarely required, and, when wanted, only need to be well executed to answer the purpose intended. But the ordinary house roof is a thing that forms a hat to a building; it may or may not have projecting eaves, or a brim to the hat, but it is always presumed to rise above the greater part of the topmost rooms, and to form an air space protective of the inmates from the extremes of heat and cold. That this is but a presumption is, in many cases, only too true, and the cruelty of putting servants in slate, or even metal-covered attics, within a few inches of the outer air, is often forgotten alike by the builder who sells and the master who buys his family residence.

The ordinary speculative house-builder gets the thinnest slates, often absorbent of moisture and permeable by the sun and wind, and he fixes these with common nails to sappy battens, secured to light rafters at the least available gauge, instead of making every third slate lap the first at least three inches, and be fastened with two copper nails to each slate to inch rough boarding, through which the snow may be further prevented from finding its way by putting an intermediate layer of nodorous felt, and thus keep back the heat and the cold and the rain and the snow, and form a sound external covering to the house.

Zinc does not last above a dozen years in the English climate as a rule; but if used, it should be put on with laps, and without soldered seams or anything to hinder its free expansion or contraction, and should be put in much thicker than is customary—not less say than No. 15 gauge.

Lead forms the best and most durable roof covering, properly laid, of sufficient thickness—say 5 lbs. weight for the square foot for ridges and flashings, 7 lbs for gutters and flats. But nothing is more effective than tiles, and nothing, when well done, warmer in winter or cooler in summer. The Broseley tiles are admirable in colour and hardness.

Projecting eaves are a great protection to the walls; and the projections on the face of the walls for cornices, labels, strings, should all be well under-cut, not only because of the good effect of a sharp shallow, but because the water is thus prevented from running down the face of a building and disfiguring it, and making it damp.

VENTILATION.

It is not my purpose to enter very deeply into the question of ventilating and warming, but it is obviously necessary to make suitable provision for ventilation not only for the purposes of human respiration, but for the sustenance of the

* I have had models made of an ordinary brick wall, and one with asphalte core, both of which I have fitted with caps to show the passage of the air through one and its exclusion in the other.

healthful condition of the materials used in the construction of a house. Dry rot, and other forms of premature decay, being induced by the want of a free circulation of air about the places where it appears, the best proof of which is that by the introduction of the air the growth of the fungus is arrested. As I have already remarked, the exclusion of the air from the enclosing roofs, walls, and basement floors of dwellings renders it necessary to provide ventilation of a simple kind, and I shall conclude my paper with a few remarks upon the subject.

If we have something to learn from foreigners of the scientific application of the principles of warming and ventilating great public buildings, as I have elsewhere shown, foreigners have much to learn from us of the domestic comfort derivable from the homely fireside of the English people. That it is wasteful of fuel is true; polluting to the atmosphere cannot be denied. Nevertheless, it is the best system of warming and ventilating ordinary living rooms. But few rooms have any corresponding inlets, and so to supply the omission, whizzing draughts come in through the keyhole and crevices of the doors and windows and floors, and even through the walls themselves. When there is no fire the aspiration by the chimney flue is much diminished, but might be maintained throughout the summer by the use of a ring of gas-jets just over the mouth of the register. There are circumstances, however, under which this system is inapplicable, and the guidance of a professional man is desirable in all cases.—*The Building and Engineering Times.*

MIND IN MAN AND BRUTE.

BY GEORGE J. ROMANES.

If it is true "The proper study of mankind is man," assuredly the study of nature has never before reached a territory of thought so important in all its aspects as that which, in our own generation, it is now for the first time approaching. After centuries of intellectual conquest in all regions of the phenomenal universe, man has at last begun to find that he may apply in a new and most unexpected manner the adage of antiquity, "Know thyself." For he has begun to perceive a strong probability, if not an actual certainty, that his own living nature is identical in kind with the nature of all other life, and that even the most amazing side of that nature—nay, the most amazing of all things within the reach of his knowledge—the human mind itself, is but the topmost inflorescence of one mighty growth, whose roots and stem and many branches are sunk in the abyss of planetary time.

The problem, therefore, which in this generation has now, for the first time, been presented to human thought, is the problem of how this thought itself has come to be. A question of the deepest importance to every system of philosophy has been raised by the study of biology, and it is the question whether the mind of man is essentially the same as the mind of the lower animals, or, having had, either wholly or in part, some other mode of origin, is essentially distinct, differing not only in degree, but in kind, from all other types of physical existence.

First, then, let us consider the question on purely *a priori* grounds. The process of organic and of mental evolution has been assumed to be continuous throughout the whole region of life and of mind, with the one exception of the mind of man. On grounds of a very large analogy, therefore, we should deem it antecedently improbable that the process of evolution, elsewhere so uniform and ubiquitous, should be interrupted at its terminal phase; and I think that, looking to the very large extent of the analogy, this antecedent presumption is really so considerable that it could only be fairly counterbalanced by some very cogent and unmistakable facts, showing a difference between animal and human psychology so distinctive as to render it in the nature of the case virtually impossible that one could ever have graduated into the other. This I posit as the first consideration.

Next, still restricting ourselves to the *à priori* aspect of the matter, it is unquestionable that human psychology in the case of every individual human being presents to actual observation a process of gradual development, or evolution, extending from infancy to manhood; and that in this process, which begins at a zero level of mental life and may culminate in genius, there is nowhere and never observable a sudden leap of progress, such as the passage of one order of psychical being into another distinct in kind might reasonably be expected to show. Therefore, it is a matter of observable fact that, whether or not human intelligence differs from animal in kind, it certainly admits of gradual development from a zero level; and to this we must add that, so long as it is passing through the lower phases of that development, it assuredly ascends through a scale of mental faculties which are *pari passu* identical with those that are permanently presented by the psychological species of the animal kingdom. These facts, which I present as a second consideration, tend still further, and I think most strongly, to increase the force of the antecedent presumption against the process of evolution having been discontinuous in the region of mind.

Again, it is likewise a matter of actual observation, that in the history of our race, as recorded in documents, traditions, antiquarian remains, and flint implements, the intelligence of the race has been subject to a steady process of gradual development—a general fact which admits of any amount of special corroboration by comparing the psychology of existing savages, where the process of evolution in the past has not been so rapid or has in part been arrested, with that of civilized man. This is the last consideration that I shall adduce of the *a priori* kind, and its force consists in the fact of its proving that if the process of mental evolution was interrupted between the anthropoid apes and primitive man, it must again have recommenced with primitive man, and since then have continued as uninterruptedly in the human species as it previously did in the animal species. This, to say the least, upon the face of the indisputable facts, or from a merely antecedent point of view, appears to me a highly improbable supposition. At all events it certainly is not the kind of supposition which men of science are disposed to regard with favour elsewhere; for a long and arduous experience has taught men of science that the most helpful kind of supposition which they can bring with them into their investigations of nature is that kind of supposition which recognizes in nature the principle of continuity.

Taking then, all these *a priori* considerations together, they must, in my opinion, be fairly held to make out a very strong *prima facie* case in favour of the view that there has been no interruption of the developmental process in the course of psychological history, but that the mind of man, like the mind of animals—and, indeed, like everything else in organic nature—has been evolved. For these considerations show, not only that on analogical grounds any such interruption must be held as in itself improbable; but also, that the human mind unquestionably admits of having been slowly evolved from the zero level, seeing that in every individual case, and during many past millenniums in the history of our species, the human mind actually does and has undergone the process in question.

In order to overthrow so immense a presumption as is thus erected on *à priori* grounds, the psychologist must fairly be called upon to supply some very powerful considerations of an *à posteriori* kind, tending to show that there is something in the constitution of the human mind which renders it impossible, or, at all events exceedingly difficult, to imagine that it can have a genetic relation to minds of lower orders. *Knowledge.*

PASTEUR'S REMEDY FOR HYDROPHOBIA TO BE INVESTIGATED.

We learn that Pasteur has communicated the results of his four years of investigation of the nature of hydrophobia and its cure to the French Academy. He asks this eminent body to appoint a commission to examine and report upon his results. The Academy has acted upon this request, and has appointed a number of eminent men to institute a board of examiners to make the necessary investigation.

The essential portions of Pasteur's communications to the Academy we quote below, from the *Popular Science News:*

"1. If the poison of rabies be transmitted from the dog to the monkey, and then from monkey to monkey, its virulence diminishes with each inoculation. If the virus which has been thus enfeebled by inoculation from monkey to monkey be then retransmitted to a dog, a rabbit or a guinea-pig, it still remains attenuated. In other words, the virulence never returns at once to the degree found in the mad dog of the streets.

"2. The virulence of the poison of rabies is increased when it is transmitted from rabbit to rabbit, or from guinea-pig to guinea-pig. When the virulence has thus increased, and reached its maximum in the rabbit, the virus still retains the high degree of virulence when transmitted to the dog, and is evidently much more intensely virulent than the virus of the mad dog of the streets. Under these conditions, indeed, the

poison is so virulent, that when inoculated into the circulation of a dog, fatal rabies is the invariable result.

"3. Although the virulence of the poison is intensified in its passage from rabbit to rabbit, and from guinea-pig to guinea-pig, it requires many successive inoculations before it recovers its maximum virulence, when it has been previously attenuated in the monkey. Further, the poison found in the mad dog of the streets, which, as I have just said, is far from being of maximum virulence, when it is inoculated in the rabbit, requires to be passed through many individual rabbits before it attains that maximum.

"If we apply rationally the results I have just communicated, we can easily render dogs proof against rabies. The investigator may have at his disposal the virus of rabies in different degrees of attenuation; the non-fatal kinds preserving the economy from the effects of the more active and fatal kinds. Let us take an example. We take the virus of rabies from a rabbit which has died, after inoculation by trephining, at the end of a period of incubation exceeding by several days the shortest period of incubation commonly met with in the rabbit. This period invariably occurs between the seventh and eighth day after incubation by trephining with poison of maximum virulence. The virus from a rabbit with the longest incubation period is inoculated again, by trephining, in a second rabbit; the poison from this rabbit in a third. Each time the poison, which is becoming less and less virulent, is communicated to a dog. The latter is at length found capable of resisting a poison of fatal virulence. It becomes, in fact, entirely proof against rabies when the poison of the mad dog of the streets is introduced into its system, either by intravenous inoculation or by trephining."

The proposition for testing his discovery by a commission is this: "The crucial test which I would propose would consist, in the first place, in taking from my kennels twenty dogs proof against rabies, and placing them side by side with twenty dogs intended to serve as my witnesses. We should then have these forty animals bitten successively by mad dogs. If the facts which I have enunciated are correct, the twenty dogs which I believe to be proof against the disease would all remain healthy, while the twenty witness dogs would become infected with rabies. In a second and not less conclusive experiment we should take forty dogs—twenty vaccinated before the Commission, and twenty not vaccinated. The forty dogs would then be inoculated by trephining with the virus of the mad dog of the streets. The twenty vaccinated dogs would be proof against the infection, while the other twenty would all die of rabies, with symptoms either of paralysis or madness."

PRZEVALSKY'S WILD HORSE

GREAT interest is attached to the question of the origin of our domestic animals, and especially to that of the horse—which is generally supposed not now to exist in an aboriginally wild state. Every fact bearing upon this subject is of importance, and the discovery by the great Russian traveller, Przevalsky, of a new wild horse, more nearly allied to the domestic horse than any previously known species, is certainly well worthy of attention.

The horses, which constitute the genera *Equus* of Linnæus, and are the sole recent representatives of the family *Equidæ*, fall naturally into two sub-genera, as was first shown by Gray in 1825 (*Zool. Journ.* i. p. 241)—*Equus* and *Asinus*.

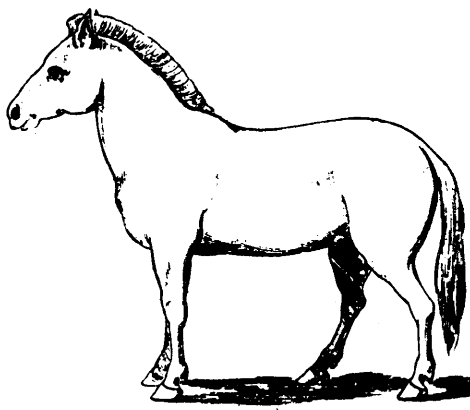
The typical horses (*Equus*) are distinguishable from the asses (*Asinus*) by the presence of warts upon the hind-legs as well as upon the fore-legs, by their broad rounded hoofs, and by their tails beginning to throw off long hairs from the base, instead of having these hairs confined, as a sort of pencil, to the extremity of the tail. Up to a recent period all the wild species of *Equus* known to science were referable to the second of these sections, that is, to the sub-genus *Asinus*, known from *Equus* by the absence of warts or callosities on the hind-legs, by the contracted hoofs, and by the long hairs of the tail being restricted to the extremity of that organ. Of this group the best known species, commonly called wild asses and zebras, are (1) the wild ass of Upper Nubia (*Equus tæniopus*), probably the origin of the domestic ass; (2) the wild ass of Persia and Kutch (*E. onager*); (3) the hemippe or wild ass of the Syrian Desert (*E. hemippus*); (4) the kiang or wild ass of Tibet (*E. hemionus*); (5) the quagga (*E. quagga*) of South Africa; (6) the Burchell's zebra (*E. burchelli*) of Southern and Eastern Africa; (7) the zebra (*E. zebra*) of Southern Africa. As already stated, these seven animals all possess the characters of the second sub-genus *Asinus* as above given, and no recent species of horse referable to the first sub-genus (*Equus*) was hitherto known to exist on the earth's surface, except the descendants of such as had been formerly in captivity.

Under the circumstances great interest was manifested when it was known that Przevalsky, on his return from his third great journey into Central Asia, had brought back with him to St. Petersburg an example of a new species of wild horse, which belonged, in some of its characters at least, to true *Equus*.

This new animal was described in 1881 in a Russian journal by Mr. J. S. Poliatow, and dedicated to its discoverer as *Equus przevalskii*.

The recently issued German translation of Przevalsky's third journey[1] enables us to give further particulars of this interesting discovery.

Przevalsky's wild horse has warts on its hind-legs as well as on its fore-legs, and has broad hoofs like the true horse. But the long hairs of the tail, instead of commencing at the base, do not begin until about half-way



Przevalsky's Wild Horse.

down the tail. In this respect *Equus przevalskii* is intermediate between the true horse and the asses. It also differs from typical *Equus* in having a short, erect mane, and in having no fore-lock, that is, no bunch of hairs in front of the mane falling down over the forehead. Nor has Przevalsky's horse any dorsal stripe, which, although by no means universal, is often found in the typical horses, and is almost always present in the asses. Its whole general colour is of a whitish gray, paler and whiter beneath, and reddish on the head. The legs are reddish to the knees, and thence blackish down to the hoofs. It is of small stature, but the legs are very thick and strong, and the head is large and heavy. The ears are smaller than those of the asses.

Przevalsky's wild horse inhabits the great Dsungarian Desert between the Altai and Tianschan Mountains, where it is called by the Tartars "Kertag," and by the Mongols "Statur." It is met with in troops of from five to fifteen individuals, led by an old stallion. Apparently the rest of these troops consist of mares, which all belong to the single stallion. They are lively animals, very shy, and with highly-developed organs of sight, hearing, and smelling.

They keep to the wildest parts of the desert, and are

[1] "Reisen in Tibet und am oberen Lauf des Gelben Flusses in den Jahren 1879 bis 1880," von N. von Prschewalski. Aus dem Russischen frei in das Deutsche übertragen von Stein-Nordheim. (Jena, 1884.)

UPPENBORN'S ELECTRICAL MEASURING INSTRUMENT.

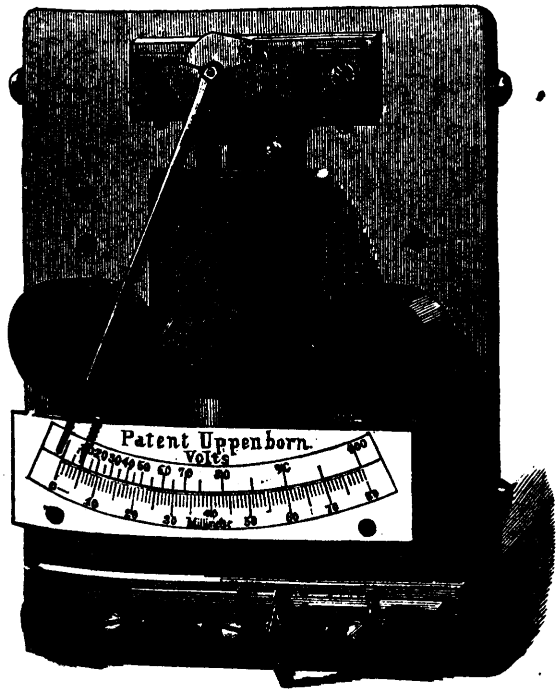


FIG. 1.

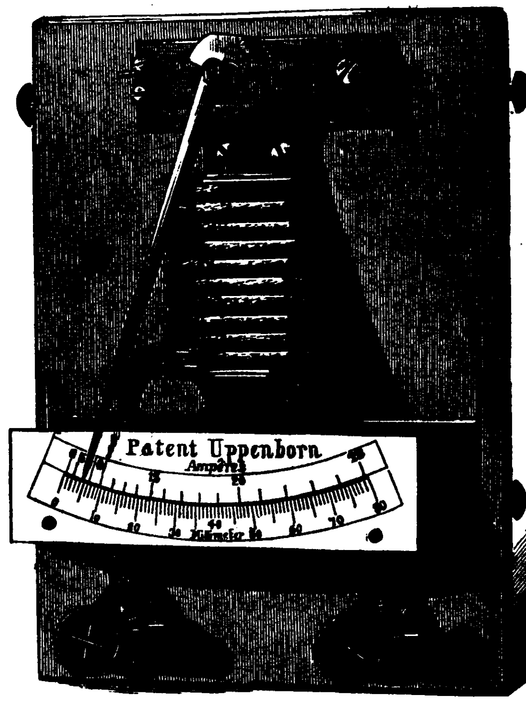


FIG. 2.

very hard to approach. They seem to prefer especially the saline districts, and to be able to do long without water.

The pursuit of this wild horse can only be carried on in winter, because the hunter must live in the waterless districts, and must depend upon a supply of water from melted snow. As may well be believed, such an expedition during the severest cold of winter into the most remote part of the desert, must take at least a month. During the whole time of his stay in the Dzungarian Desert, Prezevalsky met with only two herds of this wild horse.

In vain he and his companions fired at these animals. With outstretched head and uplifted tail the stallion disappeared like lightning, with the rest of the herd after him. Prezevalsky and his companions could not keep near them, and soon lost their tracks. On the second occasion they came upon them from one side, yet one of the herd discovered their presence, and they were all gone in an instant.

The single specimen of Prezevalsky's horse subsequently procured is now in the Museum of the Academy of Siences of St. Petersburg, and is the only example of this species in Europe.

UPPENBORN'S ELECTRICAL MEASURING INSTRUMENT.

The number of the measuring instruments recently devised is very great. The practical man is not satisfied with the delicate instrument of the physicist, whilst the latter, of course, cannot be satisfied with the results of the measuring instruments arranged by engineers and technical electricians, however satisfactory for industrial purposes. Both this circumstance and the variety in which the actions of the current and of the magnetic forces are manifested have led to the abundance of instruments which meet with practical applications.

Uppenborn's apparatus, both for the measurements of currents and of electromotive force, give their indications in consequence of the action of the current upon an eccentric disc.

The disc consists of soft iron (shown in Figs. 1 and 2 on the upper margin of the zinc plate upon which the instruments are mounted); it is fixed upon an axle, which rests with steel knife-edges upon steel planes. To the disc are fixed a pointer of aluminium and a counterpoise, which tends to bring the pointer to the zero point of the scale.

The cores of the electro-magnets of both instruments are fitted with threads, and can be approximated to the disc by means of a screw, thus rendering the apparatus more or less sensitive.

When the instrument has been adjusted, the core can be fixed in its position by means of a nut on the screw.

The apparatus for measuring currents is distinguished from that for measuring electromotive force by the manner of wrapping the bobbin of the electro-magnets, for which is used a short insulated wire of the purest copper. For wrapping the electro-magnet of the voltmeter there is used a pure and well insulated, but very thin copper wire. On both sides of the lower part of the electro-magnet in the latter are applied the coils of a resistance, which can be introduced or removed by the plug shown at the foot of the zinc plate, so as to regulate the sensitiveness of the instrument.

These apparatus are graduated empirically. In consequence of their convenience and their use in their installations arranged by Schuckert and Uppenborn they have come into very extended use.

Uppenborn makes also magnetic meters on the same principle. The action of the electro-magnets to be tested for their magnetism upon the eccentric causes it to rotate. To its disc is fixed a torsion-spring leading to a button. By turning this a second index attached to it is brought to zero, so that the angle of torsion may be read off. It is then proportional to the square of the effective magnetism. As already estimated, the indications of this instrument are sufficient for practical purposes.—*Electrical Review.*

THE PULSE OF SMOKERS.—From experiments made upon the pulse and temperature as affected by smoking, it has been found that the rate of both is increased. Let the average temperature of non-smokers be represented by 1,000, then that of moderate smokers would be 1,008 ; and while the heart of the former class was making 1,000 beats, in the latter there would be 1,180 in the same space of time. This quickening of the action of the heart is considered a dangerous symptom.

PETROLEUM FUEL FOR LOCOMOTIVES.

(*Continued from page* 243.)

Mr. Bedson remarked that his firm, being manufacturers of charcoal iron, had at one time a large quantity of charcoal dust to get rid of, and that they had utilized it by mixing it with refuse petroleum and burning it, but the price of petroleum advanced and its use was discontinued. Mr. W. S. Tomkins pointed out that the locomotive boilers shown in Mr. Urquhart's diagrams could only be regarded as make-shifts or adaptations of existing boilers; he believed that when Mr. Urquhart designed special boilers for petroleum fuel, it would be found that the construction could be much simplified, the present expensive copper firebox being done away with and other changes made. Mr. Boyd, he added, had referred to the difference between the fuel consumption in the summer and winter months during Mr. Urquhart's trials; this, he said, was always so in Russia, the consumption in water being largely increased by the inclemency of the weather, &c.

Mr. Cardew, of the Indian State Railways, next spoke as to the use of petroleum as a disincrustant in locomotive boilers. In the Indian State lines they had exceptionally bad water to deal with, this water containing a large proportion of sulphates; so much so that the boilers had to be washed out after every 100 miles run. With a view of obtaining the deposition of the solids in the form of dust, the introduction of Rangoon oil had been tried, but at first the result was to cause excessive priming and to produce leaky tubes, &c., so much so that when an engine using it went out they never quite knew when it would get back again. Eventually, however, they found that by using very minute quantities of the oil they got the desired result without these inconveniences, and the practice ultimately arrived at was simply to paint the interior of the tender tank with kerosene each time the boiler was washed out. The application of kerosene as an anti-incrustator had been made on several Indian railways, but he believed that on some it had been given up as being too ticklish to manage.

Mr. Druitt Halpin observed that he had for years successfully used petroleum as an anti-incrustator in boilers supplied with worse water than that found in the Punjaub (with the character of which he was acquainted). The boilers in which he had used it were of the Lancashire type, 7 ft. in diameter by 30 ft. long, and from a pint to one and a half pints of petroleum was used per boiler per week, the petroleum being put in the boilers through the safety valves on Monday mornings.

The President, in bringing the discussion to a close (the author not being present), remarked that he agreed with the statements in the paper as to the heating power of petroleum, but the latter, of course, varied much in quality. If we were to employ petroleum in place of coal for firing boilers in this country the effect would be a rise in the price, which would in turn render its use prohibitive. He agreed also with the desirability of carefully adjusting the air supply so as to obtain the best results, imperfect combustion being a serious cause of loss. With regard to a remark made by Mr. F. C. Marshall, he observed that as the rate of transmission of heat through the heating surfaces of a boiler fell off as rapidly as the difference of temperature on the two sides of a plate was diminished, it would never be possible practically to even approximately fulfil the conditions which Mr. Marshall aimed at, the additional heating surface required to approximate to this result being such as to render it impracticable. A speaker had referred to the firebricks in the furnace as forming a "regenerator;" this was incorrect, as the bricks trapped no heat which would otherwise be lost, they merely acted as equalizers of temperature. With regard to the differences which appeared in Mr. Urquhart's paper between the relative evaporative powers of petroleum and anthracite and their relative economic powers as fuel in locomotives, he pointed out that in the latter case, the result was affected by the heat absorbed in generating the steam used in injecting the fuel, and other losses. The admission of this steam to the furnace might also become a source of loss. Of course if the steam was decomposed heat would be absorbed and the total effect of the two operations would be *nil*; if, however, the combination did not take place a loss would ensue. In conclusion he proposed a vote of thanks to Mr. Urquhart for his paper—a vote which was heartily carried. —*Engineering.*

COVERING THE HEAD.—In a recent paper, Dr. Almond refers to the custom of covering the head out of doors and uncovering it within doors as very injurious, as making people so sensitive to draughts of air as to cause them to take cold.

THE HISTORY OF A LIGHTNING FLASH.

BY W. SLINGO.

Lately we have all felt, I doubt not, a considerable amount of interest in the various phenomena attending this summer's unusually heavy thunderstorms, accompanied, as they have been, by vivid lightning discharges of a more or less hurtful nature. The list of disasters published in *Knowledge*, No. 143, might be very materially augmented were we to record such damage as has been wrought since that list was compiled.

There is not, I suppose, in the mind of any intelligent man at the present day a doubt as to the electrical origin of a lightning flash. The questions to be considered are rather whence comes the electricity? and in what way is the thunderstorm brought about? In attempting to answer these queseions, sight must not be lost of the fact that the very nature of electricity is in itself almost sufficient to baffle any effort put forth to ascertain from lightning, as such, its whence and its whither.

It is possible, however, with the aid of our knowledge of static electricity, to arrive at hypotheses of a more than chimerical nature. In the first place, that our sphere is a more or less electrified body is generally admitted. More than this, it is demonstrated that the different parts of the earth's surface and its enveloping atmosphere are variously charged. As a consequence of these varying charges, there is a constant series of currents flowing through the various parts of the earth, which show themselves in such telegraph-wires as may lie in the direction followed by the currents. Such currents are known as earth-currents, and present phenomena of a highly interesting nature. But, apart from these electrical manifestations, there is generally a difference of electrical condition between the various parts of the earth's surface and those portions of the atmosphere adjacent to or above them. Inasmuch as air is one of the very best insulators, this difference of condition (or potential) in any particuliar region is in most cases incapable of being neutralised or equilibriated by an electric flow. Consequently the air remains more or less continually charged. With these points admitted as facts, the question arises, Whence this electricity? There have been very many and various opinions expressed as to the cause of terrestrial electricity, but far the greater portions of such theories lack fundamental probability and indicate causes which cannot be regarded as sufficiently extensive or operative to produce such tremendous effects as are occasionally witnessed. I take it that we may safely regard the evolution of electricity as one of the ways in which force exhibits itself, that, in other words, when work is performed electricity may result. When two bodies are rubbed together, electricity is produced, so also is it when two connected metals are immersed in water and one of them is dissolved, or when one of the junctions of two metals is raised to a higher temperature than the other junction. I will go further than this, so far, in fact, as to maintain that there is reasonable ground for supposing that every movement, whether it be of the mass or amongst the constituent particles, is attended by a change of electrical distribution, and if this is true it may easily be conceived that inasmuch as motion is the rule of the universe, there must be a constant series of electrical changes. Now, these changes do not all operate in one direction, nor are they all of similar character, whence it is that not only are there earth currents of feeble electro-motive force, but that this E M F is constantly varying, and that, furthermore, electricity of high E M F is to be met with in various parts of the atmosphere.

With earth currents we have here very little to do. The rotation of the earth is in itself sufficient to generate small currents, and the fact that they vary in strength at regular periods of the day and of the year enforces the suggestion that the sun exerts considerable electrical influence on the earth. Letting it be granted, however, that the earth is variously charged, how comes it that the air is also charged, and with electricity of greater tension than that of the earth itself? It was pointed out by Sir W. Grove that if the extremities of a piece of platinum wire be placed in a candle flame, one at the bottom and the other near the top, an electric current will flow through the wire, indicating the presence of electricity. If an electrified body be heated, the electricity escapes more rapidly as the temperature rises. If a vessel of water be electrified, and the water then converted into steam, the electric charge will be rapidly dissipated. If a vessel containing water be electrified, and the water allowed to escape drop by drop, electricity will escape with each drop, and the vessel will soon be discharged. We regard it as an established fact that the earth has always a greater or less charge; whence it is safe to assume that in the process of evaporation which is going on all over the surface of the globe, more particularly in equatorial regions, every particle of water, as it rises into the air, carries with it its portion, however minute that portion may be, of the earth's electric charge. This small charge distributes itself over the surface of the aqueous particle, and the vapour rises higher and higher until it reaches that point above which the air is too rare to support it. It then flows away laterally, and as it approaches colder regions, gets denser, sinking lower and nearer to the earth's surface. The aqueous particles, becoming reduced in size, the extent of their surfaces is proportionately reduced. It follows that as the particles and their surfaces are reduced, the charge is confined to a smaller surface, and attains, therefore, a greater "surface density," or, in simpler language, a greater amount of electricity per unit of surface. Electricity, as above set forth, is in what is known as the "static" condition (to distinguish it from electricity which is being transferred in the form of a current), when it has the property of "repelling itself" to the utmost limits of any conductor upon which it may be confined. This will account for the charge finding its way to the surface of the water particles and will furthermore account for the greater density of the charge as the particle gets smaller and has the extent of its surface rapidly diminished. It may be mentioned that the surface of a sphere varies as the cube of its radius. Returning to the discussion of the state of affairs existing when the particles have reached their highest position in the atmosphere, we may imagine that they set themselves off on journeys towards either the north or the south pole. As they pass from the hotter to the colder regions, a number of particles coalesce; these again combine with others on the road until the vapour becomes visible as cloud. The increased density implies the increased weight, and the cloud particles, as they sail pole-wards, descend towards the surface of the earth. Assuming that a sperical form is maintained throughout, the condensation of a number of particles implies a considerable reduction of surface. Thus, the contents of two spheres vary as the cubes of their radii, or eight (the cube of 2) drops on combining will form a drop twice the radius of one of the original drops. We may safely conceive hundreds and thousands of such combinations to take place until a cloud mass is formed, in which the constituent parts are more or less in contact, and, therefore, behave electrically as a single conductor of irregular surface, upon which is accumulate all the electricity that was previously distributed over the surfaces of the millions of particles that now compose it.

The tendency of an electric charge upon the surface of a conductor is to take upon itself a position in which it may approach nearest to an equal and opposite charge, or, if possible, to attain neutrality. If, then, a cloud has a charge, and there is no other cloud above or near it, the charge *induces* on the adjacent earth surface, electricity of the opposite kind. Thus, assuming the cloud to be charged with positive electricity, the subjacent earth will be in the negative state. The two electricities exert a strong tendency to combine or to produce neutrality, whence there is a species of stress applied to the intervening air. Possibly the cloud will be drawn bodily towards the earth more or less rapidly, according as the charge is great or small. Or, on the other hand, the cloud may roll on for leagues, carrying its influence with it, so that the various portions of the earth underneath becomes successively charged and discharged as the cloud progresses on its journey.

Should the cloud be near the earth, or should it be very highly charged, the tension of the two electricities may be so great as to overcome the resistance of the intervening air; and if this resistance should prove too weak, what happens? How does the discharge show itself? It takes place in the form of a lightning flash, and passing from the one surface to the other —or, may be, simultaneously from both—produces neutrality more or less complete.

There has recently been a little discussion in these pages on the subject of lightning, some having stated that they discerned the discharge to take place upwards—that is, from the earth towards the cloud. I will not venture so far as to say whether or not the direction of the discharge is discernible; possibly the flash may sometimes be long enough to enable one to tell; but I have never so seen it, and have always looked upon the eye as a deceitf l member—very. "The lightning flash itself never lasts more than $\frac{1}{100000}$ of a second." It is, however, just as likely that a discharge may travel upwards as downwards. What controls the discharge? Does the quality of the charge?—that is to say, is the positive or the negative more prone to break disruptively through the insulating medium? Investigations with Geissler's and other tubes containing highly rarefied gases have made it tolerably clear that there is a greater "tearing away" influence at the negative than at the positive pole, and if two equal balls, containing one a positive and the other a negative charge, be equally heated, the negative is more readily dissipated than the positive. But, so far as we at present know, this question enters into the discussion scarcely, if at all. Our knowledge seems rather to point to the substances upon which the charges are collected. The self-repellent nature of electricity compels it to manifest itself at the more prominent parts of the surface, the level being forsaken for the point. The tension of the charge, or its tendency to fly-off, is proportionately increased. And if at a given moment the tension attains a certain intensity, the discharge follows, emanating from the surface which offers the greatest facilities for escape. The earth is generally flatter than the cloud, whence in all probability, the discharge more frequently originates with the cloud.

Should a lightning flash strike the earth and produce direct neutrality, it is possible that no damage will result, although this again is not always certain, because when the cloud charge acts inductively upon the earth it produces the opposite (say negative) charge on the nearer parts, the similar (or positive) state is also produced at some place more or less distant. Sometimes this "freed" positive (which, by the way, accumulates gradually and physiologically imperceptibly) is collected at some portion of the earth's surface. When the negative is neutralised by the discharge, the freed positive is no longer confined to a particular region, but tends to dissipate itself and a shock may be felt more or less severely by any within the region. Or, again, a similar shock may be experienced by a person standing within the negative zone on the neutralisation of the charge.

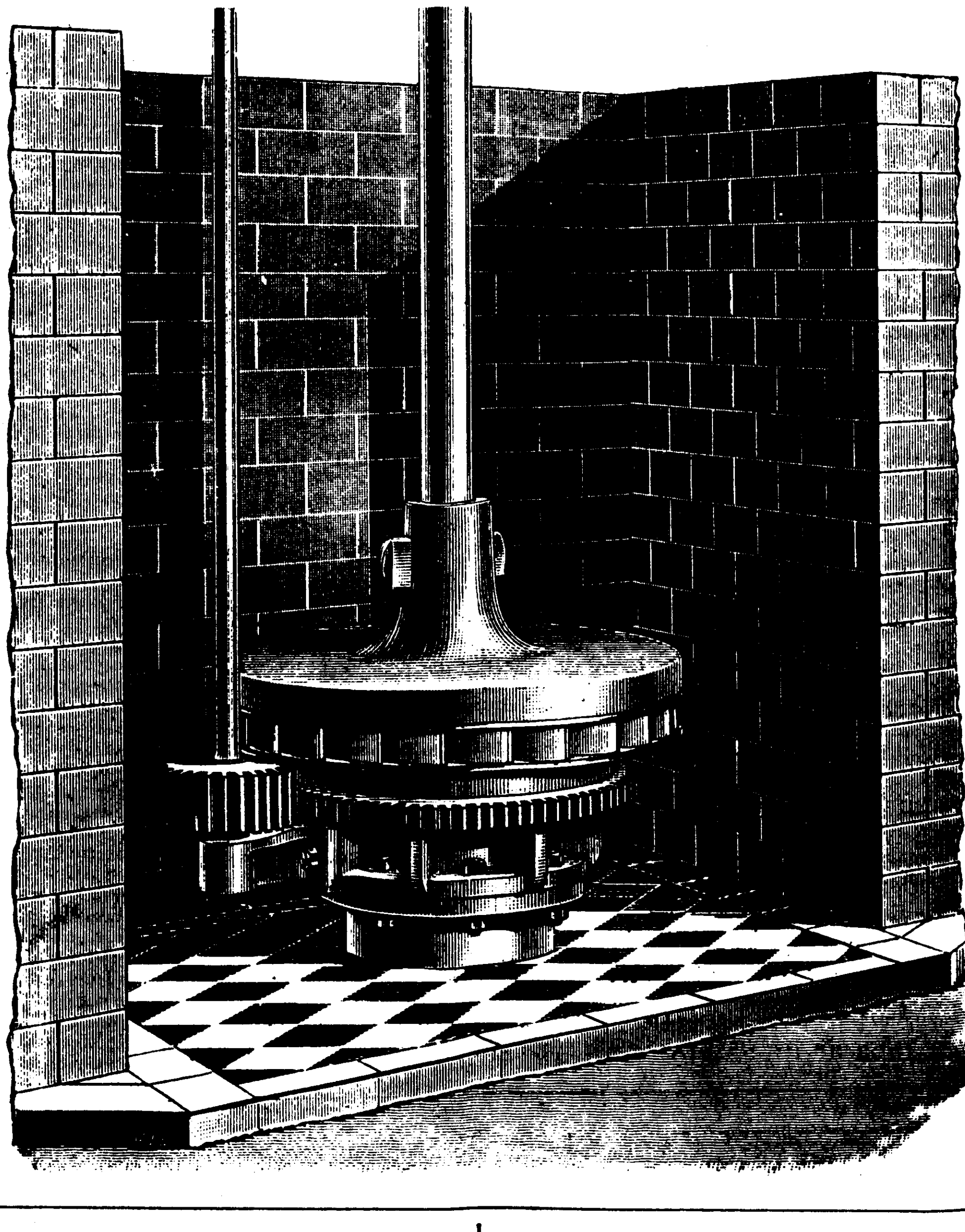
I may take the opportunity here to mention a highly interesting and instructive incident observed on local telegraph circuits during a thunderstorm. The storm may be taking place at some distance from the point of observation. The electrified cloud induces the opposite charge beneath it, the similar charge being repelled. It is noticeable that the needle of a galvanometer, starting from the middle position, goes gradually over to one side, eventually indicating a considerable deflection. Suddenly, owing apparently to a lightning discharge some distance away, the force which caused the deflection is withdrawn, and the needle rebounds with great violence to the opposite side. In a short time, the cloud becoming again charged on its under surface, and recommencing its inductive effect upon the subjacent earth, the needle starts again, and goes through the same series of movements, a violent counterthrow following every flash of lightning.

If we can so far control our imagination, we may conceive the earth to be one large insultated conductor, susceptible to every influence around it. If, then, the earth, as a mass of matter, behaves as above indicated, there is no plausible reason for declining to regard any other large conducting mass in a similar light, and, as a body capable of being subjected more or less completely to the various impulses affecting the earth. In other words, a large mass of conducting material, partially or perfectly insulated is, during a thunderstorm, in considerable danger. With this portion of the subject I shall, however, deal more fully when discussing the merits of lightning protectors.

Lightning discharges do not take place between cloud and earth only, but also, and perhaps more frequently, between two oppositely-charged clouds. We then get atmospheric lightning, the flash often extending for miles. This form of lightning is harmless, and in all probability what we see is only a reflection of the discharge. The oft-told tale of the lightning flying in at the window, across the room, and out of the door, or up the chimney, is all moonshine, and before dealing with lightning protectors I intend to expose some of the fallacies concerning lightning. Were the discharge to pass through a house it would infallibly leave more decided traces and do more damage than simply scaring a superstitious old lady now and again. Many people are often and unnecessarily frightened during a thunderstorm, but it may be safely predicted that a person under a roof is infinitely safer than one who is standing alone on a level ground, and making himself a prominence inviting a discharge. Rain almost invariably accompanies the discharge, and the roof and sides of the house being wet, they form a more or less perfect channel of escape should a flash strike the building.—*Knowledge.*

HIGH PRESSURE TURBINE.

This illustration is taken from the photograph of one of the best descriptions of these Patent Turbines. It is working from a clear head of 92 feet, or 40 lbs. per square inch, and producing 80 horse-power, while making 450 revolutions per minute. The guides, buckets and sluice are made of the best gun-metal; and the Turbine runs with perfect freedom from vibration.

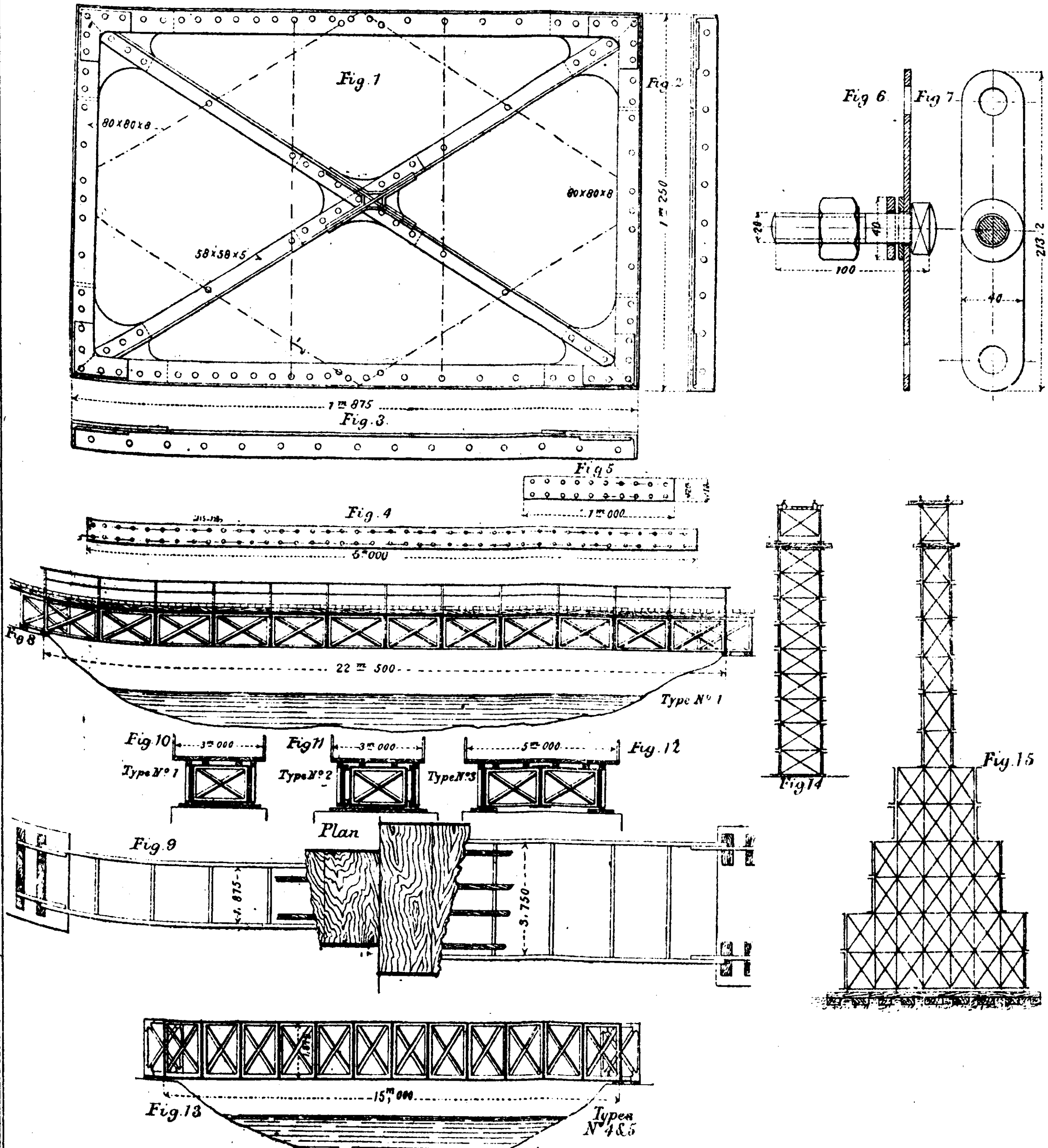


PORTABLE BRIDGES.

At the Paris Universal Exhibition of 1878, Mr. Alfred Cottrau, of Naples, the well-known Italian bridge constructor, exhibited models of a system of portable bridges, which attracted considerable attention, and for which a silver medal was awarded. Since that time Mr. Cottrau has introduced many modifications and improvements in his system, and in its latest development, it forms an important collection at the present Turin Exhibition, under the general title of Politetragenal bridges, and made by the Ironwork Construction Company, at their works in Castellamar (Stabia).

Whatever may be the span (within limits), the width and the load to be carried, bridges made upon this system, are built up of three elements, Figs. 1, 4, and 5 connected by means of bolts and keys, and washers, as in Fig. 6 and 7. As examples of bridges constructed on this system, the elements, Figs. 1, 4, and 5, weigh respectively 220 lb., 103.5 lb., and 22 lb., all are therefore very easy of transport. The combination and erection of these bridges, even by unskilled labour, or by ordinary troops, is easy and rapid, but with properly trained men, a span of 65 feet, can be completed within an hour. It is true that there exist other and well-known systems of military bridges, the erection of which can be effected in even shorter time, but the special advantage which Mr. Cottrau claims, is that while portable bridges on existing systems are necessarily limited in their spans, his principle is applicable to relatively large openings, the weights of the component parts remaining always the same; moreover, the strength of the structure can be modified according to the load which has to be carried, with

PORTABLE BRIDGES.



much greater ease and economy of transport. The several elements are made of steel, and are calculated for a working strain of about 7 tons per inch, which, under necessity may be doubled without danger to the safety of the structure. There is no occasion to enlarge on the various advantages claimed by the inventor for this system. For military and other temporary purposes, portability, rapidity of execution, and strength, which would naturally be tested far closer to the ultimate limit than would be admissable in ordinary and permanent structures, are qualities which speak for themselves. We may, however, devote some space to a notice of some of the typical bridges erected from different combinations of the elements, and which are illustrated by examples at Turin.

Figs. 8 to 12 show an application with girders 4 ft. 1½ in. deep, and adapted for ordinary road traffic, for the passage of soldiers, and for moderately heavy vehicles. In this arrangement, suitable for spans up to 74 ft., the panels are bolted end to end and form a single intersection trellis. Fig. 13 shows a method of obtaining greater stiffness, by bolting the elements together in the direction of their greatest depth, or two series of panels may be secured side by side, one series being shifted longitudinally through the length of half a panel in such a way as to obtain a double intersection trellis. As is shown in the cross sections, Figs. 10, 11, and 12, the transverse supports are obtained by means of similar elements placed between the longitudinal girders at intervals. Figs. 8, 10, and 11 show an arrangement in which the width is about 10 ft., and only one panel is employed. In Fig. 12 two such panels are used, and the width is increased to 16 ft. If desired three elements may be introduced, and the width increased accordingly. Where additional strength is required, as for the passage of heavy artillery, two light channel bars with top and bottom plates can be introduced instead of one as indicated. From experiments that have been conducted with such bridges as we have described, it has been found that a bridge of 50 ft. span, composed of 27 elements, Fig. 1, 36 elements, Fig. 5, and 664 bolts, weighs about 3.4 tons, and will carry safely a uniformly distributed load of 11 tons, or a waggon weighing 4 or 5 tons may be sent over it with safety. A second bridge, 79 ft. span, of the same type is also extremely light. Composed of 42 elements, Fig. 1, 12 elements Fig. 3, 56 elements, Fig. 5, and 1050 bolts, and weighing about 5.8 tons, its safe working load is 41 lb. per square foot, and it can carry a vehicle of 7 tons.

Bridges up to 82 ft. span, adapted for heavy military service, secondary roads, &c., can be constructed according to the type Fig. 13, and experiments have been conducted with them, showing that with a total weight of structure of 8 tons, a uniformly distributed load of 17 tons can be safely carried. For larger openings and heavier loads, the elements can be doubled as already explained, so as to make double inter-section panels, or the width and number of main girders may be increased. Such a bridge 131 ft, span, weighing 495 lb. per foot run will carry a load equally distributed of 165 lb. per square foot, with a strain of less than 6 tons per square inch.

A further development of this system, carried out by Mr. Cottrau, is for the construction of railway bridges, either for contractors, for military purposes, or for temporary work, and by suitably combining the different elements, spans relatively considerable can be very rapidly constructed. Equally the same elements can be used in the construction of piers as shown in Figs. 14 and 15.

In a large majority of cases bridges constructed on this system can be put together, on one bank of the stream they are to cross, and be launched into their ultimate positions, the extreme lightness of the structure rendering this operation comparatively easy, and without any dangerous strain being thrown upon the steel during the operation. And should it be found advisable to balance the bridge during the period of launching this can be easily effected by adding a sufficient number of panels in the ordinary elements.

The great amount of care and ingenuity which so eminent a bridge constructor as Mr. Cottrau has bestowed on the elaboration of this system of portable bridges, will doubtless command for it the attention of contractors, military authorities, and others interested in a practical solution of establishing temporary communication, rapidly and efficiently, especially in countries where the transport of materials is difficult and costly. We shall probably take an opportunity of again referring to this system.—*Engineering.*

THUNDER STORMS.

BY JOHN TROWBRIDGE.

Benjamin Franklin once remarked, in substance, sadly to a friend, "It is now eight years since I showed that mankind could be protected from the danger of lightning by lightning-rods; yet there is hardly a house in Philadelphia provided with them." The heart of the great American philosopher would be greatly warmed if he could perceive the activity of his disciples, who waylay every builder of a house, and awaken fears where all was peace before. There is no question oftener asked of the professor of physics than this: "Shall I put lightning-rods on my house, and, if I erect them, what should be their form and position?" Personally I have given the following abbreviated answers: "If your house is surrounded by tall trees, or if there are higher houses in your immediate neighborhood, I should trust to the trees, or kindly leave the expense of your lightning rods to your neighbor. If your house stands alone, a prominent point in the landscape, on a cliff, or remote from trees, I should be in favor of a properly placed lightning-rod. I should place two or three pointed rods three or four feet above the highest point of the house; allow the metallic rod, which should be at least one-half a square inch in section, to rest, without glass insulators, upon the house; connect all the tin sheathing, the copper gutters, the gas and water pipes with this lightning-rod; and conduct the latter, by the shortest course possible, to *wet earth.*"

These answers seldom conclude the correspondence, however, although one generally prefers to leave to the neighbor the expense of erecting lightning-rods. One brings instances of houses having been struck which are situated lower than one's neighbors, and are surrounded with tall trees which over-topped the houses; and one asks with a shudder, "Can I connect my gas-pipes with a lightning-rod?" Indeed, the writer or would-be authority on lightning rods has not an easy life before him. He must not only satisfy the timid heart of the believer in him, but he must also fight with all his knowledge the brazen limb of ignorance and superstition, who starts with the postulate that no scientific man knows any thing concerning thunder and lightning, and that the true knowledge has been revealed only to himself while working in a cornfield. It is not long since, that an American professor of physics was sued for twenty or thirty thousand dollars damages for maintaining that the members of a lightning rod company which placed lightning-rods like a letter U upon the roofs of houses were practically quacks; the theory of this lightning-rod being, that the lightning, if it struck one point of the U, would be dissipated into the air from the other point. There is a lightning-rod company in Massachusetts at the present time which erects lightning-rods on the theory that lightning always seeks electrical earth-currents; and, if there are earth-currents beneath a house, that house should be protected and the rods led into the path of the earth-current. If, on the other hand, no earth-currents run near the house, such a house is safe, and needs no lightning-rods. The electrician of this firm is self-taught: there are no books on electricity in his library. He discovers the earth-currents by a forked stick. Not deterred by the fact that there is no evidence to prove that a discharge takes place between a charged cloud and a current of electricity in the ground, and, moreover, no evidence to prove that earth-currents move in regular paths through the earth, and, indeed, no *conclusive* evidence of the existence of earth-currents, he persuades even the so-called practical electrician to re-arrange the lightning-rods on his house.

The student of electricity is therefore called upon to assert the grounds of his belief; and he finds it difficult to convince his audience; for they are, in general, not sufficiently conversant with electrical phenomena to appreciate his arguments. The position taken by most professors of physics on the subject of lightning-rods is based upon the experiments of Franklin, in which he showed that pointed metallic rods, so to speak, facilitated electrical discharges; the experiment of Faraday, by which it was shown that a person, and even the most delicate electrical instruments, inside a large metallic cage which was connected with the ground, was unaffected by powerful discharges of electricity between the cage and the prime conductor of an electrical machine; and the statistics collected by the English government, which show, that, since vessels have been provided with lightning rods the number of casualties produced at sea from lightning have been greatly reduced. A building covered by a metallic netting suitably connected with the ground would be well protected from lightning. The nearest approach to this condition of safety would be to connect all the network of metallic conductors about a house with wet ground; and one argument against placing under ground the network of telephone and telegraph wires in cities is, that at present, where they are very numerous, they protect buildings from danger from lightning. This is, of course, not the case where a single telephone or telegraph wire enters a house. The latter should always be well connected with the gas or water pipe. In regard, however, to the belief that tall trees, higher than the houses in their immediate neighborhood, protect the houses, we can point to the well known efficiency of small points in facilitating electrical discharges by slow degrees. Each leaf and twig is such a small point. Moreover, during a rain, the dripping from the leaves reduces the electrical charge on the tree to the same sign and amount as that of the air in the immediate neighborhood, as is shown by the well-known experiment of Sir William Thomson, in which an insulated can, from which a stream of water issues in drops, is connected with an electrometer; and the latter shows that the metallic can has taken the charge of the air in its neighborhood. The drops of water continually reduce the can to the electrical potential of the neighboring air. The tree, therefore, can be looked upon as a more important electrical factor than the few salient lower points of a building.

It is safe to affirm that not one out of a thousand lightning-rods at present upon our buildings are of any use, for the simple reason that they are not led into moist ground, and therefore offer great resistance to the passage of an electrical discharge. Any one can be convinced of this by scraping the lightning-rod at any point, connecting a bright wire at this point, and, having led the other end of the wire to the water-pipe or to a body of water, placing one or two Leclanché cells in this circuit, and leading the wire in a north and south direction directly over an ordinary pocket compass. If the lightning-rod enters moist ground, or makes a connection with the earth, the compass should indicate an electrical current by its deflection. Generally it will be found that no such earth-connection exists, and the lightning-rod is therefore worse than useless. It should be immediately connected with the water-pipe, or with a spring, or some body of water. To illustrate the fact that the mere entrance of a metallic rod into the ground is not enough to insure the passage of an electrical discharge to the ground, drive two metallic rods into your lawn, at any suitable distance apart; connect them by a wire, which includes a Leclanché or other voltaic cell; and, having led the wire over a pocket-compass in a north and south direction, see if you obtain a deflection of the needle. If, moreover, you labor under the delusion that a surface-sprinkling of the earth near the rods will give an electrical connection, it is best to perform the experiment. It is probable that several acres of lawn would have to be thoroughly sprinkled before a suitable earth-connection could be obtained. A few experiments with a modern electrical machine—a Toepler-Holtz machine, for instance—will readily convince one of the effect of points in dissipating an electrical charge, and of the fact that an electrical discharge always takes the path of least electrical resistance between two points. Having ascertained these facts, one has acquired all the intellectual capital that is possessed by most lightning-rod men. If one apparently discovers that gilded lightning-conductors, or twisted ones, have peculiar attractions for the electrical discharges, one leaves the sure ground of fact for the region of the unproven. The difficulty in our study of thunder-storms is, that we cannot experiment on a sufficiently large scale, and our means are too tardy to allow us to follow the exceedingly rapid changes of electrified bodies. What we call freaks of lightning are merely the expressions of electrical laws, combined with the laws of elasticity of matter. The forked lightning discharge is an expression of the fact that a positive charge is combining with a negative charge along a path of least resistance; and the air is fractured, so to speak, by the compression, just as a plate of glass yields in zigzag cracks when it is supported on one edge, and a force of compression is applied to the other edge. The influence of the medium through which the electrical discharge takes place can be readily seen by obtaining the electrical discharge in different gases, such as carbonic-acid gas or nitrogen, and comparing these photographs with those taken in free air. Although we can study certain phenomena of atmospheric electricity successfully in our laboratories, yet we cannot charge a cloud with positive electricity, and fill the sky with different strata of hot and cold air. It is generally believed to-day among scientific men, that the electricity of thunder-storms cannot be attributed to sudden evaporation or condensation of moisture; for direct experiment has failed to reveal any electricity which is due to these causes. Mr. Freeman made many delicate experiments in the physical laboratory of Johns Hopkins university to decide the question whether evaporation produces electricity, and he could find no evidence of any that was due to this cause. Herr Kayser has also lately experimented at the physical laboratory of Berlin upon the electrical effects of condensation, with negative results. Personally I feel that all the experiments hitherto conducted on the electricity due to evaporation and to condensation have been conducted on too small a scale to test the question; and I do not see how they can be conducted on a larger scale. When we think of the immense plan upon which these operations are conducted in nature, of the evaporation from every square foot of the ocean, and of the rapid condensation through miles of space, we can realize that an infinitesimal amount of electrical charge, too small to be detected in a laboratory, might be integrated into a large amount, and, becoming localized, might produce the tremendous electrical disturbances which we witness in thunder-storms.

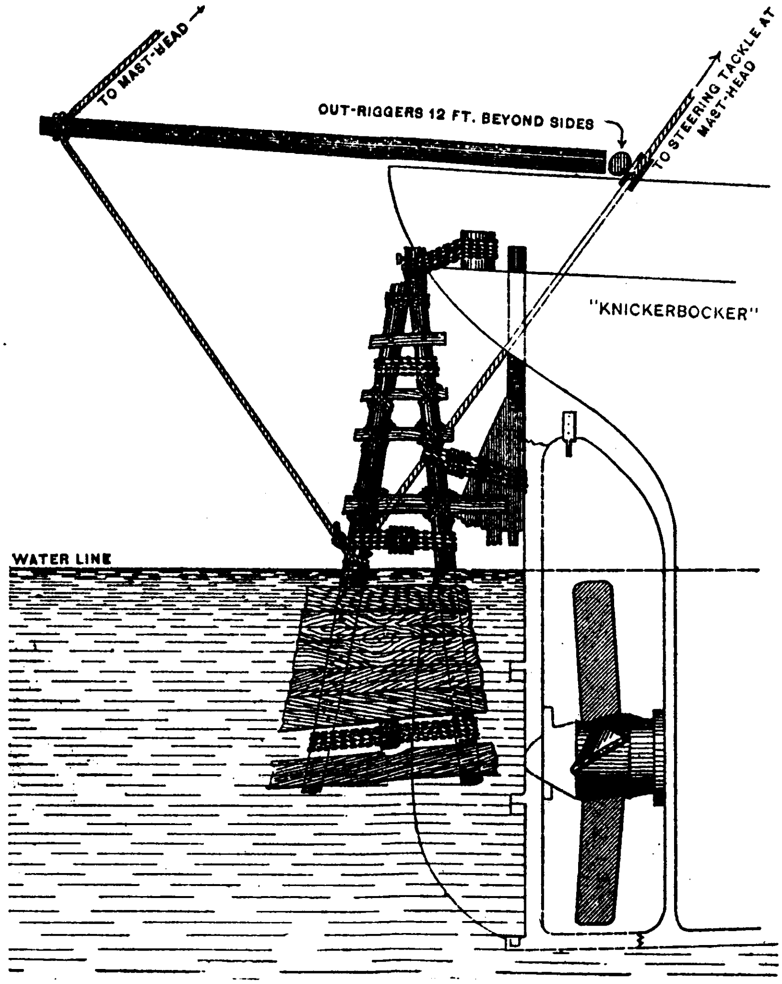
How, then, can we conduct future investigations upon thunder-storms? The most promising direction for scientific work seems to be in the establishment of systematic observations on thunder-storms, and on atmospheric electricity in general, over a large tract of country. In certain regions, thunder-storms follow certain definite paths, and other tracts are never visited by them. There is a general impression that electrical storms are, in common language, attracted by rivers, and are more severe about large bodies of water in general. However this may be, nothing but systematic daily simultaneous observation, long continued, can increase our knowledge. If the government, in connection with the signal-service, should establish a number of electrical stations throughout the west and south, where thunder-storms and tornadoes are so frequent, daily thunder-storm maps might be issued, showing the probable path of the electric disturbances. Perhaps we should then see, in districts peculiarly infested by thunder-storms, certain "insurance-against-danger-by-lightning retreats," in which Benjamin Franklin's lightning-rod should rise from a small hut, completely covered with a net-work of metallic rods which are connected with running water or a large extent of moist earth. The safe retreats would certainly be a great desideratum for many who now suffer greatly from nervous terrors during thunder-storms.—*Science.*

THE SEA HORIZON.

It is amusing to note how ignorant many ordinary seamen and nearly all sea travellers are of such matters as the distance of the sea horizon, the way in which a ship's place at sea is determined, and other such matters—which all seamen might be expected to understand, and most persons of decent education might be expected to have learned something about at school. Ask a sailor how far off a ship may be, which is hull down, and he will give you an opinion based entirely on his knowledge of the ship's probable size, and on the distinctness with which he sees her. This opinion is often pretty near the truth; but it may be preposterously wrong if his idea of the ship's real size is very incorrect, and is sometimes quite wrong even when he knows her size somewhat accurately. Any notion that the distance may be very precisely inferred from the relative postion of the hull and the horizon line seems not to enter the average sailors's head. During my last journey across the Atlantic we had several curious illustrations of this. For instance, on one occasion a steamer was passing at such a distance as to be nearly hull down. From her character it was known that the portion of her hull concealed was about 12 feet in height, while it was equally well known that the eye of an observer standing on the saloon-passengers' deck on the *City of Rome* was about 30 feet above the water-level. A sailor, asked (by way of experiment) how far off the steamer was, answered, "Six or seven miles." "But she is nearly hull down," some one said to him. "I didn't say she warn't, as I knows on," was the quaint but stupid reply. Now, it might be supposed to be a generally known fact that even as seen from the deck of one of the ordinary Atlantic steamers, the horizon is fully six miles away, the height of the eye being about 18 or 20 feet, and that for the concealed portion of the other ship's hull a distance of four or five miles more must be allowed: so that the man's mistake was a gross one. And several other cases of a similar kind occurred during my seven days' journey from Queenstown to New York.

The rules for determining the distances of objects at sea, when the height of the observer's eye and the height of the concealed part of the remote object above the sea-level are both known, are exceeding simple, and should be well known to all. Geometrically, the dip of the sea surface is eight inches for a mile, four times this for two miles, nine times for three miles, and so forth; the amount being obtained by squaring the number of miles and taking so many times eight inches. But, in reality, we are concerned only with the optical depression, which is somewhat less, because the line of sight to the horizon is slightly curved (the concavity of the curve being turned downward). Instead of eight inches for a mile, the optical depression is about six inches at sea, where the real horizon can be observed. But, substituting six inches for eight, the rule is as above given. Six inches being half a foot, we obtain the number of six-inch lengths in the height of an observer's eye by doubling the number of feet in that height; the square root of this number of six-inch lengths gives the number of miles in the distance of the sea horizon. Thus, suppose the eye of the observer to be eighteen feet above the sea level; then we double eighteen, getting thirty-six, the square root of which is 6; hence the horizon lies at a distance of six miles as seen from an elevation of 18 feet. For a height of 30 feet, which is about that of the eye of an observer on the best deck of the *City of Rome*, we double 30, getting 60, the square root of which is 7·7; hence, as seen from that deck the horizon lies at a distance of $7\frac{7}{10}$ miles. If the depth of a part of a distant ship's hull below the horizon is known, the distance of that ship *beyond the horizon* is obtained in the same way. Thus, suppose the depth of the part concealed to be 12 feet then we take the square root of twice 12, or 24, giving 4·9, showing that

JURY RUDDER OF THE S.S. "KNICKERBOCKER."



that ship's distance beyond the horizon is 4 $\frac{9}{10}$ miles. Hence, if a ship is seen so far hull down, from the hull of the *City of Rome*, we infer that its distance is 4 $\frac{9}{10}$ miles beyond the distance of the horizon, which we have seen to be 7 $\frac{7}{10}$ miles—giving for that ship's distance 12 $\frac{3}{5}$ miles. And with like ease may all such cases be dealt with.—*Newcastle Weekly Chronicle.*

JURY RUDDER OF THE S. S. "KNICKERBOCKER."

The Steamship *Knickerbocker*, Captain Frank Kemble, of the Cromwell Line, from New Orleans, arrived at New York on Wednesday morning, April 23rd, steering with a jury rudder rigged at sea. Captain Kemble reported that during a heavy north-east gale on Sunday afternoon, about 120 miles S.S.W. from Cape Hatteras, the rudder and rudder-post were carried away. During the continuance of the gale the steamer was steered by towing a heavy hawser astern, which by judicious use of the sails enabled the vessel head on to wind and sea, and to proceed on the voyage toward New York. Captain Kemble at once set to work to build a jury rudder on deck, made from cargo gaffs and spars, with cross-pieces securely nailed and fastened with strong lashings and strains, as shown in accompanying drawing taken on the dock from the rudder itself. On Tuesday morning the weather had sufficiently moderated to enable the captain to get the rudder in position, and to secure it in place, further protected by guys running along each side of the ship to the deck amidship, and kept from getting foul of the propellers by guys running to the end of a spar projecting over the stern of the ship, then steering by lines running through blocks at the end of another spar (placed amidships), thence to blocks on the mast, and so down to the deck. Thus rigged, the ship was readily and successfully steered to her destination, refusing all assistance, coming in past Sandy Hook, and up channel to the Quarantine Station at Staten Island. Captain Kemble telegraphed to his owners and came to wharf a little later, employing only a tug to assist the ship into her berth at Pier 9, N. R.

The *Knickerbocker* is a large and valuable steamer and had full cargo and forty passengers. The vessel and cargo were probably worth at least half a million dollars. Captain Kemble deserves great credit for his ability in improvising this successful and ingenious steering appliance, which enabled the steamer to complete her voyage without other assistance, saving her owners and the underwriters from large salvage and other expenses and trouble, which follow accepting assistance at sea.—*Engineering.*

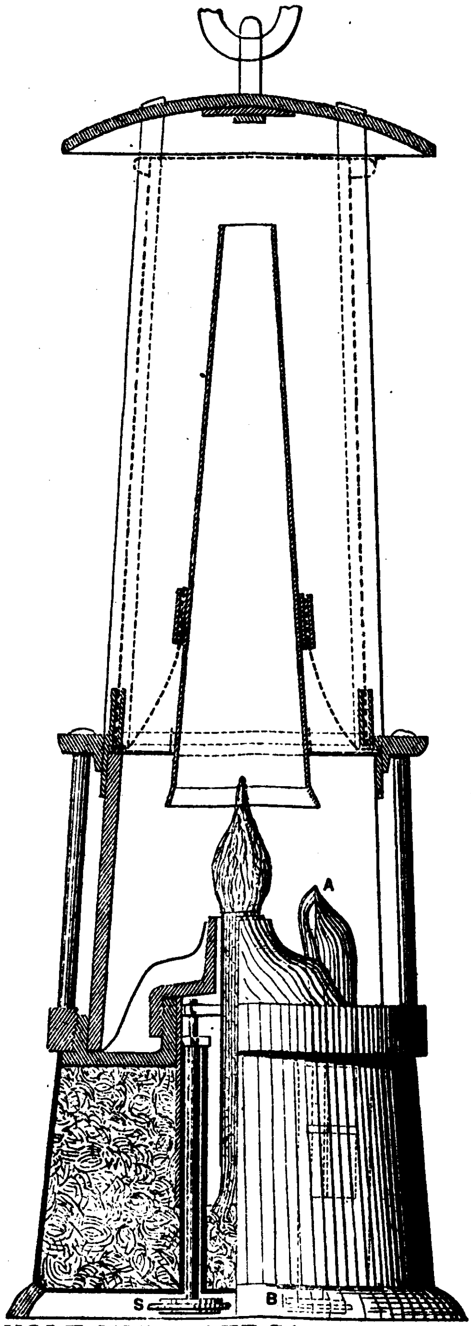
THE WOLF SAFETY-LAMP.

BY EUGENE B. WILSON, DRIFTON, PA.

(*From the Transactions of the American Institute of Mining Engineers.*)

The development of coal-mines has kept pace with the facilities at command for ventilating and lighting. In fact, it was formerly customary to leave unworked those mines, or portions of mines, in which naked lights could not be used without danger. Attention was then turned to the ventilation; but even with improved ventilation, the naked light was often not safe. The new era in coal mining dates, we may say, as far back as 1815, when Sir H. Davy and Mr. George Stephenson discovered the principle of the safety-lamp. Since then many improvements have been added to their lamps, but until recently, none can be said to have given entire satisfaction; and even now the question of more light is being agitated.

The difficulties to be overcome by improvisers were many. Attention was first directed to the locks, with the view of making them more secure, and of preventing the miners from picking them to light their pipes, or from relighting the lamps in the mines in case they had been extinguished—such a proceeding being, of course, highly perilous in fiery mines. The



WOLF-MUESELER SAFETY LAMP.

JOASSIN TYPE.

improvement of locks was not found, however, to be perfectly effectual, since the miner could, by the aid of his picker, raise the wick of the lamp to such a height as to draw the flame through the gauze and thus light his pipe. Legislature, then made the act of smoking in fiery mines a criminal offense ; but even this did not put an entire step to it, nor could it be guarded against since the pickers were indispensable in order to raise and trim the wick. On the other hand, could all the miners have been convinced that in drawing the flame through the gauze, they put in jeopardy their own as well as the lives of others in the colliery, and thus persuaded to cease from the practice voluntarily, still the danger would not be entirely removed ; for we have it from no less an authority than Mr. Darlington, that sparks may fly off from the lamp when the picker is used, and that one spark would be sufficient to cause an explosion.

The next attempt was to invent a lamp which would not pass the flame through the gauze when moved rapidly. The Boty lamp on being immersed in an atmosphere highly charged with fire-damp, becomes extinguished. But the miner thus finds himself in an unenviable position, since he cannot relight his lamp, and must, consequently, remain in the dark or grope his way back to the fire-boss to have his light unlocked and relighted—a dangerous undertaking at best.

What was needed was a lamp, the lock of which could not be tampered with ; the wick of which could not be raised ; and which did not require a picker, and could be extinguished or lighted at pleasure without opening.

Such a lamp is the invention of Mr. Wolf, of Zwickau, Saxony. A friend of the writer brought one of them from Germany last fall, and it has been greatly admired for its simplicity, efficiency and safety. The accompanying drawing shows Wolf's improvement as attached to the Mueseler lamp, which which was considered by the Belgium Commission of 1868 to be the best, and the use of which was again made obligatory by a royal decree in Belgium in 1876, as it had been also in 1864, before the Commission re-examined the question. The Mueseler lamp is, like the Clanny, a modification of the Davy in which a glass cylinder is interposed between the wire-gauze cylinder and the body of the lamp, so that the light of the flame is not diminished by the wire. The Mueseler lamp has, however, also a sheet-iron chimney inside the gauze, which is said to have the effect that the light is extinguished by a strong draft or by an oblique position. The Mueseler lamp burns vegetable oil. The Wolf lamp, on the other hand, burns benzine, which is less expensive, gives a brighter and more uniform light, and does not deposit soot. The consequence is, that a much finer wire-gauze can be used, with great increase in safety ; and the miner does not need to pick his flame or clean his lamp during the shift, the wick being made of mineral wool. The opening of the lamp is prevented by a lock which is operated by a magnet ; and as it is not necessary to open the lamp to relight it, all legitimate occasion for doing so in the mine is removed.

The body of the lamp, W, which contains the benzine, is packed with mineral wool, to prevent spilling. Thus held, the benzine is itself no source of danger. The flame may be made larger or smaller, to a limited and not dangerous extent, by the screw S, working in the collar M. The arrangement for lighting is not clearly shown in the drawing. It is similar to that which is so commonly sold by tobacconists for lighting cigars, consisting of a tape, carrying at intervals small percussion-wafers. The dotted lines between A and B indicate in a general way, the position in the lamp of this arrangement. The button B operates both the feed of the tape upward (bringing a fresh percussion-cap to the point of ignition A) and, by means of a spring, not shown, the tripping of the lever which explodes the cap. This lever is shown in the drawing in contact with the tape-holder at A, as it would be just after the explosion of the cap.

In the latest edition of Serlo's *Leitfaden zur Bergbaukunde* (Berlin, 1884), vol. ii., p. 453, the above-mentioned advantages of the Wolf lamp are enumerated (but no drawing is given) ; and it is added that the lamp is said to go out when dangerous proportions of fire-damp are present, and also to burn in "bad air," long after oil lamps have gone out. It certainly seems to the writer to be the nearest approach to a perfect safety-lamp which we have at present. There is, of course, yet room for invention. We want more light, and better instrumental means of warning when fire-damp is present.

Miscellaneous Notes.

THE SIBERIAN POLAR SEA.—Petermann's *Mitteilungen* publishes a paper by Prof. Mohn on the Siberian Sea, in which he discusses the observations on the Vega on the temperature and saltiness of the sea-water. The accompanying diagrams show very clearly to how large an extent these are affected by the warm water of the Siberians rivers.

EARTHQUAKES AND THE CHANGE OF POSITION IN THE EARTH'S AXIS.—At a recent meeting of the Geographical Society of San Francisco, Cal., Vice-President Stevens read an interesting paper on the movements of the poles of rotation, or the change of position in the earth's axis, considered as the cause of earthquakes and the recent great convulsion of nature in Italy, Java, and Alaska. The various causes which may be supposed to produce this change of position in the earth's axis of several degrees, were considered, and their relative importance discussed. Chief among these causes were mentioned the deposit of immense bodies of sediment, as by the rivers of Thibet in Central Asia. The disputed question of the solidity or fluidity of the interior of the earth was also considered in its bearings upon the subject. The conclusion was that the problem presented was one difficult of solution, but the time might come when it would be so clearly demonstrated that the wonder would be why the matter had been thought so obscure.

LIFE ON THE PLANETS.—The conclusion of the whole matter, says Prof. McFarland, as far as astronomy and physics can now tell, is this, that the four large outer planets have not sufficiently cooled down to allow life on their surface such as we see on the earth ; that Mars gives all telescopic and spectroscopic probabilities of conditions compatible with life as we see it ; that the earth certainly for millions of years has been covered with multifarious life ; that of Venus and Mercury we have no certain knowledge, and that the satellites are pretty certainly not fitted for such life as is on the earth ; that, in particular, our moon has no water and no atmosphere, consequently no climate or vegetable life. If the sun and the planets continually lose heat, then there will come a time in the far future when the son itself shall go out in everlasting night, and the planets cool down so that the "eternal snow" would be hot compared with the degree of cold throughout all space where everything shall be dead.

THE SALMON YIELD.—Mr. Huxley's report of last year's salmon fishing confirms his own assertion that very little is known about the influences which regulate salmon supply. The taking of salmon and sea-trout has increased and diminished in defiance of all theories, and Mr. Huxley is equally unable to establish any consistent relation between the take of salmon and the proportion of grilse present in succeeding years, a large take being sometimes followed by scarcity, and sometimes by abundance of grilse. Mr. Huxley's sympathy with manufactures has grown with his experience, and while he acknowledges the imporance of the rivers, his confidence in the power of legislation has diminished with experience, but he still insist on the necessity of it. The two points brought out by the continued experiments of Mr. George Murray, of the British Museum, are that the fungus may attack fish with whole skins, and otherwise perfectly healthy, and that an excess of lime in the water is not a predisposing cause of the disease.

BURNING WET OR DRY COAL.—The question of burning coal in a wet or dry state is still being discussed in the English journals, a large amount of both theory and practical information being set forth. One writer says that, although it is generally conceded to be true that wet bituminous coal will not produce as much steam in a boiler as dry coal, there are few figures to substantiate this. The result of a series of tests, made recently with much care, are regarded as having considerable weight in the determination of the points involved. It appears that a mass of washed slack, holding 18 per cent. of water and 9 9 10 per cent. of ash, evaporated 5 7-10 pounds of water per pound of fuel, while the same coal with only 3 per cent. of water made from 8 to 8 5 10 pounds of steam ; making due allowance for moisture by reducing to a standard of like quantities of coal free from moisture, a direct loss of 14 per cent. is shown in using wet coal. In reference to this matter a contemporary says : Part of the prevalent impression as to the greater value of the wet coal is based upon the notion that in some way or other the water itself is converted into gas and burns with great effect, but this in the vast majority of cases is a delusion. The water on the coal as thrown on the fire must necessarily be slowly heated and at length fully evaporated by an absorption of heat from the burning fuel beneath it. The vapor thus given off passes away under the boiler and out at the stack, carrying with it a volume of heat corresponding to the temperature of the waste gas at the entrance to the stack, and also, what is far more important, the heat due to the conversion of this whole amount of water into steam. The whole of the heat thus absorbed is an absolute loss, and the more water there is in the fuel the greater this loss must be.

Wood Carpeting.—What is described as a wood carpet has lately been patented by Herren Kuny & Marx, of Munich. It consists of prepared wood fibre, felted by the aid of oxidized linseed-oil and coloring matter on to a jute fabric, the back of which latter is covered with a coat of varnish. The material thus obtained is said to have a pleasing appearance, can be easily cleaned and repaired, is warm, noiseless, and can be taken up like carpets and quickly relaid on a change of residence. The surface can be produced either flat or with designs in very slight relief. The coloring is homogeneous throughout. As will be seen from the above description, the wood carpet is in some respects not unlike our linoleum. The price is said to be, however, much lower, while durability is also claimed for the new material.

A New Saltpetre Bed.—To the eastward of Cocha-bamba, in Bolivia, South America, an immense saline deposit has been discovered near the village of Arané. Analysed by Mr. Sacc, the ingredients are potassic nitrite, 60.70 ; borax, and traces of salt and water, 30.70 ; organic matter, 8.60 per cent. On dissolving this mixture in boiling water and cooling it, a plentiful crystallization of pure saltpetre is obtained. The soil on which the bed lies is brown and inodorous when it is dry, but when moistened it gives out an odour of carbonate and sulphhydrate of ammonia. M. Sacc has found it composed of incombustible residue, 74.20 ; borax and salts, 15.50 ; and organic matter with water and ammoniacal salts, 10.30 per cent. The incombustible residue is formed of a very fine sand, and of phosphate of lime, magnesia, and iron, in large proportion. The saltpetre has evidently originated from the oxidation of the ammoniacal salts of the soil in presence of potash and soda produced by the slow decomposition of the schists on which they rest. The potassic nitrate has mounted by capillarity to the surface of the soil, whilst the deliquescent nitrate of soda has been drawn by the rains towards the dry and warm regions of the coast, where it forms the beds of nitrate of soda actually worked in Chili. As immense quantities of fossil bones are found in the soil around Arané, it is possible that the saltpetre beds there, which are capable of supplying the whole world, are a result of the decomposition of a vast deposit of antediluvian animal remains.

The Projected Algerian Sea.—The proposal of Col. Roudaire and M. de Lesseps to flood the dry bed of the Shotts in the south of Algeria, and thus create a North African inland sea, has of late met with a good deal of unfavorable criticism in the French Academy of Sciences, one critic, M. Casson, asserting that, though M. Roudaire has abandoned the idea that the Shotts was the Triton Bay of the ancients, and though a Commission of Inquiry has pronounced unfavourably on the project, he, M. Roudaire, still clings to his original plan. Another critic, M. Letourneux, protests against the French Government giving any countenance to the scheme, which, in his opinion, would cause the complete ruin and destruction of Beiad-el-Dj rid and Souf. M. de Lesseps has replied to these criticisms, that M. Roudaire has not abandoned his theory that the Shotts is the same locality as the Triton Bay ; but, on the contrary, is still engaged in supporting it ; and he points out that the French Academy of Sciences has examined the project and regarded it in a favourable light. Moreover, the Commission, nominated by M. de Freycinet, has, he asserts, demonstrated the advantages of the plan, and has never disapproved of it, and, though they will not assist the enterprise, they are far from wishing to oppose it, provided it be carried out by private means. A group of projectors have already been formed and will begin to construct a port at the mouth of the Oued-Melah, a work whose importance requires no demonstration, since there is no shelter on the Tunisian coast, between Tunis and Tripoli, a distance of some 420 miles.

Porpoise Oil and Leather.—A new industry is growing up on the Atlantic coast, which may soon, in a great measure, supplant the loss to that portion of the Union of the whaling business. Small vessels are now being fitted out to catch porpoises, which are very numerous on the Atlantic coast and bays, and which have hitherto attracted very little attention in an industrial point of view. One of these vessels recently arrived in Philadelphia with 75 fat porpoises from which the following products were expected : 1,000 gallons of oil, 3,750 pounds of hide for leather, and 15 tons of phosphate. The oil is said to be equal in value to sperm ; leather from this source is pronounced equal to the best French calf. It has been made in small quanties for some years in England and Germany. The fish are caught in a large sea net, with wings a mile long, by which they are inveigled into a sack some 60 feet wide by 24 deep and 120 feet long. The 75 fish above alluded to were caught in two hauls, both being made in one day. If the above items are correctly stated, it will be readily seen that the business might be made a very lucrative one.

The Lost Rivers of Idaho.—One of the most singular features in the scenery of the territory of Idaho is the occurrence of dark, rocky chasms, into which creeks and large streams suddenly disappear and are never more seen. The fissures are old lava channels produced by the outside of the mass cooling and forming a tube, which, when the fiery stream was exhausted, has been left empty, whilst the roof of the lava duct, having at some point fallen in, present there the opening into which the river plunges and is lost. At one place along the Snake, one of these rivers appears, gushing from a cleft high up in basaltic walls where it leaps a cataract into the torrent below. Where this stream has its origin, at what point it is swallowed up is absolutely unknown, although it is believed that its sources are a long way up in the north country. Besides becoming the channels of streams, the lava conduits are frequently found impacted with the ice masses which never entirely melt.

New Electric Batteries.—A novel thermo-chemical battery has been invented by M. Vincent Riatti, professor in the Polytechnic School at Torli (Italy). The production of the current results from the difference of temperature of two layers or strata lying at different levels in a vessel filled with liquid. The cell consists of a wooden box or vessel traversed by two copper pipes placed the one over the other, and separated by a distance equal to about half the height of the vessel, which is filled with a solution of sulphate of copper. A current of steam passes through the upper tube, and a current of cold water in the lower, with the effect that copper is deposited on the latter, while the substance of the former is reduced. By changing, from time to time, the position of the tubes, equilibrium is established. This battery is said to work well and not to polarize, but up to the present no practical information as to its performance has been published, and consequently we cannot do more than call attention to the principle of its action. M. Grimfeld, of Vienna, has devised a modification of the Callaud battery, in which there is employed a glass vase divided in two by a mid partition half the height of the vase. The two upper halves are thus in free communication, while the two lower halves are separated by the partition. In the bottom of one of the cells is placed the disc of copper ; the zinc is at the top of the other. By this arrangement the deposition on the copper of black particles falling from the zinc is avoided ; at the same time, however, the resistance of the cell is increased and its cost augmented. A modification of the Leclanché element has received from its author, M. Fein, of Stuttgard, the name "immersion battery." It consists of a glass vase at the bottom of which is placed a layer of binoxide of manganese. The vase is closed by a cover carrying a carbon, and a ring of zinc. An inverted flask filled with a solution of chloride of ammonium keeps up the supply of liquid.

The Finland Polar Expedition.—M. Lemstrom has published the chief results of the Finland Polar expedition of 1883-84. The scientific observations were made at Sodankylä (latitude, 67 deg. 24.6 min. north ; longitude, 27 deg. 17.3 min. east of Greenwich) and at Kultula (latitude, 68 deg. 29.5 min. north ; longitude, 26 deg. 39.4 min. east). The earth currents were studied from September, 1882, to September, 1883, at the same time as the magnetic variations. Two conductors of copper wire, running from north to south and east to west for about 5 kilometres, terminated in platinum plates buried to a depth of 1.3 metres. The wires were insulated on telegraph poles and a sensitive galvanometer was interposed in the circuit of each. Wires of iron were also used with plates about 2.5 kilometres apart. At Kultala the earth plates were plunged in the river Fralo and its tributaries. With a Mascart electrometer giving eighteen divisions for a volt, and with the galvanometer, the perturbing forces due to the polarization could be eliminated. From the fact that the variations of current in the east and west was very slight, M. Lemstrom is inclined to believe that there is a belt of earth currents round the pole. The magnetic variations were found to be intimately associated with those of the earth currents. The atmospheric currents were observed with a wire network. At Kultala, four of these nettings of wire, with brass discharging points and zinc earth connections, were erected at different heights on a mountain side. With these it was found if two discharging nets of similar construction and at the same height were connected together through a galvanometer, no current was observed. With one net higher than the other, and both connected, a current was sent from the higher to the lower. The electromotive force of the currents observed did not rise above. 326 volt (on March 20). Near the surface of the earth there is a layer of air which has a much greater electric density than layers higher up. The minimum density was formed at a height of 3 to 9 metres. During the aurora the atmospheric current was always positive, that is to say, going from the atmosphere to the earth ; at some other times it was negative. With regard to the artificial aurora sometimes seen crowning the discharging networks, M. Lamstrom states that they showed either diffused light, or visible rays. They were observed by the naked eye and by the spectroscope, which showed the lines of the polar aurora. A Holtz machine working in connection with the wires could reinforce the effect under favourable circumstances. If the moon was high the phenomenon was never seen with the naked eye.

An Improved Compound for Plastering or Stucco Work.—The object of this invention is to furnish an improved plastering for a finishing coat for ornaments, mouldings, statuary, and the like. This compound is coloured uniformly throughout, and requires no subsequent labour, in tinting the surface, nor is it discoloured and defaced by the scratches on the surface, like ordinary tinted walls. It may also be made waterproof, so as to be uninjured by repeated washings, or by steam. My improved composition consists of the following ingredients : I take by measure one part of air-slacked lime, one-half of a part of fine sand, from one-half to two-thirds of a part of rice flour, and one-fourth of a part of fine salt if beach sand is used, otherwise one-half of a part. Then I mix dry, with the desired colouring matter, preferably dry aniline colours, being careful to make the mass homogeneous by thoroughly mixing its elements to ensure uniformity of colour and avoid streaks. When about to be applied to the wall or other surface I render the mass plastic by adding sufficient weak glue in which has been dissolved, while boiling, from ten to twelve grains of bi-chromate of potash to each quart of the liquid, for the purpose of rendering the finished surface waterproof. When the liquid is added the whole is stirred so as to effectually moisten all the ingredients, and intimately incorporate them into one mass of uniform consistency and colour. It is then spread over the foundation coat with the trowel, in the same manner as any fine plaster. Walls finished with my compound may be frescoed either in oil or water colours as readily as ordinary walls. For stucco or other fine work I sometimes substitute plaster of Paris for the lime, and reduce somewhat the proportion of sand and salt, while retaining the full percentage of rice flour. Less colouring matter is needed than when lime is employed. The elements are mixed and stirred with the weak glue as already described, adding the bi-chromate of potash as stated, when it is desired in either case to make the surface waterproof.

THE ENTOMOLOGY OF A POND.—(*Knowledge.*)

BY E. A. BUTLER.

(*Continued from page* 254.)

Passing on now to the stouter-bodied, shorter-horned flies, our only example will be the insect called *Stratiomys chameleon*, the common chameleon fly, which belongs to a family containing several aquatic representatives. It is a broad, flat-bodied insect (Fig. 1), with a velvety black body, adorned with yellow markings, and is a near relation of those lovely, glossy, metallic-looking flies, with long, dark wings, and bodies of a greenish, purplish, golden, brassy, or bronzy tint, that are often seen sucking the honey of flowers in damp places, or sunning themselves, and displaying their beauty on the leaves of trees. The eggs are not launched in rafts, like those of gnats, but laid in overlapping rows, like roofing slates, on the underside of the broad leaves of the water plantain, *Alisma plantago*. The larva, which is of an elongate form, tapering greatly towards the tail, is chiefly remarkable for the perfect star of about thirty feathery hairs it carries at that extremity. As usual, this circle of hairs is intended to assist in the respiratory function. To breathe, the insect slowly rises to the surface by serpentine wrigglings, and remains suspended there, the coronal hairs acting as a float, and by their capillary attraction causing the water to recede from the respiratory orifice which is situated in their centre, so that air can be taken in at pleasure. When this has been effected, the insect closes its hair star somewhat as one would shut an umbrella, and slowly descends to the depths again, carrying with it the spoils of the outer world in the form of a silvery globule of air entangled in its plume. Its jaws and other appendages of the head are in constant motion, creating currents which bring to it the minute creatures on which it feeds. During larvahood, then, it does not very greatly depart from the general style and method of life of the gnats and other long-horned flies, but when we come to the next stage we notice a great difference. Hitherto we have found the pupa shaped like a large comma, and breathing by appendages attached to the thoracic region. In the chameleon fly, however, a totally different arrangement is made. The true pupa is formed within the old larva skin, which retains its form so that but little change, except an inflexibility of body, is apparent outwardly. The pupa itself, however, reveals all the organs of the future insect, and with its wings and legs folded lengthwise along its breast looks like a miniature Egyptian mummy. It is much smaller than the larva, and so does not occupy nearly the whole of the space the old skin affords, the long tail-like part being converted into

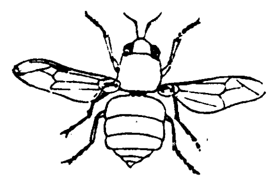


Fig. 1.—Chameleon Fly.

an air-chamber to supply with aerial nutriment the imprisoned mummy, which has its spiracles situated in the usual position down the sides. When the time for emergence arrives, a portion of the case near the head is removed, and the fly makes its exit through the opening.

There is a small family of moths whose caterpillars are aquatic, and may be found feeding on plants below the surface; but we will reserve a notice of these till we treat of the perfect insects, which are abundant amongst the rank vegetation fringing the edges of the pond.

Besides the bugs, beetles, and fly larvæ, which are the legitimate inhabitants of this part of our pond, certain perfect insects belonging to orders that one would assuredly not expect to find represented in the water—at least in the adult state—may occasionally be detected paying flying visits to these regions. About twenty years ago, Sir John Lubbock discovered that some minute insects allied to the ichneumon flies, and therefore belonging to the order Hymenoptera, are aquatic in habits. This was a most surprising discovery, for though the Hymenoptera form an enormously large order, the number of species having been estimated even at 30,000, not a single member of this vast host had previously been known to have any connection with water. Sir John Lubbock describes the discovery as follows :—"Great was my astonishment.... when I saw in the water a small Hymenopterous insect, evidently quite at its ease, and actually *swimming* by means of its wings. At first I could hardly believe my eyes, but having found several specimens, and shown them to some of my friends, there can be no doubt about the fact. Moreover, the same insect was again observed, *within a week*, by another entomologist, Mr. Duchess, of Stepney . . . It is a very curious coincidence that, after remaining so long unnoticed, this little insect should thus be found almost simultaneously by two independent observers." Twenty-one specimens in all were seen, and two-thirds of these were females. The tiny being (Fig. 2) measures no more than $\frac{1}{25}$ of an inch in length. It has no nervures in its wings, the hinder pair of which are so narrow as to be scarcely more than linear in shape, and both pairs are fringed round the edges with hairs. It belongs to a group which, like the ichneumon flies, are parasitic

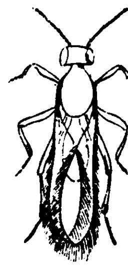


Fig. 2.—Polynema natans.

upon other insects, but many of the smaller species attack their hosts, not when the latter are in the larval condition, but actually while they are in the egg, the contents of a single egg being sufficient to furnish nutriment to the grub of the parasite during the whole of its brief larval career, and sometimes even one egg is the home of several parasites. The present insect, which was named by Sir John Lubbock *Polynema natans*, may, therefore, with much probability be presumed to have been in quest of the larva or eggs of some aquatic creature in which to deposit its own brood. It would seem, however, that this can hardly be the sole cause of the entry of these insects into the water, inasmuch as the males were found swimming as well as the females. The wings did not seem particularly effective as swimming organs, the progress of the insects being but slow, and in a series of jerks; sometimes, too, the swimming was abandoned in favour of crawling over the aquatic plants. Marvellous as it may seem that a creature should use as swimming-organs delicate membranous wings, apparently adapted only for aërial flight, the marvel becomes greater when it is remembered that the little diver is not in any way structurally adapted for an aquatic life, except it be by the fringes round the wings, but these it has in common with other members of the same group which never enter the water at all. There is no flattening of the legs, no tapering of the form in front, no arrangement to provide for subaqueous respiration. The breathing is conducted in the ordinary way by means of spiracles, and all the time the insect is under water, it has, so to speak, to hold its breath, just as one of the higher animals would have to do under similar circumstances. At first thought it would seem, therefore, that the tiny creature, in obeying its maternal instincts, incurs some risk of drowning, but it must be remembered that insects do not require a renewal of air anything like so frequently as the higher animals, and in the present instance the power of endurance seems to be much greater even than usual. Sir John Lubbock found that one of his insects could endure submersion for twelve hours without inconvenience, but that after fourteen hours it was to all appearance dead; however, on being transferred to a dry spot, it revived, and, after a time, became as lively as ever, so much so, in fact, that, notwithstanding its uncomfortable experience of temporary drowning, it did not hesitate, when an opportunity was again afforded, again to enter the water. Professor Westwood has suggested, however, in explanation of this power of enduring prolonged submersion, that the fringe round the wings may carry down entangled in its hairs a small quantity of air, sufficient for the wants of the insect during the time it would naturally remain below.

Curiously enough, a second aquatic species, a trifle larger than the other, and much less common, was discovered on the same occasion and by the same observer. It swam, however, not by aid of its wings, which were kept still, but by a rowing motion of the legs, and thus progressed more rapidly than its relative.

Ichneumon flies have recently been bred from the pupæ of a Gyrinus, or whirligig beetle, which, as will be remembered, is, in its larval state, subaqueous. It is not known, however, at what period in the history of the Gyrinus the ichneumon eggs are inserted in the body of the host, though, judging from analogy, it would seem probable that it is the larva that is thus victimised, and in that case either the ichneumon must dive, or the larva must be attacked during its temporary exposure on the aquatic plant on which it forms its cocoon; still, however, the eggs may be deposited in the pupa through the walls of the cocoon, the ichneumons possessing ovipositors long and powerful enough for the purpose.

Certain caddis flies, or water moths as they are sometimes called, and dragon flies have also been known voluntarily to submerge themselves in order to deposit their eggs in appropriate positions.

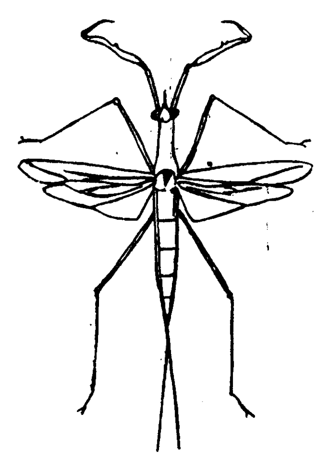


Fig. 1—Ranatra linearis (reduced).

Leaving now the middle depths, which have detained us so long, and continuing our descent, we reach the bottom of the pond. The bottom of a pond can hardly be considered a particularly attractive abode, at least so far as appearances are concerned, and if one remembers its usual composition it will appear even less desirable as a home. Here is collected a fine mud, composed of the remains of all sorts of rubbish that is continually being rained down from the watery heights above. It is, as it were, the dust-bid, the cesspool, and the cemetery of the pond. Dust blown in from time to time by high winds, fragments of plants broken from aquatic vegetation, dead

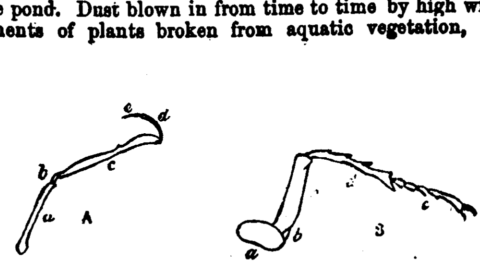


Fig. 2.—(A) Fore-leg of Ranatra: (B) Leg of Stag-beetle. *a*. Coxa; *b*. Trochanter; *c*. Femur; *d*. Tibia; *e*. Tarsus.

leaves and bits of stick fallen from the trees on the banks, the excrement of the insect and other inhabitants, together with fragments left from their repasts, empty shells of all sorts of water-snails, cast skins of larvæ, the dead bodies of the multitudinous aquatic population (and the mortality in a thickly populated pond must be considerable) together with those of worms and other terrestrial creatures that have had the misfortune to fall in and be drowned—these are some of the materials that, besides the mere earthy matter, help to form the ever-increasing mud at the bottom. There are, however, multitudes of minute creatures constantly at work on this refuse matter, dividing it up and transforming the dead and effete materials into the living tissues of their own bodies, and thereby reducing the ultimate waste substance to a much smaller bulk, and rendering it innocuous to a degree that might at first seem impossible. Half buried in this mud, or slowly crawling over its surface, are the lurking monsters of entomological pond life, the majority of which belong to two orders we have hitherto scarcely noticed, the Neuroptera and Trichoptera, the former containing the dragon flies, and the latter the caddis flies. We will, however, first consider certain bugs which haunt these parts.

They are known as water scorpions, and two species inhabit this country, one commonly found in almost every pond, the other of much less frequent oecurrence. The have, of course, no connection with the true scorpions, which are not insects at all, but eight-legged creatures belonging to the class containing spiders and mites. The water scorpions, too, unlike their terrestrial namesakes, are not venomous. The first, and much the less common, is a long, narrow insect, called *Ranatra linearis* (Fig. 3). On account of its habit of frequently lurking in an inclined position amongst the water-weeds, often only a little below the surface, this creature belongs less to the fauna of the bottom than its common relative. Still, they are best treated of together. It is of a brownish colour, except the upper surface of the abdomen, which is scarlet, but this is concealed when the insect is in the water, being made apparent only when the wings are expanded, and then it is quite astonishing to see what a beautiful creature the apparently uninteresting object becomes. The head is small, but the eyes exceedingly prominent, as is often the case with aquatic insects, and the beak short and sharp, not bent underneath, but projecting in front like an extremely acute nose. Both thorax and abdomen are elongated to an enormous extent; indeed, the insect, with a length of an inch and a-half from tip of snout to end of abdomen, has its greatest breadth no more than one-sixth of an inch. The upper pair of wings, while almost as long as the abdomen, are each only about half its width, but the hinder pair are considerably broader, and have to be carefully folded up before they can be stowed away under their narrow covers. These hind wings are beautifully delicate and transparent, similar, indeed, to those of the Corixidæ before referred to. But when we have reached the tip of the abdomen, we have by no means got to the end of the insect; from this point there extend two long bristle-like organs, about an inch in length, which project straight behind like a stiff tail; they are tubular, and communicate at their base with the tracheal system, and are, of course, respiratory in function. The legs are long and slender; the first pair are not used for progression, but for seizing prey, and it is these in front, and the respiratory filaments behind, that give the creature whatever resemblance it may have to a scorpion, although the similarity to that venemous animal is not nearly so exact as in the other species to be considered presently. The front legs are most remarkable objects, and will well repay a careful study. To understand clearly their peculiarities, we must first refer to the general plan of an insect's leg (Fig. 4).

There is first a joint, usually comparatively small, and more or less globular, called the *coxa*, by which the leg is articulated to the body, and which is usually invisible from above. Succeeding this is a small triangular joint, called the *trochanter*, squeezed in, as it were, between the coxa and the next joint, and looking as if added, as an afterthought, to fill up a gap. Then follows, attached to the side of the trochanter, the first long piece of thr leg, the thigh, or *femur*, then another long piece, the shank, or *tibia*, and lastly the *tarsus*, or foot, which is composed of from two to five joints, and usually terminated by a pair of claws.

Now let us take one of Ranatra's fore-legs and compare it with this plan. First we find a long joint, which extends far beyond the head, but still, from its being that which articulates the leg to the thorax, we know it must be the coxa, though it protrudes so far that we may easily at first mistake it for the thigh. Then there is the trochanter, a little larger and more than usual, and this is succeeded by a long piece lightly curved at the further end, and with a tooth a little beyond the middle; this, of course, is the femur. After this there is a short, sickle-shaped part, less than half the length of the femur, and looking like a great claw; it is able to be folded back upon the inner edge of the femur, along which a narrow groove, serrated at the edges, is excavated to receive it, and then the tip just reaches the above-named tooth. This sickle-shaped part consists of both tibia and tarsus, the latter of which is very small and has no claws. It will thus appear that the leg proper is, as it were, spliced on to the end of a long handle, the elongated coxa, an arrangement the effect of which is to give the limb much greater freedom of motion and a much wider sweep, and thus to enable it to levy tribute over a much more extended area. So peculiar is the plan of these limbs that it is no wonder that many persons have been puzzled to understand them.

We must leave the habits of Ranatra for consideration in the next paper.

(To be continued.)

Engineering Notes.

A New Mechanical Puddling furnace is claimed as one of the late achievements of English invention. The English correspondent of the *American Manufacturer* speaks of it as an improvement of Cort's puddling furnace, and a device for making the puddler (or boiler) no longer the drudge who handles the rabble bit, but the gentleman who watches automatically working machinery do all the labor required to turn crude iron into malleable iron, or into steely iron. It is more pretentious than the Danks furnace, says the above correspondent, since it proposes to ball-up as well as to boil. But whether it is likely to be attended with more success than that device is questionable. If it could be run as the inventor ventures to hope, then it would be a considerable improvement upon the Danks, since it would not only do more of the manual work, but would do it with a continuance scarcely contemplated by Danks; without, however, one would think, the capability of the Danks to treat heavy charges; though a series of rapidly perfect balls ought to be really beaten by the shingling hammer into massive blooms. But the device has not yet gone beyond the stage of models and plans.

How to Determine Expansion.—Mr. C. E. Emery made a very complete series of experiments some years ago upon the engines of the United States revenue cutters, Rush, Dexter, Dallas, and Gallatin, from which he deduced the following simple rule (subject to certain limitation) for the best ratio of expansion in steam engine: Rule—Add 37 to the steam pressure as shown by the guage; divide the sum by 22; the quotient will be the proper ratio of expansion. Example: An engine is running with a pressure of 90 pounds per square inch; what would be the ratio of expansion? $90+47=127\div 22=5.77$ = the best ratio of expansion.

New York's First Cable Road.—The Third Avenue Railroad Gompany is progressing rapidly with its cable road extending through 125th street from the East River to the North River, and from 125th street to 187th street on Tenth avenue. Concerning this new road Mr. J. D. Miller, the chief engineer, says: "This railway will be somewhat different from any other in the world. It is an improvement on the Chicago cable road for several reasons. In the first place, it is planned on a duplicate system—that is: there are two cables working in the same way on each track; while one is in use the other is not; but in case of accident to the one in use, it would take only two minutes to transfer the brake to the other, and the delay would be hardly noticeable. In the second place, the pulley wheels, which move the cable, are placed in vaults just 35 feet apart and 22 inches square. Now, the tracks are so formed that, in case of rain, the water will be stopped by them instead of flowing toward the curbstone, and will sink into these vaults. To take away this water a sewer pipe 6 inches in diameter will run the whole length of the road, underground. The whole road will be composed of steel iron, and concrete, no wood being used, because wood rots. The cars will be running early in October."

A NEW IRISH SCHEME.—The project for constructing a ship canal across Ireland has been warmly espoused by influential people in England. Elaborate plans and surveys have been made at considerable expense, and have been submitted by Capt. Eads, the American engineer. The plans were prepared by Mr. T. A. Walker, of Great George street, Westminster. The proposed canal would be 127 miles in length, and would contain thirty locks. For ships of 1 500 tons the cost would be eight millions; for ships of 2,500, twelve millions, and for ships of 5,000 and upward, twenty millions sterling. If built on this scale, the canal would be 200 ft. wide on the surface and 100 ft. at the bottom. The passage through the canal would be effected by a system of towage, and it is estimated that the passage of a ship from Galway Bay to Kingstown would occupy between thirty-four and thirty-six hours. An alternative scheme of a ship railway, in which the ships would be carried in cradles, which could be constructed for ten millions, is proposed, by which the duration of the passage through the island would be reduced to twelve hours. An immense aqueduct would have to be constructed to carry the canal over the Shannon at Banogue, and would be over three miles in length, being one of the most difficult and costly works in connection with the undertaking.

THE LONDON INNER-CIRCLE RAILROAD.—The London Inner-Circle Railroad is a marvelous feat of engineering skill. It runs throughout its entire distance under the business centre of the largest city in the world, and the operations attending the excavation and construction have proceeded without serious injury to or interruption of business or traffic. Quicksands have had to be passed through, beds of old rivers spanned—lofty warehouses and massive buildings secured, while their foundations have been undermined, and an intricate network of gas and water-pipes sustained until supports had been applied to them from below. Added to this the six main sewers had several times to be reconstructed. Day and night the work has been carried on for eighteen months, and now the engineers are able to announce that their tunnel is complete. The laying of the rails and the building of the stations are the portion of the immense work that remains to be done, and in a very short trains will be passing over the whole of this wonderful subterranean road.

A NEW "MAID OF THE MIST."—The keel of a new "Maid of the Mist" has been laid on the Canadian side of Niagara river. The keel of the new boat will be 70 feet long, with 16 feet beam and 7 feet hold. The propelling power will be a 5 foot bronze wheel. The boat will have two 12 x 14 engines, so constructed that they can be run separately or together as the case may require. Either of these engines is larger than is usually put in a boat of this size, but owing to the peculiarity of the water the boat is intended to navigate and to guard against any breakage the two will be put in. The engines are connected with a shaft of hammered steel 4½ inches in diameter. The timbers are of the best oak that can be procured. The hull is built in what is termed an 8-inch filched frame, covered on the outside with oak plank 2½ inches thick and ceiled with 2-inch plank. A cabin with glass sides will occupy about one-half of the after deck, while the front deck will contain a cabin only sufficient for the engine and pilot-house. The boat will be divided into three water-tight compartments, divided by boiler bulkheads. The cabin will be finished in hard wood, no upholstery whatever being used. The boat will pass inspection at 150 passengers, but will be able to carry fully one-third more.

NEW PAPER PULP MACHINE.—Mr. G. H. Pond, according to the Glen Falls (N.Y.) *Times* has deivsed a machine for the manufacture of paper pulp from saw dust. The working of the experimental machine was so successful that the inventor found no difficulty in interesting capitalists in the invention, and arrangements have been made by which a model machine will be built in that city immediately with a view of establishing a paper mill in which it is to be used. The paper further states that Mr. Pond's invention will work a revolution in paper manufacture. His experiments show that a fine quality of letter paper, as well as book, news and wrapping stock can be made from the product of his machine direct, thus doing away with the expense of beating engines and other ponderous machinery common to paper mills. He has made arrangements to establish a ten ton mill at once. Through his invention it is claimed that a ten ton mill can be put in operation for $50,000, when as by the present method of paper manufacture a mill of equal capacity will cost $150,000 or more.

BALLOON NAVIGATION.—M. Herve Mangon has presented his report to the French Academy of Sciences concerning the recent balloon ascension at Mendon. The balloon was under the direction of Captain Renard, and, although it moved against the wind, it easily followed the course along which it was, steered. It was then veered around and brought back to the point from which it started. M. Mangon considers it a memorable event in the history of aerostatic science. Captain Renad, the inventor of the navigable balloon, claims that the preblem of aerial navigation has been completely solved, and it is now only a question of time and money. He claims that he could insure a balloon postal system as easily as by railroad and could contruct balloons, each one of which could carry over 100 soldiers.

Health and Home.

MAKING ALCOHOL INNOCUOUS.—The discovery of a method for taking the fusil oil out of alcohol is creating something of a sensation in scientific circles. It is claimed that the experiment has succeeded in reducing the deaths from alcoholism in Stockholm from 600 to 100 per annum; and the inference is therefore widely drawn that the new process robs the whisky bottle of its terrors. But information is lacking as to whether the product of this process still retains the ability of getting the drinker intoxicated. If liquor is still to possess the power of bringing its imbibers down to the level of beasts, by making them first uproarious and then stupid, it does not seem to make any vital difference whether it contains the fusil oil or not. On the other hand, if the power of intoxication is removed from the whisky, none of the drinkers will want it. Could anything more disgust the old toper who starts out to get comfortably full and strikes a beverage that has no drunk in it?

ARSENIC IN GREEN WALL-PAPER A MYTH.—Mr. Robert Galloway, M.R.I.A., publishes in the *Journal of Science* for August a paper on "Emerald Green; its Properties and Manufacture," in which he satisfactorily shows that the arsenical poisoning supposed to arise from green wall-paper has in fact no foundation. Those who are interested in this question should read the paper in the journal referred to.

CHOLERA PREVENTION.—M. E. DE Cyon brought his experiments with borax as an antiseptic before the Academy of Sciences at the séance of July 21st. As a prophylactic against cholera, he recommends boracic acid or a solution of borax to be applied to all the external mucous membranes, and about six grains of borax to be taken with the food and drink every twenty-four hours.

POISONING BY CANNED FOOD.—Dr. J. G. Jonnson, of Brooklyn, N.Y., in a communication on the subject of the alleged unwholesomeness of canned provisions from various causes, calls attention to what he considers to be a source of danger in the process of sealing the cans. In this operation, it is customary to close the small opening left in the top of the can by first brushing around the surface to be soldered with what is commonly known as soldering fluid, which is a solution of zinc in muriatic acid. This operation, he asserts, is put on with brushes by boys, and the soldering iron then passed around it. Nothing is easier, he adds, than for some of the muriate of zinc to get inside the can, and to become absorbed in its contents, rendering the same "extremely poisonous." It is further noticed that the chloride of tin may be produced by the action of the free acid (usually present in the chloride of zinc) on the tin of the can. Concerning the above, we may say that borax, or some other comparatively harmless flux, should be used for the purpose instead of zinc salt. But while we do not wish to be understood as encouraging carelessness on the part of the manufacturers, or as underestimating the possibilities of danger from such carelessness, we are inclined to believe that the real danger from the cause named is grossly overstated; and the result of such extravagant statements is to cause needless alarm. The amount of chloride of zinc that would be likely to find its way into a can of provisions when used for the purpose named, is extremely small, and we think the facts will bear us out in stating that no authentic case of poisoning from its presence has ever occurred. The facts are, that the canned food products, as a class, are entirely wholesome, and the very small number of cases of sickness resulting

from their consumption will bear another and simpler explanation than that of mineral poisoning. The cause of such unwholesomeness, when it does make its appearance, we are quite satisfied is to be looked for in the quality and condition of the food itself. It is apparent that food, vegetable or animal, which is in bad condition when canned, or which is improperly prepared for canning, may occasionally escape the notice of the operatives in the large establishments where canning is carried on; and this appears to us to afford a satisfactory explanation of the few cases where bad consequences have been noticed in the consumption of this class of food products. The fact that the presence of sufficient lead, tin, or zinc salt, in a can of prepared food to cause any serious consequences, would render it so nauseating as to be utterly unfit for food, is a complete answer to the sensational statements of danger from mineral poisoning in using canned provisions.

ON THE EVOLUTION OF FORMS OF ORNAMENT[1]

II.

THE leaf in Dracunculus has a very peculiar shape: it consists of a number of lobes which are disposed upon a stalk which is more or less forked (tends more or less to dichotomise). If you call to your minds some of the Pompeian wall decorations, you will perceive that similar forms occur there in all possible variations. Stems

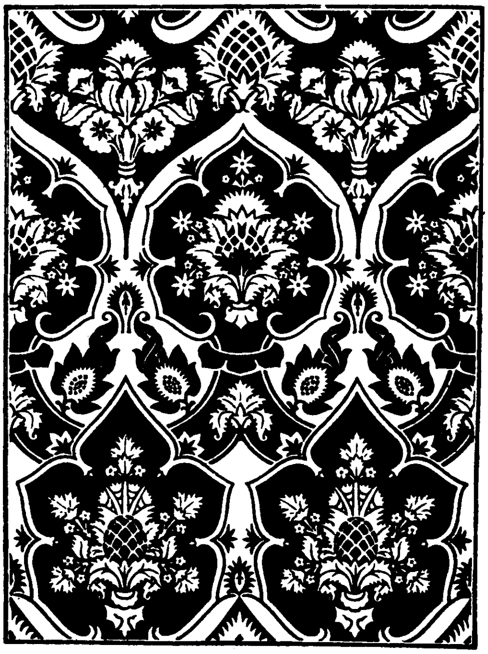


FIG. 12.

are regularly seen in decorations that run perpendicularly, surrounded by leaves of this description. Before this, these suggested the idea of a misunderstood (or very conventional) perspective representation of a circular flower. Now the form also occurs in this fashion, and thus negatives the idea of a perspective representation of a closed flower. It is out of this form in combination with the flower-form that the series of patterns was developed which we have become acquainted with in Roman art, especially in the ornament of Titus's Thermæ and in the Renaissance period in Raphael's work. [The lecturer here explained a series of illustrations of the ornaments referred to (Figs. 12, 13, 14).]

[1] From a paper by Prof. Jacobsthal in the *Transactions* of the Archæological Society of Berlin. Continued from p. 251.

The attempt to determine the course of the first group of forms has been to a certain extent successful, but we meet greater difficulties in the study of the second.

It is difficult to obtain a firm basis on which to conduct our investigations from the historical or geographical point of view into this form of art, which was introduced into the West by Arabico-Moorish culture, and which has since been further developed here. There is only one method open to us in the determination of the form, which is to pass gradually from the richly developed and strongly differentiated forms to the smaller and simpler

FIG. 13.

ones, even if these latter should have appeared contemporaneously or even later than the former. Here we have again to refer to the fact that has already been mentioned, to wit, that Oriental art remained stationary throughout long periods of time. In point of fact, the simpler forms are invariably characterised by a nearer and nearer approach to the more ancient patterns and also to the natural flower-forms of the Araceæ. We find the spathe, again, sometimes drawn like an Acanthus leaf, more often, however, bulged out, coming to be more and more of a mere outline figure, and becoming converted into a sort of background; then the spadix, generally conical in

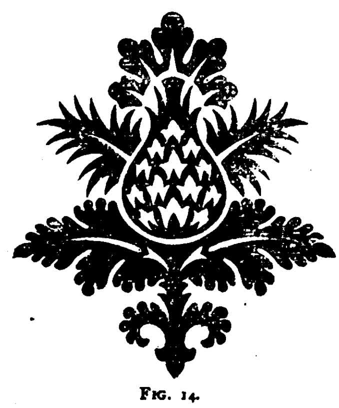


FIG. 14.

shape, sometimes, however, altogether replaced by a perfect thistle, at other times again by a pomegranate. Anberville in his magnificent work "L'Ornement des Tissus," is astonished to find the term pomegranate-pattern almost confined to these forms, since their central part is generally formed of a thistle-form. As far as I can discover in the literature that is at my disposal, this question has not had any particular attention devoted to it except in the large work upon Ottoman architecture, published in Constantinople under the patronage of Edhem Pasha. The pomegranate that has served as the original of the pattern in question is in this work surrounded with leaves till it gives some sort of an approach to the pattern. (There are important suggestions in the book as to the employment of melon-forms.) Whoever has picked the fruit from the tender twigs of the pomegranate-tree, which are close set with small altered leaves, will never dream of attributing the derivation of the thorny leaves that

FIG. 15.

appear in the pattern to pomegranate-leaves at any stage of their development.

It does not require much penetration to see that the outline of the whole form corresponds to the spathe of the Araceæ, even although in later times the jagged contour is all that has remained of it, and it appears to have been provided with ornamental forms quite independently of

FIG. 16.

the rest of the pattern. The inner thistle-form cannot be derived from the common thistle, because the surrounding leaves negative any such idea. The artichoke theory also has not enough in its favour, although the artichoke, as well as the thistle, was probably at a later time directly pressed into service. Prof. Ascherson first called my attention to the extremely anciently cultivated plant, the

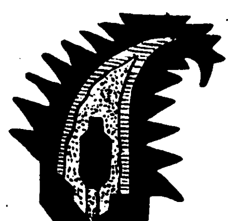


FIG. 17.

FIG. 18.

FIG. 19.

Safflor (*Carthamus tinctorius*, Fig. 15), a thistle plant whose flowers were employed by the ancients as a dye. Some drawings and dried specimens, as well as the literature of the subject, first gave me a hope to find that this plant was the archetype of this ornament, a hope that was borne out by the study of the actual plant, although I was unable to grow it to any great perfection.

In the days of the Egyptian King Sargo (according to Ascherson and Schweinfurth) this plant was already well known as a plant of cultivation; in a wild state it is not known (De Candolle, "Originel des Plantes cultivées"). In Asia its cultivation stretches to Japan. Semper cites a passage from an Indian drama to the effect that over the doorway there was stretched an arch of ivory, and about it were bannerets on which wild safran (*Saflor*) was painted.

The importance of the plant as a dye began steadily to decrease, and it has now ceased to have any value as such in the face of the introduction of newer colouring matters (a question that was treated of in a paper read a short time ago by Dr. Reimann before this Society). Perhaps its only use nowadays is in the preparation of rouge (*rouge végétale*).

But at a time when dyeing, spinning, and weaving

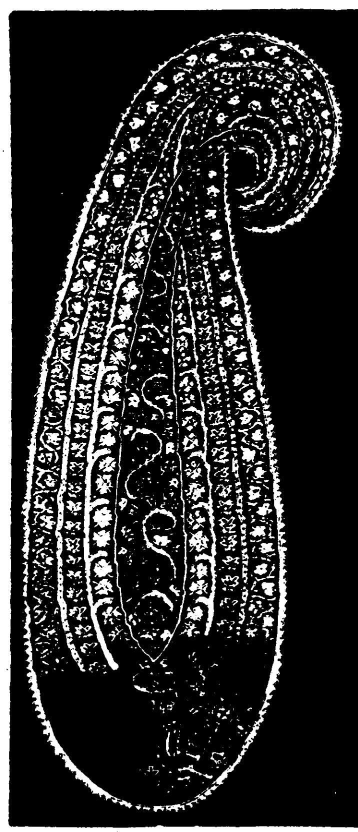


FIG. 20.

were, if not in the one hand, yet at any rate intimately connected with one another in the narrow circle of a home industry, the appearance of this beautiful gold-yellow plant, heaped up in large masses, would be very likely to suggest its immortalisation in textile art, because the drawing is very faithful to nature in regard to the thorny involucre. Drawings from nature of the plant in the old botanical works of the sixteenth and seventeenth centuries look very like ornamental patterns. Now after the general form had been introduced, pomegranates or other fruits—for instance, pine-apples—were introduced within the nest of leaves.

Into the detailed study of the intricacies of this subject I cannot here enter; the East-Asian influences are not to be neglected, which had probably even in early times an effect upon the form that was assumed, and have fused the correct style of compound flowers for flat ornament with the above-mentioned forms, so as to produce peculiar patterns ; we meet them often in the so-called Persian textures and flat ornaments (Fig. 16).

We now come to the third group of forms—the so-called Cashmere pattern, or Indian palmetta. The developed forms which, when they have attained their highest development, often show us outlines that are merely fanciful, and represent quite a bouquet of flowers leaning over to one side, and springing from a vessel (the whole corresponding to the Roman form with the vessel), must be thrown to one side, while we follow up the simpler forms, because in this case also we have no information as to either the where or the when the forms originated. (Figs. 17, 18, 19.)

Here again we are struck by resemblances to the forms that were the subjects of our previous study, we even come across direct transitional forms, which differ from the others only by the lateral curve of the apex of the leaf ; sometimes it is the central part, the spadix, that is bent outwards, and the very details show a striking agreement with the structure of the Aroid inflorescence, so much so that one might regard them as actually copied from them.

This form of ornament has been introduced into Europe since the French expedition to Egypt, owing to the importation of genuine Cashmere shawls. (When it cropped up in isolated forms, as in Venice in the fifteenth century, it appears not to have exerted any influence ; its introduction is perhaps rather to be attributed to calico-printing.) Soon afterwards the European shawl-manufacture, which is still in a flourishing state, was introduced. Falcot informs us that designs of the celebrated French artist, Couder, for shawl-patterns, a subject that he studied in India itself, were exported back to that country and used there (Fig. 20).

In these shawl-patterns the original simple form meets us in a highly developed, magnificent, and splendidly coloured differentiation and elaboration. This we can have no scruples in ranking along with the mediæval plane-patterns, which we have referred to above, among the highest achievements of decorative art.

It is evident that it, at any rate in the high stage of development, resisted fusion with Western forms of art. It is all the more incumbent upon us to investigate the laws of its existence, in order to make it less alien to us, or perhaps to assimilate it to ourselves by attaining to an understanding of those laws. A great step has been made when criticism has, by a more painstaking study, put itself into a position to characterise as worthless, ignorantly imitated, or even original, miscreations such as are eternally cropping up. If we look at our modern manufactures immediately after studying patterns which enchant us with their classical repose, or after it such others as captivate the eye by their beautiful colouring, or the elaborative working out of their details, we recognise that the beautifully-balanced form is often cut up, choked over with others, or mangled (the flower springing upside down from the leaves), the whole being traversed at random by spirals, which are utterly foreign to the spirit of such a style, and all this at the caprice of uncultured boorish designers. Once we see that the original of the form was a plant, we shall ever in the developed artistic form cling, in a general way at least, to the laws of its organisation, and we shall at any rate be in a position to avoid violent incongruities.

I had resort, a few years ago, to the young botanist Kuhner, assistant at the Botanical Museum at Schoneberg, who has unfortunately since died of some chest-disease, in order to get some sort of a groundwork for direct investigations. I asked him to look up the literature of the subject, with respect to the employment of the Indian Araceæ for domestic uses or in medicine. A detailed work on the subject was produced, and establishes that, quite irrespective of species of Alocasia and Colocasia that have been referred to, a large number of Araceæ were employed for all sorts of domestic purposes. Scindapsus, which was used as a medicine, has actually retained a Sanscrit name, "vustiva." I cannot here go further into the details of this investigation, but must remark that even the incomplete and imperfect drawings of these plants, which, owing to the difficulty of preserving them, are so difficult to collect through travellers, exhibit such a wealth of shape, that it is quite natural that Indian and Persian flower-loving artists should be quite taken with them and employ them enthusiastically in decorative art. Let me also mention that Haeckel, in his "Letters of an Indian Traveller," very often bears witness to the effect of the Araceæ upon the general appearance of the vegetation, both in the full and enormous development of species of Caladia and in the species of Pothos which form such impenetrable mazes of interlooping stems.

In conclusion, allow me to remark that the results of my investigation, of which but a succinct account has been given here, negative certain derivations, which have been believed in, though they have never been proved ; such as that of the form I have last discussed from the Assyriad palmetta, or from a cypress bent down by the wind. To say the least the laws of formation here laid down have a more intimate connection with the forms, as they have come down to us, and give us a better handle for future use and development. The object of the investigation was, in general words, to prepare for an explanation of the questions raised, and even if the results had turned out other than they have, it would have sufficed me to have given an impulse to labours which will testify to the truth of the dead master's words :

"Was Du ererbt von deinen Vätern hast,
Erwirb es, um es zu besitzen."—*Nature.*

EPIDEMIC CHOLERA AND INFECTIOUS DISEASES.

The presence of cholera this summer in epidemic form in southern France, the appearance of sporadic cases at widely scattered places and on shipboard at various seaports of the European continent and of England, have brought western civilization once more face to face with two of the most important problems which modern science and social organisation can be called upon to solve. These problems just now come home to every one, but in ordinary years are put out of mind, or left to the care of laboratory devotees, or of officials charged with departments concerned with public hygiene.

The first involves a purely scientific question as to the causes, modes of origin, and ways of propagation, of the infectious or so-called zymotic diseases : the second, evolving itself naturally from the first, is of a more immediately practical nature, and deals with the processes best calculated to prevent and antagonize these diseases, especially when presenting themselves as epidemics. And these problems owe this much to such epidemics,—that by them men as individuals, and governments (their representatives),are stimulated to a vigor of inquiry and action which are never evoked by a customary rate of mortality, however high, from endemic diseases, such as are always with us ; just as the stimulus of prospective want often meets with a ready response where chronic destitution make an ineffectual appeal to action. Typhoid-fever, resembling cholera very much in its propagation, demands a steady toll from the populations of Europe and North America, compared to which the occasional ravages of cholera become insignificant ; and yet it is impossible to inspire them with an intelligent dread of that enemy expressing itself in possible and comparatively simple precautions. The self-reliant Anglo-Saxon continues to regard typhoid-fever with a measure of the same indifference felt by the fatalist of India toward cholera ; and the explanation is to be found, we believe, largely in association, and not merely in the fact that fifty per cent of those attacked with the latter disease die, whereas about eighty-five per cent of typhoid fever cases survive. The typhoid sufferer, as a survivor even, is robbed far more ruthlessly of time and strength, which by the Anglo-Saxon are transformed into wealth, which to him is life.

By this seeming digression we would impress upon readers, begging them to keep it steadily before themselves and their public authorities, the fact that cholera is but one form under which these great general problems of the cause and prevention of infectious diseases present themselves. The prevelance of cholera in France gives the health evangelist in the United States, who might otherwise continue crying in the wilderness, at once a text and a hearing, from which those who have come out from their usual routine must not be allowed to depart without a resolve to amend their ways, even though they escape this especial visitation. This threatening of cholera should be the spur to animate northern zeal for the solution of these problems which the south so often finds in the proximity of yellow-fever.

It now seems quite possible that the United States may escape, at least this year, an invasion of epidemic cholera ; but if so, the reprieve should be used to perfect precautions and vigilance against next year, and to collate, as far as may be, the latest scientific investigations with previous observation and experience. *Science* has already published, either in full or in abstract, the seven reports to the German government emanating from the cholera commission under Dr. Koch, in Egypt and in India. These, in giving in a somewhat popular form the results of studies of the fresh excreta of forty cholera patients and of the cadavers of fifty two recent victims, offer an interesting and doubtless valuable contribution to the subject under discussion, but by no means demonstrate that the active principle of cholera resides in a microbion, or that the particular microbion has been discovered.

Notwithstanding the labours and advances in this direction during the last ten or twelve years, the number of diseases in regard to which a positive affirmation can be made that they are caused by a micro-organism, and by a specific micro-organism, is still very small, and neither cholera nor typhoid fever can as yet be included in that number. The number in regard to which there is only a strong probability that they result from a specific germ, propagating amid favorable surroundings, and finding entrance to the system of the victim under favorable circumstances, is much larger, and must still be regarded as embracing cholera.

The investigations of the German commission will probably be continued under the auspices of the German health bureau at Berlin, or otherwise; and the British government has at last appointed a commission consisting of Drs. Klein and Heneage Gibbes, to go to India and pursue this inquiry as to the nature of cholera; so that a further elucidation of the subject and of the precise significance of Koch's observations, may reasonably be anticipated at no distant day. In the mean time it is our duty to protest against a confident application to the disease itself of measures of prophylaxis, of treatment, of disinfection, or of quarantine, based upon the life-history of the *comma-tipped bacillus*, or upon its behavior when subjected to the action of certain media or of certain germicides.

Although their specific microbions have not been definitely demonstrated, experience and observation have fairly established the probable accuracy of certain views in regard to both typhoid fever and cholera; and upon these the measures to be adopted against such maladies are at present to be based. They are clearly and concisely set forth in a circular entitled "Suggestions relative to epidemic cholera," lately issued by the Massachusetts board of health, itself following generally a previous circular emanating a year ago last June from the English local government board, and reprinted under the same authority, with other supporting papers, last July.—*Science.*

Scientific Notes.

Temperature of the Spheroidal State.—Prof. Louis Bell, of Dartmouth College, communicates to *Science* the particulars of some experiments which he has recently made to determine the temperature of the spheroidal state of liquids. The experiments were very carefully conducted and were simple in manner. The spheroids of the liquids experimented upon were produced in a spoon heated over a spirit lamp. A large number of experiments were made, the average variation of which did not exceed 1°. The size of the spheroids had no effect upon the temperature. The temperature thus found was: for water, 90°, and for alcohol 69°. We are not aware that any effort had previously been made to determine such temperature. The results of Prof. Bell's experiments show a much lower temperature than has hitherto been assigned to the spheroidal state, and they are both interesting and important.

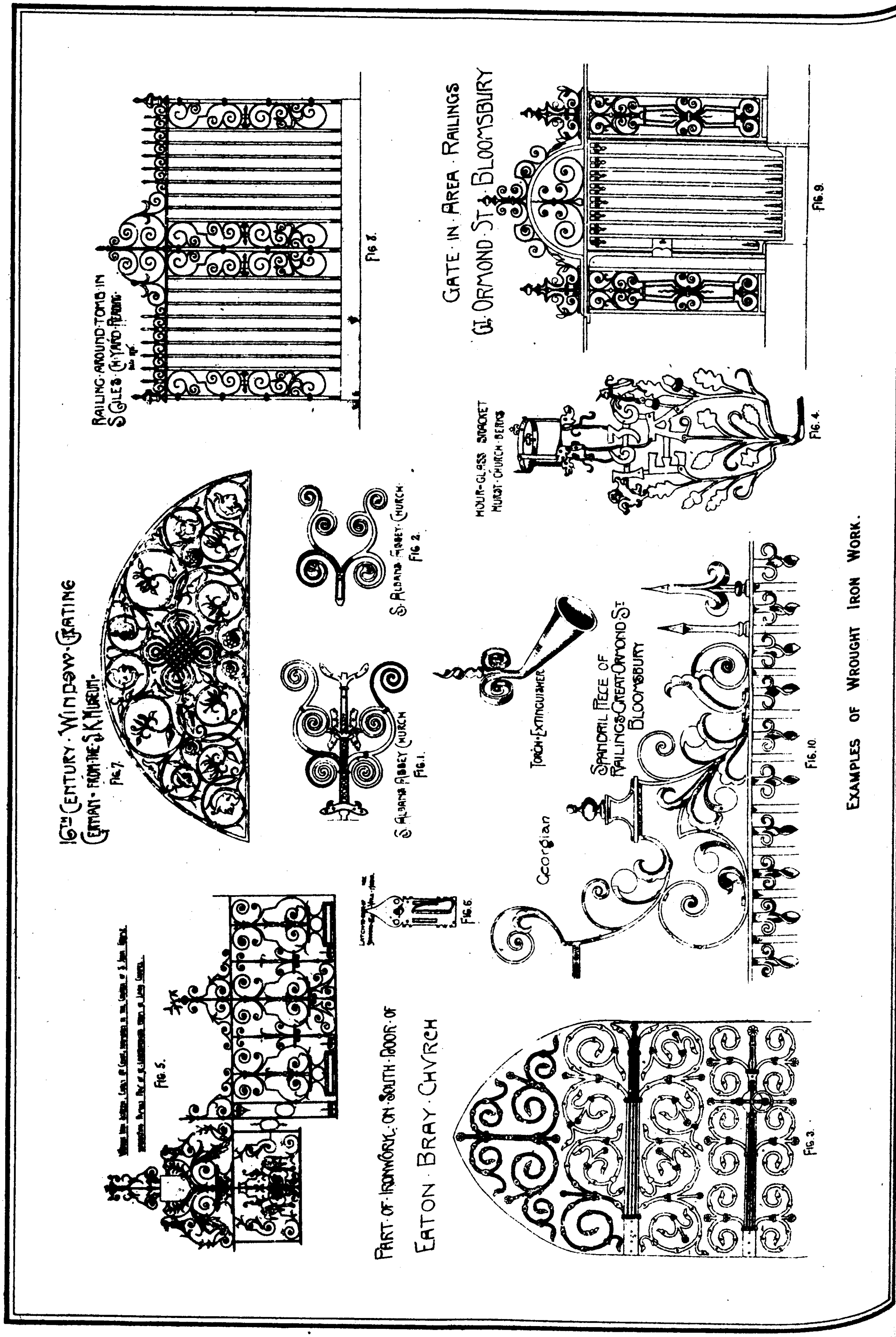
Effect of Case-Hardening on Iron.—Among some master mechanics and locomotive builders there exists a strong prejudice in favor of using case-hardened pins, yet pins of this kind fail oftener than any other part of a first class locomotive. Some time ago the Baldwin people becoming convinced that case-hardened pins were unreliable, they determined to make some systematic tests to prove the matter beyond peradventure. The took a bar of 2 inch iron and cut it into lengths of 12 inches. One piece they kept out and the others they put in the case-hardening furnace. After being an hour in the furnace one piece was taken out, and another after it had been two hours in, and so on till the five pieces had gone through the case-hardening operation, the last piece taken out having been in five hours. All the pieces were then in succession subjected to a breaking strain, when it was found they had decreased in strength in proportion to the time they had been in the furnace. Examination showed that the case-hardening process did not merely affect the outside of the iron, it went to the centre. In the piece that had been in longest, the heart had become crystaline, and very coarse. All the others showed similar indications in small degrees according to the time they had been in the furnace. In the breaking tests, the pieces that had not been in the furnace doubled without breaking, but all the others snapped off.

Mineral Formations.—By an ingenious artificial contrivance, chemists in France and Germany have succeeded in imitating the conditions which are supposed to exist in nature and have produced crystals of native copper, and red oxides of copper, and of various oxides and sulphurets like those which are deposited in the mineral veins. These results explain several hitherto irreconcilable facts in the phenomena of mines. Native sulphides, if brought in contact with metallic solutions, effect the reduction of the dissolved metal. Galena if placed in a solution of auric chloride, becomes gilded, Mercury is also precipitated under the same conditions. These facts indicate certain geological consequences, particularly as regards the combinations to be found in metallic veins. We have convincing proof that long ago, when the waters covered the face of the earth, the influence of electricity (in producing crystals and entire veins of metallic bodies in their rocky repositories) was felt and that when the convulsions of nature forced the waters to recede and evaporate, the metals which were then held in a state of solution, were precipitated and thus quartz leads were formed. The action of electricity, by which heat is produced, is the grand principle which creates and sustains both animal and vegetable life and by which the earth was formed—this same agent is the origin of not only base metal ores, but of all ores containg gold and silver in their native state.

A New Means of Producing Light.—Professor Matthew Williams, writing in the *Gentleman's Magazine*, says:—I now learn that Professor Radziszewski has actually separated the luminous matter of the *Pelagia noctiluca*, one of the multitude of species of marine animals that appear like little lumps of jelly, and produce the phosphorescence of the sea. . . . I have collected and examined a great variety of these animals at different times; the most remarkable occasion being one morning after a magnificent display of marine luminosity in the Mediterranean, a few miles off the shores of Algiers. The surface of the sea was encrusted, I might almost say, with countless millions of small jelly-like creatures, spherical, ovoid, oblong, dumb-bell, and other shapes, varying in size from a mustard-seed to a pea; a bucketful of water taken over the ship's side appeared like sago broth. They were all internally dotted with a multitude of what I suppose to be germs, that would be liberated on the death and decay of the parent. The practical importance which I attach to the study of the luminosity of these creatures is the fact that they supply light without heat. The costliness of all our present methods of artificial illumination is due to the fact that we waste a largely disproportionate amount of energy in producing heat as well as light.

Protecting Steel and Iron from Rust.—Professor Calvert has recently made the interesting discovery by practical tests, that the carbonates of potash and soda possess the same property of protecting iron and steel from rust as do those alkalies in a caustic state. Thus it is found that, if an iron blade be immersed in a solution of either of the above carbonates, it exercises so protective an action that that portion of the iron which is exposed to the influence of the damp atmospheric air does not oxidize, even after so extended a period as two years. Similar results, it appears, have also been obtained with sea water, on adding to the same the carbonates of potash and soda in suitable proportion.

Disinfecting the Sick Chamber.—Dr. Vilandt recommends that the atmosphere of a sick chamber where the patient is ill of diphtheria, measles, scarlet fever, or any allied disease, should be impregnated with the odor of a mixture of equal parts of turpentine and carbolic acid. Half a teaspoonful of the mixture will be enough at a time, if it is put into a kettle of water kept near the boiling point. The odor generally gives some relief to the sufferer, and tends to prevent the spread of the malady. A disinfecting lamp can also be advantageously used and may be easily prepared for purifying any place where a disagreeable odor is perceived, being especially useful in sick rooms and in damp cellars where vegetables have decayed. Take any glass lamp for burning kerosene or oil, fill it chloric ether and light. The old-fashioned camphene or burning fluid lamps, with a small, round wick, will burn longer and be of more service than the flat-wicked lamps. While the ether burns, a disinfectant escapes that will soon purify the most offensive atmosphere, even that of a sewer.



Examples of Wrought Iron Work.