SCIENTIFIC AMERICAN
ESTABLISHED 1845

MUNN & CO., - - Editors and Proprietors

Published Weekly at
No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year for the United States, Canada, or Mexico $3.00
One copy, one year, to any foreign country, postage prepaid. £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS.

Scientific American (Established 1845) .... $3.00 a year
Scientific American Supplement (Established 1876) .... 5.00 "
Scientific American Building Monthly (Established 1885) .... 2.50 "
Scientific American Export Edition (Established 1878) .... 3.00 "

The combined subscription rates and rates to foreign countries will be furnished upon application.

Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, SEPTEMBER 10, 1904.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE ART COMMISSION AND PUBLIC STRUCTURES.

The creation of the Art Commission was one of the most fortunate provisions of the new charter of the city of New York. In the scope of its judicial powers and the make-up of its personnel the Commission is admirably adjusted to its important duties. The work of the Commission is purely honorary, and it needs but a glance at the list of members to realize that its decisions will be rendered solely with an eye to the highest interests of the city. Under the charter, the Commission has jurisdiction over the acquisition, reconstruction, or removal of works of art, and over all designs of municipal buildings, bridges, and other city structures that may be referred to the Commission by the Mayor or Board of Aldermen. This jurisdiction has been actively exercised since the year 1898, and during the past six years over 200 subjects have been submitted for approval.

On January 1, 1902, the powers of the Commission were greatly enlarged by a provision requiring that all municipal structures exceeding in cost one million dollars must be approved by the Commission. Whereas previous to 1902 the Commission merely had jurisdiction over such buildings as might be submitted, now all public buildings that cost over one million dollars pass directly within the scope of the Commission, and do not have to be referred to it by the Mayor or the Board of Aldermen.

Now, that this second provision confers no mere empty authority has recently been established by the courts. The charter provides that expenditure of the city's funds without the approval of the Art Commission is illegal in such cases as come within its jurisdiction. Thus, for instance, if the designs for a public structure costing several millions of dollars should be disapproved by the Commission, and the contractors nevertheless proceed to carry them out, or if the contractor should fail to submit them to the Art Commission, payment of any money to the contractor under such circumstances would be illegal. The decision of the courts above referred to as bearing on this subject was on an application for an injunction against proceeding with the erection of Blackwell's Island bridge, except on the original plans, and involved the legality of a proposed expenditure of about seven million dollars. In its opinion the court said: "The Art Commission called in by the Mayor, and invested with the veto power by law, has rejected the original design. That disapproval disposed of it. The bridge could not, therefore, be constructed in accordance therewith."

By far the most important case that has come before the Art Commission is that of the new Manhattan Bridge, which involves an expenditure of about twenty million dollars; and recently a great deal of confusing and profitless discussion has taken place, in this connection, as to the actual scope of the authority of the Commission. It has been claimed that this body, not being composed of expert engineers, is necessarily unable to pass upon any but the æsthetic features of this bridge or any other engineering structure that may be submitted to it. It will be seen, from what we have said above, that, on the contrary, its powers are absolute as to the acceptance or rejection of a proposed structure. Its jurisdiction is not specifically limited to the artistic and architectural features only; it covers the structure as a whole.

Now it must frequently happen that the subjects submitted, especially if they are of an engineering character, will contain elements upon which the Commission must be advised by expert opinion before it can render an intelligent decision. This fact was recognized when Mayor Low appointed a commission of five eminent bridge engineers to pass upon the then current plans for the Manhattan Bridge, so as to provide the Commission with an independent estimate of the engineering features of the structure, upon which they might base their action. Obviously, this was the proper course for the Mayor to take, and upon the presentation of the report, favorable action was speedily taken by the Art Commission.

The new Bridge Commissioner, however, wishes to reject the design accepted by the Art Commission, and asks that body to indorse his own plans, which are for a structure of an entirely different character. In making a choice between the two designs the Commission, as matters now stand, finds itself confronted by a difficult dilemma; for the new plans are backed by the opinion of the Bridge Commissioner only. They have received no consideration by any independent board of experts, such as indorsed the Art Commission's accepted plan, and that body is, therefore, entirely without any expert advice as to the engineering merits of these plans.

Under the circumstances, in order to enable the Commission to make an intelligent comparison of the relative merits of the two designs, the obviously wise course would be for the Mayor to follow the example of his predecessor in office, and appoint an engineering commission. Surely, the Bridge Department has everything to gain and nothing to lose by such a searching investigation of their strain sheets and working plans as this Commission would make. If their report should establish the fact that, from an engineering and constructive point of view, the new designs will provide a bridge stiffer, stronger, cheaper, and quicker of erection than one built on the accepted plans, there is not the slightest doubt that the Art Commission would render an immediate decision in its favor, and the present intolerable delay of this greatly-needed public work would be ended.

THE AGRICULTURAL IMPORTANCE OF BACTERIA.

Nitrogen is to the soil in which our plants grow much what the oxygen of the air is to us; for without it the death of vegetation must ultimately ensue. For that reason we add the necessary quantity of nitrogen to the tilled soil in the form of fertilizers. It happens, however, that the supply of fertilizers, which in turn is dependent upon the supply of nitrates in the world, is limited. Like the coal fields of Pennsylvania, the nitrate beds from which nitrogen compounds are obtained must ultimately be exhausted. And because the free nitrogen of the air in its elemental state cannot be assimilated by vegetation, it is no wonder that the agricultural chemist has taken it upon himself to devise some means for restoring to the earth the nitrogen which it must give up to the growing plant, and without which the plant could not grow.

Just how the nitrogen of the air could be converted into nitrates suitable for fertilization is a problem that has been attacked time and time again with scant success. Crookes proposed a plan not without merit, a plan by which the nitrogen of the air was converted into nitric acid through the agency of the electric spark. In the current issue of the Supplement another solution of the vexing problem is outlined, which comes from an entirely different quarter of the scientific world. For centuries farmers have known that different crops should be grown in the same field with each succeeding year. Some crops following clover and other plants were found to flourish admirably. Careful analyses by agricultural chemists have shown that the benefits derived by this rotation are due directly to the increased stores of nitrogen placed at the disposal of the benefited plants. It would necessarily have followed that plants of the clover type were able to render available nitrogen which would otherwise be unassimilated. Further investigation showed that this nitrogen was fixed in a manner entirely unsuspected, and that we need have no fear of the exhaustion of the nitrate beds which supply us with the chief ingredients of our fertilizers.

The *Leguminosæ* family of plants, among other distinctions, have well-defined nodules at their roots, highly charged with nitrogen and constituting the habitat of certain bacteria indispensable in nitrogen assimilation. Elaborate experiments proved that the destruction of these bacteria was equivalent to the destruction of the plant life itself. Bacterial life, then, and nothing else, contains the secret of nitrogen production. It having been settled with reasonable certainty that the fixation of nitrogen in the case of *Leguminosæ* is directly traceable to bacteria, the next investigation to be carried out had for its determination the life process of these bacteria—the conditions under which they thrive, the amount of light, heat, and moisture that they require, the manner in which the plant appropriated the nitrogen brought to it from the air, and finally, the possibility of artificially stimulating plant life by inoculating soil with the bacteria. These investigations have been carried out with striking success. At no very distant day the farmer will either inoculate his field with a culture of bacteria adapted to the crop he wishes to grow, or incorporate with his soil earth of a field where the crop has already been successful. The uncertainty of a good crop will then have vanished, and a farmer will be assured of the best obtainable crops from the seed which he has planted. Guesswork will have given place to absolute certainty.

POSSIBILITIES OF PEAT AS FUEL.

The discovery of extensive deposits of valuable peat in many parts of this country, and the invention of improved machinery for cutting, extracting, and compressing it into commercial size bricks, must eventually have a most important bearing upon the question of economical power production. Unquestionably we are rapidly approaching a time when steam and electrical uses will be less dependent upon anthracite coal than in the past. With a continuation of our industrial expansion, anthracite coal must soon be regarded more in the light of a luxury than a necessity. Fuel economy must begin with the fuel itself, and not limit itself to the invention of machinery for extracting a larger percentage of thermal units from the material burnt.

The immense amount of material in one form and another scattered around in the shape of waste must be utilized in order to keep down the present high bills for operating power stations. The heavy deposits of peat naturally must call for attention. Raw peat has not been considered an economical or satisfactory fuel in this country. It has been questioned whether it could ever be extracted and put on the market in such a condition as to attract power producers in a way that would make it a commercial success. With over 85 per cent water, and scarcely 13 per cent of combustible material, with about 2 per cent of inorganic matter, raw peat has not apparently offered very great inducements to manufacturers.

The problem of extracting this 13 per cent of combustible material from the peat at a cost which would enable the owners to sell it at a commercial profit, and at the same time make it cheaper for producing steam than either coal or liquid fuel, has not been an easy one to solve. Peat cutting and compressing machinery has reached a remarkable state of development in the past decade in Germany and other continental countries. This machinery has reduced the cost of working the fuel into commercial forms, and has at the same time improved its burning qualities.

One of the most important of recent methods of handling peat in Germany is to reduce the combustible material through grinding and maceration, and then mix it with other inflammable material to insure superior heat-producing qualities. The different materials mixed with the peat pulp are usually dry sawdust, anthracite culm and bituminous coal dust. These are added to the wet peat when in a dry state, and they are run through the grinding machinery with it. The result is that the two are mixed thoroughly, and the dried product is very inflammable and steady in its burning. The added ingredients give to the peat a more compact density, which adds to its value in many ways. It is less liable to break and pulverize in handling, and it does not disintegrate in the furnace so readily.

As high as 30 per cent of bituminous coal dust, 40 per cent of anthracite culm, and 15 per cent of dry sawdust are added to the peat pulp. When thus mixed the bricks are pressed into shape by hydraulic machinery, which makes them suitable for almost any kind of use. The amount of worthless coal dust that accumulates at the coal yards as well as at the mouths of the mines cannot be utilized to any greater advantage than by helping to form a new fuel of this character.

The conversion of peat into coke is a comparatively new process that may be considered as the most scientific method of utilizing this fuel. Chemical engineers of all countries have sought to accomplish this end. As a new industrial process it has already become established in parts of the leading peat-producing countries, especially in Germany and Russia. The peat is converted into coke by carbonization in retort ovens. To make it more profitable and successful, the effort has been successfully made to recover the gas, tar, and other by-products of distillation. These by-products represent a gain of no small figure, and they add to the profits of the undertaking in a way that promises to make the process extremely valuable.

The peat is carbonized in closed ovens, which are heated by burning under them the gases generated by the coking process. In other words the process is self-sustaining after the fire of wood or coal is first started to produce the coking. A very small amount of fuel is thus used at the start, and thereafter there is no expense whatever in burning fuel. The gases are carried from above to the burning chamber where they are consumed to continue the process.

To make the process even more complete and profitable, the escaping heat of the retort ovens is utilized for heating the drying ovens. This escaping heat is carried through a dry-air chamber to an upper receptacle where the raw peat is placed for drying. The raw peat must be dried to a crisp point where carbonization follows quickly when introduced into the coking oven. Ordinary wet peat, when put into the carbonizing ovens, wastes heat to such an extent that the process in the past has been rendered unprofitable. More than this, the drying of the peat for carbonization in ovens prepared for it has been found unsatisfactory owing to the cost of fuel required to heat the ovens. By utilizing the escaping heat of the retort ovens, and utilizing the waste gases for firing the ovens, a double process of economy is obtained.

The by-products of peat coke are obtained in the form of commercial distillates. About one-third of the peat used for coking is converted into pure coke, one-third into gas liquor, and one-third into tar. From the gas liquor there are derived several other commercial products. One of these is the valuable methyl alcohol, which is assuming such important commercial value in our industries. Another is acetate of lime, and a third sulphate of ammonia. With these different articles selling at present market prices, one pound of peat is raised in value to nearly five times that paid for it in the open market.

The peat coke is a firm, jet-black substance that is as pure as charcoal. It has a thermal value of nearly 7,000 calories, varying a little according to the quality of the peat used. Its value for certain industries is considered much higher than coke made from any other process. It is particularly highly prized for smelting foundry iron, copper refining, and other metallurgical processes. For blast-furnaces it is also excellent, but it is too high-priced for general use in smelting iron ores. In Germany it sells as high as $9.50 to $11.50 per ton, and as its supply is still small the demand at these prices exceeds the supply.

The coke for burning purposes is a smokeless fuel, and it possesses all the merits of our best anthracite and charcoal. It can consequently be used in place of charcoal in all industries where a smokeless fuel is absolutely necessary for success. It is employed in place of anthracite only in a comparatively limited field, and it may never come in as a substitute for this fuel to any extent.

As a fuel for direct use in power plants, peat has less actual thermal value than coal or even the brown or lignite coal which is of comparatively recent geological formation. Peat is of such recent geological formation that it is only slightly carbonized. Its thermal value depends upon its composition. In some parts of the country the "mud peat" has a very low order of vegetable composition, and its value is relatively small for fuel purposes. These mud-peat bogs, however, furnish excellent fuel material when they are properly cut and dried for compression. The "mud peat," when dried by air until "bone-dry," has a calorific power of from 9,600 to 14,000 British thermal units per pound. This represents about 65 per cent of that of the best American coal. The wet peat of the mud bogs, or those furnishing the best material, weighs from 100 to 125 pounds per cubic foot. This weight, when dried in the open air or by hot-air blasts or in ovens, is reduced to 50 or 55 pounds. In this condition the fuel is hard and tough. It is not easy to cut it with a knife or saw, but it can be cracked or split with a heavy implement quite easily.

THE SORTING OF ATOMS.

BY PROF. A. W. BICKERTON.

The discovery of radium, and the compound nature of an atom, has so fascinated the popular mind, that scientific discoveries of equal importance with regard to the whole atom have been neglected. The great physicist whose early death was such a loss to science—Clerk Maxwell—told us that without energy, by intelligence alone, that if the atoms could be sorted into their different velocities, the whole conception of the fate of the cosmos would change. Such a power has been found to be in action, and the demons demanded by Clerk Maxwell are replaced by natural physical laws, and this discovery has shown that Clerk Maxwell is right, for the possibility of an immortal cosmos grows up with the knowledge of this power of the sorting of atoms, and Lord Kelvin's magnificent generalization of dissipation of energy, although still true as regards the solar system and the visible universe, fails when treating of the cosmic whole.

A jar of gas is a dust swarm of nature's ultimate particles. It is a giddy reel of moving molecules; sometimes the particles are detached atoms, as in the case of such gases as the newly discovered helium, argon, neon, etc. Sometimes the molecules are groups of atoms, as in the case of oxygen and carbonic acid. A particle of free oxygen consists of two similar atoms locked in a close embrace. If a piece of smouldering carbon be plunged into a jar of oxygen, there is such a great heat produced by the attraction of the molecules, that it bursts into a brilliant light. Heat is a violent motion of molecules. The heat produced causes the oxygen pairs to strike one another so violently that they part company, and both of the two isolated atoms are then clasped by a carbon atom, and built into a group still more firmly locked together than were the oxygen pair. Carbon has a great attraction for oxygen. We call the force that attracts them "chemical affinity." So tremendous is the pull, that, as the atoms rush together, the blow they strike causes the particles to shiver so violently that the whole mass becomes white-hot. Heat may be a vibration or shivering of the ultimate atoms, or it may be the free flight of the particles we have called molecules. The hotter a gas, the more rapid the dance of its countless particles; so the new molecular groups of carbon and oxygen that we call carbonic acid move with tremendous velocity, striking each other and the sides of the jar. Had we sealed the jar when we plunged the glowing carbon into oxygen, so great would have been the force with which the particles would have struck the sides of the jar, it would probably have been blown to pieces. The pressure that produces explosions is caused by a bombardment of the ultimate particles of matter.

Some gas particles are light and some scores of times as heavy, but light or heavy, the same number of particles are required to fill the same jar. So the density of a gas depends on the weight of its molecules. Carbonic acid is so much heavier than the air that the gas can be poured from one jar to another; while so light is hydrogen that an open vessel has to be held upside down to hold it. If we half fill a jar with oxygen, and then fill the remainder with hydrogen, the hydrogen will float above the oxygen. Yet, such is the dance of the molecules that the hydrogen particles will travel downward, and the oxygen upward, until there is a uniform mixture throughout the jar. If, however, the jar be a tall one, it will be found that the hydrogen will reach the bottom four times as quickly as the oxygen reaches the top, for the hydrogen particles move four times as quickly as the particles of oxygen. When a gas particle is four times as light, it moves twice as fast. When it is sixteen times as light, it moves four times as fast, and so on. As the physicist puts it, the speed of a particle of gas varies inversely as the square root of its molecular weight.

The hydrogen particle is sixteen times as light as the oxygen particle, so it moves four times as fast.

The atoms are exceedingly minute. A pea is made up of many millions; so when free they can get through very small holes. They wander easily through the pores of a plaster partition, also through most membranes. Hence, if an India-rubber balloon be filled with hydrogen, the atoms soon find their way out. Fill a collodion balloon with this gas, and it floats; presently it becomes smaller and then sinks. The hydrogen has wandered away, and a smaller number of air particles have wandered in to take its place.

All through the atmosphere, in addition to being carried by winds, the atoms thus wander, so that, if we allow time enough, the composition of a confined mixture of gases gets to be uniform throughout, and this, whether the gas be held in its place by gravitation, as it is in the atmosphere, or be laid carefully layer above layer in a closed jar.

But nature can also sort as well as mix atoms. Chemical affinity enables us to sort a mixture by putting something in that will take one and leave the other constituents of a mixture. Thus air is a mixture of oxygen and nitrogen. If we burn phosphorus in it the oxygen is taken away, and the nitrogen left.

But nature has another mode of sorting molecules, by making them outrun one another, when all are traveling in one direction. In such a race, if hydrogen had a velocity of sixteen, oxygen would only have a speed of four, while uranium would be traveling at the rate of one only. But how can the atoms be started on such a race? By grazing impact of stars or dead suns. In the Philosophical Magazine for August, 1900, it is shown that such a grazing impact will result in the parts that meet one another being cut from the remainder of the stars, coalescing, and forming a new body, and this body may have so small a mass and be at so high a temperature that the velocity of its molecules will be great enough to escape the body entirely.

When all are fairly started on their outward journey, the light atoms will be in advance, and the other cosmic elements in concentric shells, in the order of their atomic weight. It will be as though shot, bullets, and cannon balls had each similar energy, the shot having an enormous velocity to make up for the mass of the cannon balls; and this is the law of the distribution of energy among molecules. Molecules at the same temperature have the same energy. It will easily be seen that not merely can the light molecules escape from the body produced by the collision, but they may have a velocity sufficient, and in fact often would have velocity sufficient to escape the very universe itself; and having escaped it, might travel across the intervening space to other cosmic systems, but when at the point most distant from either, they would travel more slowly than in any other position. The velocities observed in Nova Persei were many thousands of miles a second. And it is easily seen that in the case of indiscriminately moving particles, where they move slowest there they will tend to be more thickly spread than elsewhere. Hence here is a new aggregating agency the reverse of gravitation, that causes a concentration depending on the lightness and power of flight of atoms, whereas gravitation tends to collect the heavier particles. So that in old universes, the heavier molecules will predominate, but incipient universes will be built up of the light atoms. In the course of time other agencies come into work that modify this segregating action. These agencies are very fully discussed in a book on the subject entitled "The Romance of the Heavens."

The formation of these aggregations of light molecules carries us to a stage beyond the theory of dissipation of energy, and a study of the whole subject shows that the cosmos as a whole is a cyclical process in which we have rejuvenescence of universes, just as it has long been seen that collision would give us rejuvenescence of dead suns; and the cosmos as a whole is thus seen to be infinite and immortal.

Thus this fact of nature's power of sorting molecules which goes under the name of "selective molecular escape," entirely alters our conception of the whence and where of the universe.

AUTOMOBILE NOTES.

The fact that out of seventy-six cars that participated in the St. Louis tour at one place or another, but one American car failed to reach its destination on account of a serious break down, should be distinctly encouraging to our manufacturers. The only other machines of American make to drop out were a huge Peerless racer, which ran into a railway train, and an Oldsmobile touring car, which was burned in a garage. A large Mercedes touring car which met with many breakdowns, finally broke its crankshaft thirty miles before reaching St. Louis, while another car of the same make went through without mishap. This would tend to show that it is a difference in men and individual machines, rather than the inferiority or superiority of any one type, that accounts for failure or success. The lightweight cars had a decided advantage in many ways, besides less tire trouble. A car equipped with solid tires broke a steering-knuckle. The last day's run was through very muddy roads, and it is worthy of note that most of the cars got through.

The creating of a non-stop (i. e., without stopping the motor) record of 3,400 miles in connection with the St. Louis tour by running from New York to that city and back again—a feat which was accomplished by Mr. F. A. La Roche in a Darracq touring car—was doubtless the hardest test of this character a machine has ever been given. When it is understood that the car was run night and day for thirteen days over the worst of American roads without its motor having a second's rest, one marvels at the degree of perfection the automobile motor has already attained. Altogether, the motor ran fifteen days and two hours unceasingly, which is a much longer time than has been the case in any non-stop test heretofore.

Apropos of touring, an attempt is being made by L. L. Whitman (who last year crossed the continent in an Oldsmobile) to repeat the journey with an air-cooled car. The four-cylinder Franklin is the machine he is using. He reached Denver in sixteen and one-half days, or in thirteen and one-half days better time than the previous record, so in all probability the time of sixty-one and a quarter days for the complete journey, made last year by Tom Fetch with a Packard car, will be beaten.

Many motor car accidents have been attributed to the collapse or bursting of pneumatic tires while traveling at high speed, causing the car to swerve violently and come into collision with an object. Practical motorists, however, have considered this a fallacious contention, and for the purpose of illustrating the error of the deduction, Mr. S. F. Edge carried out a series of interesting experiments recently at the Crystal Palace, London. For the purposes of the demonstration, a section of the track was covered with broken glass and boards were laid down with the sharp edges of chisels projecting, while in addition a specially prepared sheet of iron was employed which was thickly set with iron spikes. Mr. Edge used the 100-horse-power car which had contested in the Gordon Bennet race, and drove it over the prepared patch at 50 miles an hour. One front tire was punctured, but the car did not swerve. On repeating the process one of the back tires was deflated, but still the car kept perfectly straight. The front tire on the near side was then deflated, while the cover on the near side rear tire was removed over the entire circumference of one edge, so that it was holding on by one edge only instead of two, and in a deflated condition instead of inflated. He then started off with the intention of wrenching off the back tire if possible. The car was driven in a perfectly straight line, notwithstanding the two flat tires for some distance, and then the demonstrator swerved it from side to side when driving it at about 45 miles an hour. The cover flew off, but even then, on the bare rim, the car could be steered in a perfectly straight line. The result of these experiments showed that it is not the collapse of tires to which accidents are due, but to improper driving and insecure holding of the steering wheel, unprepared for any emergency, on the part of the driver.