Scientific American.

ESTABLISHED 1845.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT
NO. 37 PARK ROW, NEW YORK.

O. D. MUNN. A. E. BEACH.

TERMS FOR THE SCIENTIFIC AMERICAN.

One copy, one year postage included $3 20
One copy, six months, postage included 1 60

Clubs.—One extra copy of THE SCIENTIFIC AMERICAN will be supplied gratis for every club of five subscribers at $3.20 each; additional copies at same proportionate rate. Postage prepaid.

Remit by postal order. Address
MUNN & CO., 37 Park Row, New York.

☞ To Advertisers.—The regular circulation of the SCIENTIFIC AMERICAN is now **Fifty Thousand Copies** weekly. For 1880 the publishers anticipate a still larger circulation.

The Scientific American Supplement

Is a distinct paper from the SCIENTIFIC AMERICAN. THE SUPPLEMENT is issued weekly. Every number contains 16 octavo pages, uniform in size with SCIENTIFIC AMERICAN. Terms of subscription for SUPPLEMENT, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all news dealers throughout the country.

Combined Rates.—The SCIENTIFIC AMERICAN and SUPPLEMENT will be sent for one year, postage free, on receipt of *seven dollars*. Both papers to one address or different addresses, as desired.

The safest way to remit is by draft, postal order, or registered letter Address MUNN & CO., 37 Park Row, N. Y.

Scientific American Export Edition.

The SCIENTIFIC AMERICAN Export Edition is a large and splendid periodical, issued once a month. Each number contains about one hundred large quarto pages, profusely illustrated, embracing: (1.) Most of the plates and pages of the four preceding weekly issues of the SCIENTIFIC AMERICAN, with its splendid engravings and valuable information; (2.) Commercial, trade, and manufacturing announcements of leading houses. Terms for Export Edition, $5.00 a year, sent prepaid to any part of the world. Single copies 50 cents. ☞ Manufacturers and others who desire to secure foreign trade may have large, and handsomely displayed announcements published in this edition at a very moderate cost.

The SCIENTIFIC AMERICAN Export Edition has a large guaranteed circulation in all commercial places throughout the world. Address MUNN & CO., 37 Park Row, New York.

NEW YORK, SATURDAY, JULY 24, 1880.

Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF
THE SCIENTIFIC AMERICAN SUPPLEMENT
No. 238,
For the Week ending July 24, 1880.

Price 10 cents. For sale by all newsdealers.

MATTER AS A MODE OF MOTION.

It is a curious circumstance that while from the non-scientific point of view the unpardonable fault of modern science is its "materialistic tendency," the actual drift of scientific thought is toward eliminating from the scientific idea of matter everything which answers to the popular notion of it. Already science has permanently transferred to the domain of motion all those possibilities of sensation, such as light, heat, electricity, and so on, formerly defined as imponderable matter; and latterly the indications have been very clear that ponderable matter may sooner or later share the same fate.

This comes out strongly in the discussion awakened by Professor Crookes' discoveries touching the behavior of molecules in high vacua. As our readers are well aware, Professor Crookes claims to have demonstrated an ultra-gaseous or fourth state of matter, as unlike the other three recognized states of matter as they are unlike each other. In answer to a friendly challenge to make good his position, Professor Crookes has reviewed (in a letter to the Secretary of the Royal Society, to be found in full in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT) the accepted views as to the constitution of solids, liquids, and gases, and has added thereto a concise explanation of the ultra-gaseous state and his reasons for holding it worthy of a class by itself.

Stated with the utmost brevity, a solid is an aggregation of molecules held together by cohesion and oscillating about fixed centers. The movements of the molecules are large in comparison with their diameters, since the mass "must be able to bear a reduction of temperature of nearly 300° C. before the amplitude of the molecular excursion would vanish." What would result from the arrest of molecular movement and the actual contact of the molecules is beyond our conception, all we know of matter being based wholly upon our experience of molecular movements.

When the temperature of a solid is raised and the force of cohesion so far overcome that the molecules lose their fixity of position, the second or liquid state of matter obtains. A further raising of the temperature brings the liquid at last to a point at which cohesion ceases, the molecules fly apart freely, and the third or gaseous state begins. Under the restraining force of gravitation or the resistance of an inclosing vessel, the molecules of a gas fly about in every conceivable direction, with constant collisions with each other and with the vessel's sides. The gaseous state is thus pre-eminently one dependent on molecular collisions, the mean free path of the molecules, in other words, their flight between collisions, being small compared with the dimensions of the inclosing vessel.

The fourth state of matter, according to Professor Crookes, obtains when the gas has been so rarefied that the collisions of the molecules are few compared with the misses, the free path of the molecules being so long, on an average, that each molecule is allowed to obey its own motions or laws, without interference from collisions with other molecules or with the sides of the inclosing vessel. The same condition prevails when the molecules of a denser gas are so marshaled in their flight that their motion is rectilinear and no collisions occur. Between the third and fourth states there is no sharp line of demarkation, any more than there is between the solid and liquid states, or the liquid and gaseous states; they merge insensibly one into the other.

Thus starting from a possible, though in our present state undemonstrable, condition of matter, in which the molecules are motionless and in contact—a condition, we must remember, in which "matter" would in no way answer to the definition of matter as discovered by our senses—we pass on through stages of increasing molecular freedom and amplitude of motion, until we arrive at a stage of comparative molecular independence and rectilinear flight, limited in our experiments by the necessary walls of our vacuum apparatus. If we try to follow in imagination the free molecule in its flight into unlimited space, it loses all known properties of matter and becomes as if it were not. For what is a single free molecule in space? Is it solid, liquid, or gas?

Professor Crookes answers: "Solid it cannot be, because the idea of solidity involves certain properties which are absent in the isolated molecule. In fact, an isolated molecule is an inconceivable entity, whether we try, like Newton, to visualize it as a little hard spherical body, or, with Boscovitch or Faraday, to regard it as a center of force, or accept Sir William Thomson's vortex atom. But if the individual molecule is not solid, *a fortiori* it cannot be regarded as a liquid or a gas, for these states are even more due to intermolecular collisions than is the solid state. The individual molecules, therefore, must be classed in a distinct state or category."

Further on Professor Crookes takes up again the consideration of the molecule, and describes it as the only true *matter*. "What we call matter is nothing more than the effect upon our senses of the movements of molecule. The space covered by the motion of molecules [from which we derive our idea of continuous matter] has no more right to be called matter than the air traversed by a rifle bullet can be called lead. From this point of view, then, matter is but a mode of motion; at the absolute zero of temperature the intermolecular movement would stop, and, although something retaining the properties of inertia and weight would remain, *matter* as we know it would cease to exist."

Thus, whether we pursue our quest of the ultimate basis of matter atomward or massward, we lose matter as a reality the moment we eliminate molecular interaction; and molecular movement forms no part of the popular idea of matter.

◆

EXPLOSIVES.

Were the question suddenly proposed to any intelligent person, "What is an explosive?" the chances that he would give a correct answer are indeed small. Our first and usual idea is that an explosive is something which will blow up, making a big noise and doing more or less damage. Generally it is some solid or liquid capable of burning with great rapidity and thus generating a large quantity of gas. Gunpowder is a familiar example; the niter furnishes oxygen to burn the sulphur and charcoal, most of the products being gaseous. Bunsen, who made some careful quantitative experiments upon the combustion of gunpowder, found that 1 gramme of sporting powder produced 193 c.c. of gas, while Linck obtained 218 c.c. of gas from 1 gramme of war powder, and as one gramme of powder will occupy less than 1 c.c. of space, the increase of volume is very considerable. But this is not all, for the temperature at the time of explosion is calculated to be about 3,000° C., and gases double their volume whenever the temperature is raised 273°.

Explosions are in but few cases due to the rapid combustion of solids or liquids, but more frequently they consist in the rapid combination of two gases, or of a vapor and a gas. When pure hydrogen and oxygen are mixed in proportion of two volumes of the former to one of the latter, a spark causes them to unite with explosive violence, although the resulting product, at 100° C., occupies but two-thirds as much space of the mixed gases, and at ordinary temperatures it occupies but $\frac{1}{3500}$ as much space. The rapidity with which a flame travels in such a mixture is not less than 100 feet per second. The temperature produced is very high, and at this temperature, of course, the gases occupy a very large space.

Rapid combustion of solids in a fine state of division may exhibit the usual phenomenon of an explosion, as has several times occurred in flouring mills, or wherever dust mixed with air has been ignited by a spark. The explosion of gasolene and benzine is of the same nature. The vapor is the substance in an extremely fine state of division and mixed with the air; as in the case of oxygen and hydrogen a union of the two takes place instantaneously throughout the mixture.

Explosives are not always combustible substances, and their explosion is not the result either directly or indirectly of their rapid combustion. A good example of this class of explosives is found in chloride of nitrogen. Neither of its constituents will unite directly with oxygen, but they are wedded to each other so slightly that each seems equally eager for divorce on the slightest provocation. It is the dissociation of this substance, which suddenly passes from the liquid to the gaseous form, that renders it a dangerous explosive. Many other nitrogen compounds behave in a similar manner; such, for example, as the iodide nitrogen, formed when iodine is washed with ammonia.

Then follow the nitro compounds, or nitrous ethers, familiar among which are nitro-cellulose, nitro-glucose, nitro-starch, and nitro-glycerine. These substances, which are so readily formed by treating cotton, glucose, starch, or glycerine with strong nitric acid, contain an atom of nitrogen united with two of oxygen. This nitro group is a mischievous partner, and is pretty sure to break up any stock company that he gets into as a member. He is not satisfied to walk out peacefully, but like Goliath pulls the whole fabric down about his ears. Although nitro-glycerine requires a high temperature to explode it, a very slight shock or jar will set up decomposition. Nitro-cellulose, or gun-cotton, on the other hand, burns quietly but rapidly. The former produces a powerful effect when exploded without confinement, as on the surface of a body; gun-cotton can be exploded on the open hand without inconvenience.

Another nitro compound of some interest as an explosive is picric acid, a trinitro-phenol, formed by treating carbolic acid with strong nitric acid. The nitro groups here, as in nitro-benzol, seem to possess an entirely different position, the result not being, as in nitro-cellulose, a nitrous ether. The potassium and some other salts of this acid possess explosive properties.

Finally we have a class of bodies known as *fulminates*. They have the same percentage composition as the harmless cyanates and cyanurates, with which they are said to be polymeric. They consist of a metal combined with carbon, oxygen, and nitrogen in the proportion of their atomic weights. Fulminating mercury was discovered by Howard in 1800. It is made by dissolving 1 part of mercury in 12 of nitric acid (sp. gr. 1·3), and when cold it is mixed with 11 parts of 85 per cent alcohol, and the mixture heated on a water bath. It must be removed from the fire as soon as it begins to show turbidity, then left to cool, decanted, and recrystallized from boiling water. It crystallizes in white silky needles. It detonates with great violence when forcibly struck, hence it is used in percussion caps, torpedoes, and the like. Ten grains of this substance produces 4 cubic inches of permanent gases, but at the high temperature of explosion occupy far more space. The explosion is so sudden as to be particularly dangerous when in large masses. Mixed with 30 per cent water it can be triturated on a marble slab with a wooden pestle, but when dry must be kept in small separate portions. One kilogramme (2·2 lb.) of mercury will make enough fulminate to fill 57,600 gun caps, but their preparation is not unattended with danger. Fulminating silver is made by the action of nitric acid and alcohol on nitrate of silver.

A substitute for fulminating mercury is employed in the needle guns in Germany. It consists of a mixture of equal parts of chlorate of potassium and sulphide of antimony. As both of these substances are largely employed in medicine it is highly desirable they should not be combined in the same prescription. A mixture of sulphur and chlorate of potassium will also explode by friction or percussion. When a solution of sulphur in carbon disulphide is poured upon finely divided chlorate the mixture will often explode spontaneously when the solvent has evaporated, if not, the touch of a feather is sufficient to produce a violent detonation. Chlorate of potassium and red phosphorus form a safe and powerful mixture for ignition by percussion, known as Armstrong's mixture.

In addition to the above explosives there are many compounds known only in chemical laboratories, which, either from their danger, uncertainty, or danger of preparation have not been made public.

From the above we see that an explosive may be a solid, liquid, or gas, and its explosion may result either from its dissociation or combustion.

They may be divided according to their effects into slow and rapid, although these terms are only relative. Gunpowder burns so slowly as to be well adapted as propulsive for projectiles, while nitro-glycerine decomposes so rapidly as to be useful only for bursting and rending, and should have well reserved for it the name of "rend rock." Guncotton has been used especially in the compressed form, for artillery, and picrate powder was used in France as substitute for gunpowder.

CURIOUS CAPILLARY PHENOMENA.

When a drop of water falls on a surface which does not absorb it, it is well known that it assumes a special form—that of a plano-convex lens. If above such a drop of water there be suspended, by means of a thread having no twist in it, a fine needle, the point of the latter, being repelled by the edges or attracted by the center of the convexity, at length remains stationary at the latter spot. There is, then, on the surface of this convex drop a point where the forces of tension are in equilibrium. But the above mode of experimenting is too imperfect to allow a serious study of the phenomenon, since the tension of the convex surface has to overcome the weight of the needle in order to swerve it from the vertical. M. Coutance, says the *Revue Industrielle*, has suggested an ingenious method of surmounting the difficulty by making the needle stationary and rendering the drop movable. A small piece of glazed note-paper is floated on water, and on the surface of this is placed a large and very convex drop of water. The paper, thus freighted, moves about under the slightest influence. Pushed gently toward the fixed point, it begins to move as soon as the latter touches the edge of the drop, and the two elements always arrange themselves in such a way that the needle point occupies the center of the convexity; thus proving the existence of a center of equilibrium for the tensile forces of the liquid surface. By means of this ingenious method of experimenting, we are enabled to determine points of equilibrium in drops of liquid having most varied outlines, but of a convex surface. For instance, a curved liquid surface, having the outline of an isosceles triangle, will, when presented by its apex, so displace itself that the needle, on traversing it, stops exactly at the center of gravity.

One of the most curious means of showing the equilibrium of tensile forces in these variously shaped liquids with curved surfaces is this: Draw a helicoidal figure on glazed paper with a moistened pencil. This will represent the circumvolutions of the snail's shell. Now carefully fill in the figure with water so that its surface shall have a broadly convex form. Then push the attenuated apex of the figure toward the fixed needle. As soon as contact takes place, leave the whole to itself. Then, all at once, the paper will be seen to gyrate, and the needle will traverse the whole spiral and stop just before reaching the broad base of the latter.

Here, then, we have the forces of tension of liquid surfaces shown by a physical phenomenon. The use of glazed paper in these experiments is attended with some inconvenience, because it absorbs water. It is better, therefore, to use cork or wax. In all these movable convex surfaces, the point of the fixed needle always locates itself at the exact center of the figure. Suppose, for instance, a convex figure having the outlines of France be made on the surface of the paper or wax; when it is placed in contact with the needle point, the latter will fix itself in the center of the country, *i. e.*, at a spot which would correspond to a point a little to the east of Bourges. To determine the center of a country by means of capillarity might, at first sight, seem an impossibility; but, as will be seen, the question is capable of being scientifically resolved. As to the practical applications of phenomena like these, it would be as yet difficult to cite them: but it is certainly remarkable to see revealed to our eyes, by means of these experiments, those forces whose operation our intelligence alone is powerless to understand, and whose laws can now be studied, analyzed, and translated into algebraic language.

◆

A QUICK TRIP FROM GALVESTON.—The quickest recorded passage from Galveston, Texas, to this port, was completed July 6, by the steamship Rio Grande. Her actual running time from Galveston bar to Upper Quarantine, New York harbor, was 5 days 19 hours 28 minutes; distance, as shown by the ship's log, 1,935 nautical miles

PANAMA HATS.

Now that the summer season is on us, it may not be uninteresting to the reader to learn something about the origin and manufacture of Panama hats. This is given by Dr Seeman, in an interesting article on the vegetation of the Isthmus of Panama, in the *Journal of Botany*. An indigenous production, he says, deserving of especial notice, is the "Jipijapa" (*Carludovica palmata*, R. and P.), a palm-like plant, of whose unexpanded leaves the far-famed "Panama hats" are plaited. This species of *Carludovica* is distinguished from all others by being terrestrial, never climbing, and bearing fan-shaped leaves. The leaves are from six to fourteen feet high, and their lamina about four feet across. The spathe appears toward the end of the dry season, in February and March. In the Isthmus the plant is called "Portorico," and also "Jipijapa," but the latter appellation is the more common, and is diffused all along the coast as far as Peru and Chili; while in Ecuador a whole district derives its name from it. The plant is common in Panama and Darien, especially in half shady places, but its geographical range is by no means confined to them. It is found all along the western shores of New Granada and Ecuador; and has been found even at Salango, where, however, it seems to reach its most southern limit, thus extending over twelve degrees of latitude from north to south. The Jipijapa, or Panama hats, are principally manufactured in Veraquas and Western Panama. Not all, however, known in commerce by that name are plaited in the Isthmus; by far a greater proportion being made in Manta, Monte Christi, and other parts of Ecuador. The hats are worn almost in the whole American continent and the West Indies, and would probably be equally used in Europe did not their high price (varying from $2 to $150) prevent their importation. They are distinguished from all others by consisting only of a single piece, and by their lightness and flexibility. They may be rolled up and put into the pocket without injury. In the rainy season they are apt to get black, but by washing with soap and water, besmearing them with lime juice, or any other acid, and exposing them to the sun, their whiteness is easily restored. So little is known about these hats, that it may not be out of place to give an account of their manufacture. The "straw" (paja), previous to plaiting, has to undergo several processes. The leaves are gathered before they unfold, all their ribs and coarser veins removed, and the rest, without being separated from the base of the leaf, is reduced to shreds. After having been exposed to the sun for a day, and tied into a knot, the straw is immersed in boiling water until it becomes white. It is then hung up in a shady place, and subsequently bleached for two or three days. The straw is now ready for use, and in this state sent to different places, especially to Peru, where the Indians manufacture from it those beautiful cigar cases, which sometimes bring as high as $30 each. The plaiting of the hats is very troublesome. It commences at the crown and finishes at the brim. The hats are made on a block, which is placed upon the knees, and requires to be constantly pressed with the breast. According to their quality, more or less time is occupied in their completion—the coarser ones may be finished in two or three days, while the finest may take as many months. The best times for plaiting are the morning hours and the rainy season, when the air is moist. In the middle of the day and in dry clear weather, the straw is apt to break, and this, when the hat is finished, is betrayed by knots, and much diminishes the value.

THE PROTECTION OF WOODWORK.

It not unfrequently happens, when a frame structure is hastily erected, and in our country they are always hastily erected, especially bridges, that a good oil paint is properly applied, and yet in a comparatively short time it begins to peel off more or less completely, making it necessary to repaint them. What is still more unfortunate, some timber, which has had a good coat of oil or tar paint that did not peel off, begins to decay in a short time, so that the original intention of the paint is not fulfilled, but, on the contrary, the paint itself seems to hasten its destruction.

These and similar circumstances lead people to distrust paint as a wood protector, and from different quarters we hear the assertion that unpainted wood will last longer than it would if painted.

This view, says Engineer Sauerwein, requires modification. In judging this matter we must ask how long was it from the time the wood was felled until it was painted, and was it dry or not, for these unfortunate cases have only occurred in wood which were painted too soon.

It is well known that the sap of wood contains substances like albumen, gelatine, gum, etc., which easily undergo decomposition, and under certain circumstances, such as favor fermentation, and in warm damp air, are able to destroy very rapidly the stronger woody fibers. The more sap there is in the wood, that is to say the greener it is, and the sooner the evaporation of this sap is stopped by an airtight cover, the quicker the fermentation will set in, and with it the destruction of the woody fiber.

These circumstances are correctly understood by practical men, who prescribe that the timber be felled in winter, and try to obtain a free circulation of air through the structure.

They think they avoid the disadvantages above mentioned if they, further, demand "seasoned wood," because it is clear that there is less danger of decomposition in such wood than in fresh or green stuff. But here we at once stumble on this difficulty, namely, of determining what degree of dryness in the wood to be tested seems most advantageous for its use, and the time required for this is much longer than generally supposed. The appearance of the wood is very seldom a reliable guide, and people are accustomed to think that the wood is much drier than it really is. The comparatively important changes which the wood undergoes during the first year from shrinkage enable us to measure approximately the time necessary to destroy the last evil effects of its interior life. Not until it has reached this stage, which requires four to six years, unless artificial seasoning is resorted to, is the timber benefited by covering it with a protecting coat of paint. At this time the paint must have a beneficial effect in protecting the wood, for it prevents atmospheric moisture penetrating into the wood to serve as a reagent to decompose the albumen, which is now dried and coagulated as well as less abundant.

Owing to the position of the lumber yards and the urgency for materials to build with it is seldom possible to obtain well seasoned lumber and wood. Sauerwein, therefore, proposes the following process:

The most rational and sensible process for large, heavy timbers is the impregnation, as for railroad ties, with chloride of zinc under six to eight atmospheres of pressure, where this can be done. (Fresh green wood is best for this.) No arguments are necessary in defense of the value of this method; it cannot be too strongly recommended, nor is the expense great—about $1 per cubic meter. When there is no opportunity for impregnation the woodwork should be left two or four years unpainted.

In my experience, says Sauerwein, wood tar is better than coal tar, because it penetrates into the wood more easily, and, containing a larger amount of antiseptic substances, its effect is more permanent. Although wood tar is considerably dearer it is to be preferred. Its color being somewhat similar to wood color it can be used on small unimportant buildings. Its cost is only one-fourth that of oil paint and can be applied by a common workman.

Planed and worked surfaces should be merely oiled (three times) not painted. Besides having a better appearance, this oil varnish is necessary to prevent cracking and drawing of thin parts like doors and windows. It does not interfere with the gradual drying out of the wood.

After the expiration of three to five years the oiling may be replaced by a protecting coat of paint to prevent water from penetrating into the wood work. It should be added that it seems advantageous to mix about one part of elutriated chalk with three parts of the white lead which is used with the special color for all oil paints. This seems to make the paint adhere better to the wood, as shown by experience.

Without going into the subject of oil paints the author cautions the public against the many new fangled and highly extolled paints and substitutes. They are generally much dearer, he says, and at best are only equal to ordinary linseed oil paint made with equal care from well selected pure material. The chief effect of a good oil paint depends on the purity of the materials used, especially of the oil and white lead or zinc white, whether it is finely ground and thoroughly mixed, and the paint carefully applied in good weather.

THE BARTHOLDI STATUE OF LIBERTY.

The completion of the subscription for the statue of Liberty on Bedloe's Island, New York harbor, was celebrated by a grand banquet in Paris, July 7. M. Laboulaye presided. Among the principal guests were M. Ferdinand de Lesseps; M. Lepère, late Minister of the Interior; General Pittie, Chef de la Maison Militaire of President Grevy; Oscar de Lafayette; Henri Martin, the historian; Victorien Sardou; General Noyes; Consul General Walker; and M. Bartholdi, the sculptor of the statue.

An address to the people of the United States—signed by the French participants at the banquet, and indorsed by 181 towns, represented by votes of municipal councilors, forty conseils-generaux, ten chambers of commerce of the most important towns, and 100,000 subscribers—announces that the statue will be finished in 1883, and erected on a monumental pedestal on Bedloe's Island. The preparation of a suitable foundation devolves, we believe, upon the American public. It is to be hoped that there will be no delay in completing the work. The placing and inauguration of the statue may form an appropriate feature of our World's Fair celebration in 1883.

49th Exhibition of the American Institute.

The annual exhibition of the American Institute, of the city of New York, will open September 15. The Board of Managers announce a novel and very promising feature, namely, an exhibition of the work of amateurs and apprentices in all branches of mechanical, industrial, and decorative art. Such exhibits will be admitted free of charge, and premiums are offered for the best. To pass upon exhibits of this character the Institute proposes to add to the corps of judges ladies who are proficient in art work, in which department are embraced sculpture, painting, drawing, bric-a-brac, fancy work, embroidery, decorated china, wood carving, sawing, and all other artistic handwork calculated to adorn American homes.

◆

NEW CANAL IN CHILI.—The *Chilian Times* announces the completion of the Canal de la Merced. The canal is seventy-five miles long, and has been twenty-five years in construction. It is considered one of the most important works executed in Chili. It has cost about $400,000.