THE STRUCTURE OF MATTER.

Read before the New York Academy of Sciences by Prof. C. F. Kroeh, of the Stevens Institute of Technology.

[*Continued from page* 25.]

LEIBNITZ.

Leibnitz (1646–1716), one of the inventors of the calculus, maintained that extension is not a fundamental, but a derived idea. It can be explained by the assumption of some thing of which it is the property, of some thing that is itself simple, without parts, and consequently without extension, shape, or divisibility. He imagined the universe to be made of such simple, ultimate things, and gave them the name of monads. Although a monad has no parts, it may nevertheless be the exponent of numerous perceptible relations, just as a point in space may be viewed as the vertex of numerous angles. Great numbers of these monads are continually acting upon our senses with infinite rapidity, and producing in our minds confused images of the external world. We perceive what we call the properties of matter only because we are incapable of analyzing the impressions made upon us by these immaterial monads.

A monad can be produced by creation only, and can be destroyed by annihilation only. This follows from the assumption that it has no parts. Nothing can be added to it nor taken from it. Being a created thing, it must be subject to continual change, and the cause of this change must lie within it. In consequence of this changeability there must exist an infinite variety of monads. They appear to us to occupy space, because they have certain positions with regard to one another, certain geometric relations, and because many of them act upon our senses at once. Motion is the sum of infinitely small impulses exerted by them; yet they in no wise act upon one another, but each monad moves independently by virtue of the force that is in it, and enters into various relations with other monads in obedience to a predestined harmony which is the law of its being.

To account for the phenomena of life Liebnitz goes so far as to endow his monads with greater or less degrees of consciousness, of perception and volition; but in these speculations we need not follow him.

KANT.

Kant (1724–1804), the originator of the nebular hypothesis, fixed upon mobility in space as the essential property of matter. Our senses can be affected by motion alone. Extension is explained in this system by supposing that a body fills space by reason of the resistance it offers to all motion tending to displace it. This resistance is itself motion in a direction contrary to that of the invading body. It may be called a repulsive force, and must be inherent in all its parts. If every particle of matter is endowed with repulsive force, we have an explanation of expansion, elasticity, and impenetrability. Infinite divisibility also follows from this conception, because the mobility of every particle makes it separable from every other particle. The divisibility of matter must, therefore, be commensurate with the mathematical divisibility of space.

To account for the occupation of definite space by a body we must also endow its particles with an attractive force, which counteracts repulsion and prevents the particles from flying off into space.

It will be perceived that we are now entering a region of thought more familiar to the modern chemist and physicist.

BOSCOVITCH.

The idea that the particles of matter are endowed with both attraction and repulsion constitutes the basis of the atomic theory of Boscovitch (1759), which has formed the working theory of scientific men until quite recently.

When bodies are said to touch each other they are by no means in mathematical contact, but separated by an insuperable repulsive force, so that a distance of $\frac{1}{5000}$ to $\frac{1}{2000}$ of an inch intervenes. Within this interval, according to Boscovitch, there are several alternations of attraction and repulsion. In other words, if two atoms, separated by $\frac{1}{5000}$ of an inch, are brought a little nearer together they will attract each other; if still nearer, they will repel, and so on, with this limitation, that no force however great can bring them into mathematical contact. At distances greater than $\frac{1}{2000}$ of an inch atoms attract each other according to the law of gravitation. It is evident that at smaller distances there will be intermediate positions of stable and unstable equilibrium, and that atoms moved from these positions in any direction will oscillate to and fro by virtue of their inertia, until they either return to their old position or arrive at a new one, where there is again a balance of attractions. It is thus that the phenomena of cohesion and elasticity are explained.

Boscovitch interprets the three states of matter as follows: In a gas, the repulsive force prevails between the particles, so that it would expand indefinitely if no external force interfered. In a liquid, the particles are maintained at a definite distance by mutual attraction and repulsion; and each particle is free to rotate in any plane. In a solid, the distances between the particles are also determined by both forces; but the particles are polarized or obliged to rotate in certain definite planes. If any particle is swung out of its natural plane, it will return to it again after performing a certain number of oscillations.

In this and all the other atomic systems the fundamental assumptions are:

That matter does not continuously fill space.

That its particles are separated by distances which are great in comparison to the size of the particles.

That they act upon each other at a distance, and not by contact.

That the particles are extremely hard, and both indivisible and unalterable by any means, physical or chemical.

That the particles are impenetrable and possess inertia.

That the chemical and physical properties and behavior of bodies depend upon the collocation and motions of its atoms; and consequently,

That our senses deceive us when they convey to our minds the impression that bodies are continuous, and when they appear to reveal to us any other changes than changes of place.

Those who endeavor to make the atomic system account for the *existence* of the physical universe, and reject creation, are obliged to make certain additional assumptions, which will be examined elsewhere.

FARADAY.

Faraday, in his speculations touching electric conduction and the nature of matter (*Phil Mag*,, 1844), reasons as follows: Of the two constituents of matter involved in the atomic hypothesis (atoms and spaces), space is the only continuous one. Consider, then, he says, the case of shellac, a non-conductor, space in it must be an insulator, whatever the atoms may be; for if it were a conductor, the shellac could not insulate. But now take the case of platinum, which must also be composed of atoms and spaces. Since platinum is a conductor, space, being its only continuous constituent, must be a conductor. Space, which is every where uniform, is therefore both a conductor and a non-conductor. "Any ground of reasoning which tends to such conclusions as this must be false." He then adds, Why should we assume the existence of matter independent of force at all? and he modified the system of Boscovitch by substituting the term "center of force" for atom. According to this view matter, in the ordinary acceptation of the term, disappears entirely, to make room for the emanations of force which fill the universe, and the atom is replaced by points at which lines of force converge.

THE LATEST VIEWS.

Since by the labors of Joule, Clausius, Krönig, Maxwell, and others, the science of thermodynamics has been created, the hypothesis of atoms and molecules has been greatly developed by the mathematical study of their motions, so that we are no longer obliged to define them after the vague manner of former theories; but we possess tolerably definite information relative to their size, weight, distances apart, velocity, and energy. I shall have to content myself this evening with giving a single example of this new knowledge, postponing the evidence. Thus we know with tolerable certainty of the hydrogen molecule:

1. That its weight is $\frac{46}{10^{25}}$ gramme.

2. That its volume is subject to great variation in its compounds. In its elemental state its volume is taken as the unit of comparison, and corresponds to a diameter of $\frac{5{\cdot}8}{10^{10}}$ meter (5·8 tenth-meters).

3. The distance between two neighboring molecules of hydrogen is $\frac{965}{10^{10}}$ meter (965 tenth-meters).

4. The velocity of vibration 0° C., 1,859 meters per second.

5. The number of collisions between hydrogen molecules per second is 17,750 millions.

6. Nobert can draw 4,000 lines in the breadth of a millimeter. The interval between two such lines can be seen with a good microscope. I have calculated that a cube with an edge of $\frac{1}{4000}$ mm. would contain about 17 million molecules of hydrogen.

The theory that matter is continuous has been revived to a certain extent. In studying elastic bodies Prof. Stokes has availed himself of the idea that the smallest portions into which we can divide them are sensibly homogeneous. The theory of fluxions and modern mathematics then become applicable, provided we do not carry the divisibility too far. The smallest particles considered must be sensibly similar. Sir Wm. Thomson illustrates this by the statement that contiguous cubes of water $\frac{1}{1000}$ cm. in breadth are sensibly similar, but cubes of $\frac{1}{1000000000}$ cm. must be very sensibly different. Take two lengths of masonry, he says, each of 20,000 cm.; one may contain 1,000 bricks, and the other 999 bricks and two half bricks. They would then be sensibly similar. If, however, you take two lengths of 40 cm., one might contain 2 whole bricks and the other 1 whole and 2 halves. They would be sensibly dissimilar.

In Boscovitch's theory there is no contact of atoms, and all action is therefore action at a distance. Of this it is impossible, at least for me, to form a clear and philosophical conception. Clerk-Maxwell in his electrodynamics drops this assumption entirely, together with that of *hard* atoms. He imagines the ether filling space to contain a system of cells with elastic walls and cylindrical cavities, in which elastic balls can rotate and be flattened out by centrifugal force. In the cells there must be other balls of invariable volume as friction rollers. These would rotate freely; but their centers of gravity, in insulating media, would merely be displaced by elastic yielding of the cell wall; in conducting media every displacement would be attended with resistance similar to friction in a viscous liquid. Motion is transferred in these balls by surface adhesion only. Their displacement produces dielectric polarization in the medium, and their onward motion an electric current. The rotation of the elastic balls corresponds to the magnetizing of the medium, the axis of rotation being the direction of the magnetic force. While Helmholtz designates such a conception as too artificial, he admits that Maxwell has developed from it a complete and mathematically very elegant theory of all electrical phenomena. An entirely novel and suggestive view of the construction of matter was originated by Sir William Thomson.

Vortex Atoms.—Helmholtz had shown that if any portion of a perfectly homogeneous fluid, incompressible, continuous (not made up of molecules), and devoid of internal friction, is caused to rotate, it will form a vortex ring of invariable volume. The matter partaking of this rotation is thereby differentiated from all the rest, and will remain so for ever. Nothing short of a creative art can start or stop such rotation. If two such rings are linked together, they can never be separated, and if a single one is knotted on itself, it can never be untied.

The formation and properties of such rings may be studied experimentally, bearing in mind that we have only imperfect fluids to deal with. Prof. Wm. B. Rogers, in the *American Journal of Science*, 1858, p. 246, described various methods of producing them. Prof. J. Trowbridge, in the *Philosophical Magazine*, 1877, says: "All liquid drops falling from such a height that the surface of the liquid in which they are about to diffuse themselves is not too much disturbed to enable the drop to be acted on symmetrically by the forces at the free surface, will form rings, if too great differences of density do not exist." To render them visible the drop may be colored. "That a drop of pure water will descend through the same liquid in a vortex ring can be shown experimentally by covering the free surface of the water with a fine light powder." (I would suggest lycopodium.) "Particles of the powder will be carried down by the drop and will be seen to rotate in a ring shape far below the surface."

Prof. Tait rendered visible the formation of vortex rings in air by means of a cloud of finely divided sal ammoniac. He used a common wooden box of a capacity of about two cubic feet. In one end there was a circular hole about six to eight inches in diameter, while the other end had a towel stretched over it. By sprinkling ammonia over the bottom and then generating in it hydrochloric acid from common salt and sulphuric acid, he obtained a copious evolution of sal ammoniac vapor, which rendered the rings visible. They were produced by sudden blows upon the stretched towel. Two such rings impinging upon each other behave like rings of solid India-rubber. As such a ring approaches one's face its inner particles are seen to rotate forward, and its outer ones backward, while the air in the center moves forward faster than the ring itself and strikes the face first.

These rings suggested to Sir Wm. Thomson the idea that the universe is continuously filled with a perfect fluid, and that whatever produces upon us the impression of matter is portions of this fluid in vortex rotation. In other words his atoms are vortices, and it proposed to explain all the properties of matter by the laws governing vortex motion.

While the atoms with which we have dealt heretofore are in reality patch-work, altered and amplified to suit each new discovery in chemistry and physics, the vortex atom is not capable of such adjustment. As Maxwell puts it: "His primitive fluid has no other properties than inertia, invariable density, and perfect mobility, and the method by which the motion of this fluid is to be traced is pure mathematical analysis. The difficulties of this method are enormous, but the glory of surmounting them would be unique."

Rankine, in a paper on "Molecular Vortices," before the Royal Society of Edinburgh, 1849–50, illustrated knotted vortex atoms by means of diagrams and wire models. "Their endless variety," says Sir Wm. Thomson, "is infinitely more than sufficient to explain the varieties and allotropies of known simple bodies and their mutual affinities."

Helmholtz, Tait, Maxwell, Rankine, Stokes, and other celebrated men have all contributed to this theory.

CONCLUSION.

Having now passed in review the leading theories of the structure of matter up to the present day, I shall conclude my paper by a brief statement of the manner in which it is my purpose to continue my studies.

I shall, in the next place, examine the idea of an atom and the question whether the material universe can logically be constructed according to the requirements of the atomic system. Then will be presented the evidence metaphysical and experimental of the existence of molecules. This will include the beautiful experiments of Crookes. Another chapter will be devoted to the facts ascertained about molecules, such as their weight, relative and absolute; size, relative and absolute, shape, velocity of motion, length of path, number of collisions per second, etc. I may mention in this connection that I have no less than seven different lines of argument based on experimental data, all of which concur in assigning to molecules a diameter not far from the $\frac{1}{5000000}$ of an inch.

Finally, I shall endeavor to show how such a knowledge of atoms enables us to explain the behavior of gases under pressure; the spectra of gases, liquids, and solids; heat resulting from chemical action, quantivalence, and other phenomena.

A LARGE HORSE.—One of the largest horses ever seen in this city arrived from Ohio June 22. His registered height is 20 hands and 1 inch, or 81 inches; his weight is said to be 2,450 lb The animal was bred from native draught stock, is of a dark bay color, well proportioned, and in excellent health. It is said that a horse measuring 21 hands 2 inches was shown in this city many years ago; and more recently one which measured 19 hands 1 inch.

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Wages and Earnings in Pennsylvania.

Mr. Miles Humphreys, chief of the Pennsylvania Bureau of Industrial Statistics, has issued a report embodying the information gathered by him last year by circulars addressed to employers in various parts of the State. Mr. Humphreys is careful to mention the fact that in many cases the returns received show only the weekly wages paid, and that, in tabulating them on a basis of fifty-two weeks, the aggregate earnings must be considerably over-estimated. When the necessary deductions are made for lost time the total must be materially reduced. Many circulars were issued to ascertain earnings from the wages worker's standpoint, but not a sufficient number of intelligible replies were received to furnish the information desired. The failure is attributed to the fact that workingmen as a rule do not keep accurate yearly accounts of earnings and expenditures.

The summary of employers' reports is given in the following table,

SHOWING THE AVERAGE WEEKLY WAGES OF EMPLOYES, THE AVERAGE WEEKS EMPLOYED DURING THE YEAR, WITH THE TOTAL EARNINGS FOR THE YEAR 1879:

Occupation.	Average. Weekly wages.	Average. Weeks Worked.	Average. Earnings for the Year.
Miners, coal (anthracite)	$9.28	43	$399.04
Miners, coal (bituminous)	8.51	40	340.40
Blast furnace employes	9.04	48	433.92
Puddlers (iron)	15.14	38	575.37
Heaters (iron)	17.98	40	719.50
Rollers (iron)	23.52	37	870.24
Roll turners (iron)	40.97	44	1,802.68
Roughers (iron)	17.94	44	789.36
Catchers (iron)	9.50	45	427.50
Refiners (iron)	16.97	46	780.62
Forgemen (iron)	15.56	39	606.84
Hammermen (iron)	17.50	40	700.00
Roll hands (iron not specified)	22 66	47	1,065.02
Helpers (iron)	11.00	34	374.00
Shearer, sheet (iron)	18.90	43	812.70
Straightener (iron)	10.00	52	520.00
Hammer driver	12.00	43	516.00
Steel melters	30.48	39	1,188.72
Steel converter	16.50	22	363.00
Steel helper	15.00	33½	502.50
Nailers	19.27	36	693.72
Tack maker	32.70	26	850.20
Nail cutter	12.00	25	300.00
Spike maker	9.00	48	432.00
Nail packer	8.40	52	436.80
Rivet maker	20.00	36	720.00
Wire drawer	15.00	52	780.00
Pipe threader	9.00	50	450.00
Moulders (iron)	11.26	43	484.18
Blacksmiths	10.33	48	495.84
Bricklayer	12.87	43	553.41
Carpenters	10.61	48	509.28
Cabinet makers	7.80	46	358.80
Carriage makers	8.62	48	413.76
Engineers	15.10	48	724.80
Glass workers	18.39	45	827.55
Machinists	10.84	47	509.48
Painters	9.86	42	414 12
Plasterers	7.71	44	339.24
Printers	8.66	50	433.00
Sawyers	15.78	35	552.30
Shoemakers	8.08	45	363.60
Stonecutters	9.33	41	382.53
Stonemasons	9.02	33	297.66
Tailors	8.00	46	368.00
Hatters	6.00	52	312.00
Tanners	7.53	50	376.50
Tinsmiths	11.12	51	567.12
Gasfitters	10.50	36	378.00
Track foremen (railroad)	10.00	53	530.00
Brakemen (railroad)	11.94	49	585.06
Flagmen (railroad)	7.30	51	372.30
Firemen	7.74	50	387.00
Teamsters	8.50	46	391.00
Slater	6.00	39	234.00
Quarrymen	6.25	46	287.50
Laborers	7.08	42	297.36
Butcher	10.00	36	360.00
Calker	9.00	31	279.00
Coopers	6.75	45	303.75
Brass finisher	6 24	48	299.52
Iron ore miner	9.00	48	432.00
Lead furnace helper	7.00	41	287.00
Carpet weavers	6.50	51	331.50
Loom fixer	11.71	52	608.92
Beamer	10.00	50	500.00
Dyer	10.00	52	520.00

The Projected Florida Ship Canal.

The survey of the route of the proposed ship canal across the peninsula of Florida has been completed under the direction of General Q. A. Gillmore, who reports in favor of the work. The principal direct benefits expected are the saving of about five hundred miles in the passage from our Atlantic ports to Gulf ports, and the avoidance of the dangerous passage through the Florida Straits.

The eastern terminus of the canal is fixed at Camp Pinckney, at the head of ship navigation, and twenty-nine miles above the town of St. Mary's. From here it will run southwesterly to and through the Okefinokee Swamp, crossing the Suwanee River, near Blount's Ferry, in Columbia County, and thence to Ellaville, in Madison County. At first it was contemplated making St. Mark's the western terminus of the canal, but General Gillmore failed to approve this selection, owing to the increased distance involved. The St. Mary's River is ascended by means of seven lift locks, each of fifteen feet lift to the summit level, one hundred and eight feet above tide. No guard lock is required, as the lift of the first lock exceeds any rise or flood in the river. The summit level enters the Okefinokee Swamp, through which it extends twenty-two miles, eleven and a half miles above Camp Pinckney. Fourteen miles beyond the Suwanee River is reached, near Blount's Ferry, the waters of which will be raised by means of a dam to the height of the summit level and taken into the canal. Crossing the river in the lake so formed the canal continues eighteen miles beyond to the end of the summit level, which has a length of sixty two miles. From this point the line descends by two locks, each of ten feet lift, crosses the Alapaha, and, turning again to the south, crosses the Withlacoochee River, near Ellaville, and thence runs through the center of San Pedro Bay, descending from it by five locks of fifteen feet and one of ten feet lift directly to the level of the Gulf.

A channel will have to be dug from the mouth of the canal to the deep water of the Gulf, seven or eight miles from the shore. The protecting jetties will form a harbor of safety for shipping.

The length of the canal route is about one hundred and sixty-nine statute miles, or one hundred and forty-seven nautical miles, divided as follows:

From the bar to mouth of St. Mary's River	5·5
Navigation of St. Mary's River to Camp Pinckney	34·0
Canal	122·0
To deep water in Gulf	7·5
Total	169·0

The plan contemplates a cross section of canal eighty feet wide at the bottom and twenty-five feet deep. The water surface will be one hundred and eight feet in width. The canal is widened, however, to one hundred and fifty-five feet at the bottom and two hundred and fifty-five at the top for one thousand feet above and below each pair of locks to permit the approach of vessels, and there are passing places one thousand six hundred feet by thirty feet every six miles.

The locks are five hundred feet in useful length (from the end of the gate chamber to face of breast wall), sixty-five feet wide at the gates, with twenty-five feet of water on the sills. They are arranged in pairs, side by side, to prevent the interruption of traffic during repairs, and the walls are carried to five feet above the water line. The lifts are ten and fifteen feet. The locks have about the same dimensions as those advised for the Panama route, except in the matter of lift.

The estimated cost of the canal is $50,000,000. The drainage area available for the summit level is one thousand two hundred square miles, with an average annual rainfall exceeding four and a half feet.

The Nicaragua Canal Concession.

The interoceanic canal concession granted by Nicaragua to the American Provisional Society has been ratified by the Nicaragua Senate and published as a law by the Republic. It secures to the society the exclusive privilege of constructing a ship canal across the territory of Nicaragua.

The canal is to be of sufficient dimensions to accommodate steamers of the largest class used between Europe and America, and the locks are to be not less than 500 feet long and 28 feet deep. The concession is for 99 years from the date of the opening of the canal for general traffic, and at the expiration of that period the Nicaraguan Government is to take possession of the canal in perpetuity, with the right reserved to the company to lease it for another 99 years. During the period of the concession the company is to have the privilege of constructing a railway along the whole or any part of the canal; also, such telegraph lines as it deems necessary for the construction and working of the canal, and these lines shall transmit public messages free of charge. The Government of Nicaragua will declare the terminal ports, and the canal itself throughout its length to be neutral, and that the transit in case of war between other powers and Nicaragua shall be uninterrupted. In general, the canal shall be open to free navigation of all vessels, provided they pay the dues and observe the regulations of the company. Troops of foreign nations and vessels of war will be allowed to pass through the canal under regulations of existing treaties. Vessels of war belonging to other nations engaged in hostilities with Nicaragua or any other republic of Central America will be rigorously excluded.

This concession, with all its advantages and privileges, will appertain to a construction company, and is transferable only to the company which is to be organized by the Provisional Society, and in no case can it be transferred to a foreign government or power. It is to be organized in the usual manner of such enterprises, with its principal office in New York or elsewhere, as it may deem most convenient. Its designation will be "The Nicaraguan Ship-canal Company."

The Increasing Use of Steel Castings.

The rapid substitution of steel castings for expensive forgings, and for iron castings where great strength is required, has compelled the doubling of the capacity of the works of the Chester Steel Castings Company during the past year; and now the company announce a still further extension of their establishment. Their chief success, as well as the heaviest part of their business, is in the production of heavy gear wheels, pinions, roll spindles, couplings, coupling boxes, etc., for rolling mills and sugar mills. In heavy plate mills their steel castings outlast many times the iron castings formerly used. It is claimed also that nearly all the locomotive builders and makers of large steam engines are now using the Chester castings, and that the fifteen thousand crank shafts and several thousand cross-heads on locomotives of their make show a better record for durability and smoothness of wear than any equal number of forged pieces for the same uses.

The Manufacture of Coal Tar Dyes.

The extent to which the manufacture of coal tar colors is now carried is shown by the following statistics of labor and production at one of the principal coal tar color works in Germany. There are employed over 1,000 workmen, in addition to 40 overlookers and branch managers, 25 chemists, 1 engineer, and 30 clerks and accountants. The yearly consumption of coal amounts to 17,000,000 kilos; anthracen, 825,000 kilos; naphtha and benzol, 950,000; chromate of potash, 289,000; caustic soda, 1,245,000; sulphuric acid, 2,250,000; muriatic acid, 4,050,000; nitric acid, 825,000; alcohol, 91,500; and sundry chemicals, 3,560,000.

Photographic Prizes.

The following is the list of prizes which the Photographic Society of Vienna offer for competition in the course of the present sessional year:

VOIGHTLANDER MEDALS.

(Open to members of the society only.)

1. A gold medal, value 140 ducats, for a method of increasing the sensitiveness of wet plates.

2. A gold medal, value 140 ducats, for the most reliable and sensitive dry process.

3. A gold medal, value 50 ducats, for researches into the gelatine emulsion process.

4. Medals in gold, value from 40 to 100 ducats, in silver, and in bronze, for scientific treatises, discoveries, and improvements, which have been published in the official journal of the society—the *Photographische Correspondenz.*

5. Medals in silver and bronze for the achievement of valuable results in the practice of photography.

SOCIETY MEDALS.

(Open to members or non-members.)

1. A gold medal, value 140 ducats, for the production of plates in relief for printing copies of drawings in half tint.

2. A gold medal, value 140 ducats, for monograph on pyroxyline and collodion.

3. A gold medal, value 140 ducats, for an improvement of the collotype process which will render unnecessary the constant wetting of the plate between the pulls.

4. A gold medal, value 50 ducats, for a rigorous investigation of the conditions of sensitiveness of asphalt.

Further particulars of the competition are contained in a detached programme, which, together with the prospectus and rules of the society, will be forwarded post paid on application to Dr. E. Hornig, 9, Hauptstrasse, Vienna III., to whom also should be addressed applications for admission to membership.

Curious Experiment in Magnetism.

M. Obalski describes a pretty magnetic curiosity to the Académie des Sciences. Two magnetic needles are hung vertically by fine thread, their unlike poles being opposite one another. Below them is a vessel containing water, its surface not quite touching the needles. They are hung so far apart as not to move toward one another. The level of the water is now quietly raised by letting a further quantity flow in from below. As soon as the water covers the lower ends of the needles they begin to approach one another, and when they are nearly immersed they rush together. The effect appears to be due to the fact that when the gravitation force downwards is partly counteracted by the upward hydrostatic force due to immersion, the magnetic force, being relatively greater, is able to assert itself.

Progress in Utilization of Solar Heat.

Since May, last year, M. Mouchot has been carrying on experiments near Algiers with his solar receivers. The smaller mirrors (0·80 m. diameter) have been used successfully for various operations in glass, not requiring more than 400° to 500°. Among these are the fusion and calcination of alum, preparation of benzoic acid, purification of linseed oil, concentration of sirups, sublimation of sulphur, distillation of sulphuric acid, and carbonization of wood in closed vessels. The large solar receiver (with mirror of 3·80 m.) has been improved by addition of a sufficient vapor chamber and of an interior arrangement which keeps the liquid to be vaporized constantly in contact with the whole surface of heating.

This apparatus on November 18, last year, raised 35 liters of cold water to the boiling point in 80 minutes, and an hour and a half later showed a pressure of 8 atmospheres. On December 24 M. Mouchot with it distilled directly 25 liters of wine in 85 minutes, producing four liters of brandy. Steam distillation was also successfully done. But perhaps the most interesting results are those relating to mechanical utilization of solar heat. Since March the receiver has been working a horizontal engine (without expansion or condensation) at the rate of 120 revolutions a minute, under a constant pressure of 3·5 atmospheres. The disposable work has been utilized in driving a pump which yields 6 liters a minute at 3·50 m., or 1,200 liters an hour at 1 m., and in throwing a water jet 12 m. This result, which M. Mouchot says could be easily improved, is obtained in a constant manner from 8 A.M to 4 P.M., neither strong winds nor passing clouds sensibly affecting it.

Rise of Butter and Cheese at Sea.

When the schooner Eddie Pierce, from Boston, bound to Baracoa, Cuba, was southeast of Nantucket, about 300 miles from Sandy Hook, June 18, a firkin of butter was seen to rise in the water. Others followed until three hundred and twenty-seven had come to the surface. Boxes of cheese also came up, to the number of twenty-four, and were secured, when the schooner turned back to Boston, where her owners filed a libel for salvage. The marks on the packages were illegible. There are two theories regarding the origin of the butter and cheese thus found "derelict" at sea. One is that some unknown freight vessel had been lost at that spot, and that the packages were released by its breaking up. The other theory is that the butter and cheese were lost from the compartments of the Anchoria after her collision with the Queen, near that place, June 12, and that the refrigerators in which the packages were stored had only begun to break up when the Eddie Pierce arrived upon the scene.

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