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Contents:

(Illustrated articles are marked with an asterisk.)

ELEVATION OF THE ELASTIC LIMIT BY STRESS.

The SCIENTIFIC AMERICAN first published, on page 336, volume XXIX, the novel and unexpected discovery by Professor Thurston of the "Elevation of the Elastic Limit by Stress," as the discoverer has since called it, which was communicated to the American Society of Civil Engineers, in a note published in the transactions of the Society for November, 1873.

The *Journal of the Franklin Institute*, in the last month's issue, contains an interesting statement of the results of experiments made subsequently by Commander Beardslee, United States Navy, at the Washington navy yard, independently and by a different form of apparatus, which led to the re-discovery of the same important fact. The editor of the *Journal* presents the paper as furnishing "most conclusive confirmation of the discovery of Professor Thurston."

In these experiments of Commander Beardslee, the iron was generally of poor quality, the tests were made by tensile strain, and the results were recorded from observation instead of by automatic registry, all of which circumstances differ from those of the earlier researches, and the confirmation which is given of the phenomenon referred to is thus rendered the more conclusive. Samples were taken in pairs and subjected to a strain which exceeded the elastic limit. One was removed from the machine and laid aside; the companion specimen was left under the load in the testing machine. In the former case, four tests gave an average increase, in sixteen hours, of 10·00 per cent. The latter method, with six specimens, gave an average of 11·30 per cent, or, leaving out one exceptional result, 12·20 per cent. These specimens were of ½ square inch section. With smaller pieces of ¼ square inch section, the same treatment gave, by the two methods, 8·20 and 13·40 per cent, respectively.

The (at first sight) very singular fact, that an increase of resistance should be developed when the specimen is taken out of the machine after giving a set, is, we presume, readily explained by the fact that the set, produced by the refusal of some of the particles to return to their original positions, holds other groups of particles separated, and, as explained by the discoverer, allows a flow to take place, relieving internal strain, and permitting nearly all portions of the piece to act together in resisting external force. The set thus holds the piece under strain somewhat as does the machine.

The subject loses neither interest nor importance by investigation, and we shall hope to learn more of its practical bearings. We have already given much of our space to the discussion of these new facts relating to the strength of materials, and shall from time to time endeavor to present our readers with the latest results of research in this field. There is no subject which is of more direct importance to every mechanic and engineer than that of the strength of the materials upon which he is compelled to rely in all his constructions.

There are many facts still unknown to the public, or to the engineering profession even, and of which no knowledge can be gained by reference to books. For example, one of these is the resistance of iron to compression at different temperatures.

Many of our readers can undoubtedly furnish facts of interest and importance; and we hope that those who find themselves in possession of such facts, which have evidently escaped the observation of acknowledged authorities, will assist their brother workmen by sending them to us for publication.

THE GEOLOGICAL SURVEY OF JAPAN.

We have received from our countryman, Mr. B. S. Lyman, who was appointed, by the government of Japan, Director of the Survey, a preliminary report containing some of the results of the first season's work in Yesso.

It is a pamphlet of 46 pages, excellent in typography and appearance, published and printed in English by the *Kaitakushi* at Tokei. The work, according to the instructions of the Hon. K. Kuroda, Jikuwan of the Kaitakushi, was confined to the four southwesternmost provinces, Oshima, Shiribets, Iburi, and Ishcari, about one third of the island. A number of fossils were collected at several places, but they were too few to justify the employment, at least for the present, of a foreign palæontologist. Besides Mr. H. S. Munroe, an American, Professor Lyman was assisted by eleven natives. They are not only the first Japanese but the first Asiatics to undertake the study and practice of geology; and although the training of native geologists in India has been begun nearly at the same time, Professor Lyman trusts that the Japanese will continue to take the lead, and that Japan will become in a few years independent of foreign countries in this direction.

In determining the importance of the points to be more carefully surveyed, regard was had chiefly to their mining value, and many places were visited where valuable minerals had been supposed to exist, but where they proved to be deficient either in quantity or quality.

Along the principal and many of the smaller rivers are rich alluvial plains, which would be admirable farming sites, were it not for the lack of roads at the present time. The soil indeed seems to be very good, even on the uplands, and supports a rich growth of wild plants. The chief exception is in the neighborhood of Tarumai volcano, which so recently as the first of March, 1867, was in active eruption; and where for many miles around, even the low plains by the seashore have been so covered with pumice as very much to lessen their fertility. Yet even here a rich black soil, in some places six feet thick, exists at the depth of only about a foot below the surface of the ground. The volcanoes that still have active sulphur vapors seems to be mostly along the shores of Volcano Bay and the adjoining coast. Besides these, there are many more that seem to have long been quite extinct. The highest, most symmetrical, and beautiful of them all, is Shiribets Mountain, perhaps 6,000 feet high above the sea, and almost a regular cone. The useful minerals of chief importance in the field gone over are: Coal, iron sand, sulphur, limestone, gold, and rock tar and mineral springs; and traces of silver, lead, zinc, manganese, and copper.

The Kayanoma coal field covers about half a square mile, and has six workable coal beds from three to eight feet in thickness. The coal is what is strictly called brown coal, probably of tertiary age, though closely resembling bituminous coal in its appearance and in many of its qualities. Of iron, the whole amount of pure ore in the principal workable deposits is perhaps 125,500 tuns, containing 91,000 tuns of iron. Only 5,500 tuns of the ore (containing 4,000 tuns of iron) are of the easily smelted kind. The sulphur occurs mostly within the craters of now inactive volcanoes. Hot sulphur fumes rise through small crevices and deposit yellow sulphur on the cold surface of the ground, forming a crust more or less impure, with a mixture of partially decomposed rocks. The shape of such deposits is extremely irregular and often inaccessible in many parts; so that the precise extent can hardly be measured except very roughly. The whole quantity of sulphur to be got from the places thus far visited is possibly five hundred tuns. The gold occurs in the form of small grains and scales in alluvial gravel. No gold-bearing quartz has been discovered. The amount of gold in all the fields surveyed would seem to be less than two millions and a half of dollars, and in none of them to be abundant enough to give much encouragement to working. The oil is all black, and so very thick as to deserve better the name of tar; moreover it has not as yet been found in noteworthy amount. Mineral springs are abundant; and of the twenty-one which were examined, thirteen were sulphur springs with temperature from coldness up to boiling; six iron springs, from 27° to 91°; one cold spring, with copperas; and two nearly pure springs, 30° and 50° hot.

Though scanty, these details are sufficient to interest us in the future development of Japan, and it cannot be long before representatives of our commerce will follow where those who have represented our Science have already led the way.

A. B. L.

THE INCREASED USES OF THE MEMBERS.

We doubt if the human body has ever in any instance attained the acme of its possible development; and by this we mean that while certain sets of muscles or organs have, in individual cases, become subjected to the will so as to perform feats impossible save through education, we do not believe that the being ever lived who could control every member so as to cause it to operate to the extent of its capabilities. Whether in future ages such a condition will mark a higher stage in the development of the race: whether, as the human mind expands, or, as the saying is, the "world grows wiser," it is reserved for physical culture to keep pace with such mental growth: is a subject for speculation, which, in view of the doctrines of evolution and the constant approach of organic species toward more perfect individualism, is by no means devoid of present interest.

We have discussed at some length the question of the use of the left hand, and we have pointed out that, by a mistaken notion, children are taught to discard the use of the member, and hence to lose half the powers which Nature intended they should have when she formed the body as it is. We have also suggested that, so far from restraining the infant from using its left hand, its tendency to employ both members indiscriminately should be encouraged. Now, we propose to advance a step further, and to ask why should not a child be taught to utilize both hands at once, and at different occupations. The idea may seem somewhat chimerical at first, but it is not without the bounds of possibility. The reader has doubtless seen jugglers who, in performing their dexterous tricks, become so expert that, without any apparent difficulty, they can keep half a dozen knives or balls constantly in the air or in each hand. The falling and rising of these objects are not uniform, and hence to all intents the performer accomplishes a totally different result with each member. In similar manner great pianists—Rubinstein is a very striking example in point—use either hand upon the keys with equal dexterity and both together, in playing music of tremendous difficulty which requires a power of perception and a control of the muscles of each individual finger which is simply wonderful. Again, an organist, in performing upon a grand instrument, has several things to think of at once: both hands on the keyboard, both feet on the pedals, with stops on either side, couplers and the separate devices for *crescendo* and other accidental effects are to be looked after. Here are four members of the body acting different parts at the same time.

We could multiply instances of this kind with little trouble, all going to show that, even when advanced in life, it is possible to educate a certain set or even sets of muscles to perform hitherto unnatural work. Cases there are where men, on being disabled in the arms, have had recourse to their toes, and used those members for writing and even handling tools. We have visited the studio of quite a celebrated French artist whose exquisite paintings were entirely produced with brushes handled in the above manner. But while an individual member, or even the body, may be educated to perform feats apparently impossible, it requires a higher order of training to compel the members to perform different operations at once—a training, we think, only to be fully imparted in beginning at the earliest years, but still fully possible. With our dual brains, the right lobe is now the most developed, and with it the dexter side of the body. Let means be taken to develop the left side equally, and the body is symmetrical in its powers. Each side, governed by both brains, will be capable of work for which now, when controlled by, say, three quarters of the brain power, it is inadequate.

We need not point out the advantages to a person who can thus use both hands in connection with the brain. We have known an artist who could draw two different pictures at once; and in a former article, we alluded to a very eminent professor of natural history who, while watching a specimen through the microscope, sketches with one hand while writing with the other. Now, if a person advanced in life can become so educated, how much easier it would be to impress the same on the plastic mind of a child! Once taught, the person could write upon two different subjects at once, could make two copies at the same time, could write up two sets of books, could make stenographic notes and write them out in long hand simultaneously, and perform in brief a variety of operations productive of lucrative results. Moreover, he would do each understandingly, and not semi-automatically with one hand. Nine tenths of ordinary pianists who have to "learn a piece" play the treble with their brains and the bass with their muscles. The left hand learns certain fixed skips and jumps by practice, and performs them automatically at certain times, while the right hand carries the expression as well as the air of the composition, and is much more directly under the control of the performer.

We began by speaking of a possible future of the race. Is it then improbable that at some time man may have every faculty educated to its utmost, and thus become raised to a creature mentally and physically infinitely the superior of such as we now are, as much beyond us as we are beyond the monkey? Traits developed in the parent may be transmitted to the child and there intensified, and thus an approach to human perfection ultimately attained. But meanwhile, who is to begin? To whom among the scores of thousands who will peruse these lines—who may perchance give them a second thought—will it occur that the idea may be carried into practice with the very yellow-haired youngster, perhaps at this moment clambering upon his knee?

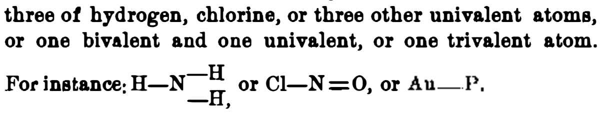
THE NEW THEORY OF QUANTIVALENCE.

The theory of quantivalence, by which the modern chemistry differs so radically from the science laid down in the old text books, thus far used and still taught in most of our scientific institutions, is based on close comparisons concerning the nature of divers chemical combinations; and these have taught that each elementary atom possesses a certain definite number of bonds, by which alone it can combine with other atoms.

There are two material conceptions by which we may assist our imagination to realize this abstract idea: One is to imagine the bonds as hooks attached to the atoms, by which the combinations are held together, so that, for instance, the hydrogen has one hook, oxygen two, nitrogen three, carbon four, phosphorus five, manganese six, etc. A combination of two or more atoms is called a molecule; and in the molecule of a compound, every atomic hook is attached to another hook, either of another atom or of itself. The other material conception realizing this idea is that of regarding these atomic bonds as poles of a magnet, with the difference that, unlike a magnet, which has only two poles, the different elementary atoms possess one, two, three, four, or more attracting poles, by which they have the capacity of uniting other atoms to themselves, so forming the compound molecule, having totally different properties from the component atoms: so different, indeed, that every chemical compound is to all intents and purposes a body totally different from the elements of which it is made up.

Chemists have agreed to distinguish the elementary substances (by their capacities for combining with one, two, three, four, five, six, or more atoms of other elements) as univalent, bivalent, trivalent, quadrivalent, quinquivalent, sexivalent, etc., or otherwise as monads, diads, triads, tetrads, pentads, hexads, etc., and to accept a modification of the existing chemical symbols by representing the bonds, hooks, or poles, by as many dashes. After this idea, the univalent elementary atoms are written with one dash, in front, over, or under the symbol, thus: H—, Cl—, F—, K—, Na—, Ag—, meaning that hydrogen, chlorine, fluorine, potassium, sodium and silver, are univalent; in other words that, when each is combined with a single atom of another element, its chemical affinities will be satisfied. The bivalent atoms are written thus: —O—, —S—, —Ca—, —Mg—, —Hg—, —Zn—; or O=, S=, Ca=, Mg=, Hg=, Zn=, meaning that oxygen, sulphur, calcium, magnesium, mercury, and zinc are bivalent, and thus will combine with two univalent atoms, or one bivalent atom. So oxygen will combine with two hydrogen atoms to form water. This is expressed in the ordinary way by H_2O, but after the new method by H—O—H, indicating how the oxygen atom has two bonds, while each hydrogen atom is only attached by one bond. On the other hand, one atom of oxygen will combine with one of zinc, thus: Zn=O, both being bivalent, having two bonds, and in the same manner one atom of hydrogen will combine with only one of chlorine, thus: H—Cl, both being univalent.

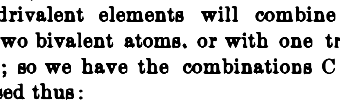
Among the principal trivalent atoms, we will mention nitrogen, phosphorus, arsenic, antimony, boron, and gold, and their symbols may be written:



In each of these elements, every atom will combine with three of hydrogen, chlorine, or three other univalent atoms, or one bivalent and one univalent, or one trivalent atom.

For instance: $H—N\begin{smallmatrix}—H\\—H\end{smallmatrix}$, or Cl—N=O, or Au≡P.

Finally we will mention a few quadrivalent substances: Carbon, silicon, tin, platinum, of which the atoms are represented thus: =C=, =Si=, =Sn=, =Pt=, or,



and the quadrivalent elements will combine with four univalent or two bivalent atoms, or with one trivalent and one univalent; so we have the combinations CH_4, CO_2 and Sn Si, expressed thus:

$$\begin{smallmatrix}H—\\H—\end{smallmatrix}C\begin{smallmatrix}—H\\—H\end{smallmatrix}, \quad O=C=O, \text{ and } Sn\equiv Si.$$

It is especially in the organic compounds, in which carbon plays the most essential part (in fact so much that this element has been called the great organizer), that the law of quantivalence finds the most extensive application. It ought to be stated here that this quantivalence of the atoms is not totally invariable; but it is remarkable that, if variations take place, they are according to a law which allows a quadrivalent atom to become bivalent or sexivalent, so that a quantivalence expressed by an even number will always be even, and one expressed by an odd number will always be odd. Atoms of the first class are called artiads, of the the second (with odd numbers), perissads; and this classification appears to rest on a fundamental law.

This is a short explanation of the fact that a definite quantivalence of the atoms of each elementary substance is one of its most important inherent properties; and it is therefore the most distinctive feature in which the new school differs from the old. It is the chief cause of the recent revolution in chemical science. The old fashioned authors and teachers did not question how the elementary substances were united in a compound; but now it is considered of the utmost importance to investigate and determine the exact manner in which the atoms are united in order to build a molecular structure. It has long since been suspected that the quality of a chemical compound depends as much on the manner of structure of its molecules from the atoms as in the nature of the atoms themselves; and now it has been proved that a compound may be totally changed by simply changing the relative position of the atoms in regard to the nucleus of the molecule, which itself may change without any alteration in the number or quality of the individual atoms.

It ought to be considered that the above is not merely the expression of an hypothesis, but is the result of actual experiment. Not a shade of doubt clings to it, notwithstanding that the actual view of the atoms constituting a molecule is far beyond the range of the most powerful microscope. Nevertheless, although it has been proved that the molecule of nitro-glycerin, consisting of 20 atoms, $C_3 H_5 N_3 O_9$, cannot be larger than the twenty-five millionth part of an inch, we are now almost as positive about the internal structure, position, and arrangement of its atoms as we are of the structure, position, and arrangement of the bodies in our planetary system.

The theory that heat is a mere mode of motion, residing in the molecules or atoms of bodies, may be considered to be as firmly established as any in the field of Science; and the theories that rise and descent of temperature are nothing but increase and decrease of this molecular motion, and that the absolute zero point of temperature, that of 460° below the zero of Fahrenheit, corresponds with absolute molecular rest, are necessary consequences of this theory. Every substance must be composed of moving molecules, of which the atoms themselves are in constant motion; every complex molecule therefore resembles a planetary system, not only in the arrangement of its different members, but even in the motion of its atoms, which is rotary as well as progressive. It is, indeed, a grand idea that the same force which, on the infinitesimally small scale is called chemical affinity, and holds the different constituent atoms of matter in well balanced and unalterable groups, so securing the stability of compounds, prevails also throughout the immense distances of the heavenly bodies, wherein we call it gravitation, which secures the stability of the systems of worlds which make up constellations and galaxies.

FARMERS' HEALTH.

The State Board of Health of Massachusetts are doing admirable work. Their fourth annual report, published last year, was a model volume of its kind, and copious reproductions from its pages found place in our columns. Its successor, now before us, is every whit as valuable. It is not a dry mass of undigested statistics, nor a bundle of official platitudes which nobody understands and no one takes the trouble to read; but a series of papers, plain, practical, and full of common sense on sanitary questions which are of the nearest importance to every one. We commend the work as exemplifying what a report addressed to the people should be; and it seems to us that an immense amount of good would be done if the general government, among the tuns of documents supplied to our representatives for distribution to their constituents, would provide similar volumes on similar subjects, and compiled in a similar manner.

Some papers in the book before us, we have already embodied in articles on these topics. At the present time we desire to direct attention to the very important subject of the sanitary condition of farmers, who, though popularly considered the healthiest people in the world, have, it appears, yet something to learn tending toward their improvement and to the prevention of dangers incidental to their calling.

The basis of the views presented is the opinions of the country doctors all over Massachusetts, and no better foundation could be obtained. A paper based upon their combined experience cannot be otherwise than instructive. The farmers in the above State constitute one eighth of the industrial population, a less proportion than in the Western States, as in Illinois the farmers with the farm laborers make up one half of all persons having occupations; so that no further argument is necessary to prove that their sanitary welfare is that of a very large proportion of the entire population of the country.

The first question considered is that of longevity. A table collated over twenty-eight years shows the average age of farmers at death to be 65·13 years, figures far in advance of all other callings, and greatly exceeding the lifetime of active mechanics (not in shops), who, averaging 52·62 years, appear next on the list. The opinions of the physicians consulted also go to show that the farmer's chances of long life are somewhat greater than those of any other class. As regards general health, there appear to be divided views, the large majority of doctors, however, holding that farmers and their families enjoy better health than most people, while a respectable minority advocate the reverse. This leads to a more direct examination of the causes which tend to impair the health and shorten the lives of the agricultural classes. First of these is overwork, that is, not the nature but the amount of labor performed, combined with exposure to the weather. Labor carried too far exhausts and enfeebles the frame. During a short season, however, when the year's operations are crowded into a space of five months, and when wages are high, overwork on the part of the farmer is too common. In spring he works at the plow from morning until night, to hurry through the planting; in summer, prodigies of mowing and pitching of hay are done, which too frequently tend to cause serious rupture or other physical injury. In winter, there is a continual series of hard work in hauling wood and doing similar exhausting labor, causing sudden changes of temperature in the body. The result of the whole is that rheumatism becomes by far the most prevalent disease. Again, farmers' wives work even harder than their husbands, and, it is said, are the most likely to be overburdened. The remedy for such excess of labor on the part of farmers and their families is a better comprehension of sanitary laws. It should be understood that it is not true economy to lay up money when the process of accumulating it makes the farmer's wife an invalid, and necessitates the expenditure of a much larger sum for sickness. More labor-saving machinery should be introduced. For small farms, where the more expensive machinery is not available, cheaper substitutes would doubtless be invented, were inventive genius turned that way through the liberality of agricultural societies.

It is a somewhat singular fact that farmers live so little upon their own productions. They send their fresh vegetables, fruits, eggs, and poultry to the market, and live themselves upon salt pork, pies, and saleratus bread. The result is dyspepsia and a train of kindred diseases. It is important that good cooking should be cultivated. It is actually easier to cook well than badly, provided the work is not done in a hurry. In the bad cookery, the overwork is again traceable, and it is the very pressure of labor which causes the preparation of the food to be done in any way so long as the materials are rendered eatable. A pork diet is not healthy. The meat is slow of digestion; it contains an excess of fat; it may, if improperly cooked, produce trichiniasis and tapeworm, and it increases the liability to consumption and scrofula. Farmers should live on plenty of fresh meat, use less tea, avoid frying as a means of preparation, eschew pies and cake in excess, and provide for their own tables an abundance of vegetables and fruits, with wholesome, well kneaded, yeast bread.

As a rule, it is said, farm houses are very badly located, worse so than city residences. Farmers should comprehend the necessity of choosing a dry and airy locality, and the dangers resulting from living on damp soil or in a low, shut-in situation. Where the house is placed low, house drains are sluggish and imperfect, and fogs are frequent; when shut in by higher ground, the air is stagnant, and the effluvia from the house and outbuildings are not blown away. Too many trees conduce to dampness and shut out the sunlight.

Uncleanliness of surroundings is a prolific cause of disease. Typhoid fever and summer bowel diseases abound in the vicinity of putrescent animal matters, which poison both air and waters. Faulty drains and neglected privies are the most dangerous, while foul cellars and barnyards are also deleterious. No farmhouse should be without a commodious covered cesspool several rods from the house, on lower ground, if possible, and connected with the kitchen sink by a well constructed covered drain. In default of a brick cesspool, an inverted hogshead will do, if the soil be porous, but a barrel never; it is too small to be of any use. The drain should then be kept free, so that the cesspool can be so used that not a drop of dishwater, slops, or any kitchen refuse whatever shall find its way out upon the surface of the ground from the back door or window. Everything should go into the cesspool, except what the pigs can consume, and the back of the house should rival the front in cleanliness and tidiness. Privies should be thoroughly disinfected by the combined use of earth and copperas. The latter can be bought for from two to five cents a pound, and it should be kept constantly on hand. The place should be perfectly inodorous, otherwise the disinfection is not accomplished. In winter the earth closet should be used indoors, and the waste will be found a most valuable addition to the compost heap.

Bad drinking water is another cause of sickness. As a rule, a well receives drainage from a superficial area, whose diameter is from one to three times the depth of the well, varying with the character of the soil. To keep the latter area in a thoroughly purified condition is a good and safe rule to follow. A well, for example, twenty feet deep should have no privy, pig pen, barnyard, drain, nor should slops or garbage be thrown upon the surface, within thirty feet of it in any direction.

MR. SALEM H. WALES, after a connection with this paper of more than twenty years, withdrew some three years ago, and was appointed by the mayor one of the Commissioners of Public Parks in this city. Mr. Wales was subsequently chosen President of the Board by his colleagues, which office he held to the satisfaction of the public until a few days ago. In a pithy letter to the mayor, resigning his office, Mr. Wales animadverts very pointedly to the acts of our city comptroller, for interfering with the Park Commission in the appointment of its employees. On Wednesday evening, the 26th ult., a score and more of Mr. Wales' friends gave him a complimentary dinner at the Union League Club; and on the following Saturday he sailed, with a member of his family, for Europe, for a few months' rest and recreation on the continent. His friends everywhere will join us in wishing him a pleasant voyage, improved health, and a safe return.

ISOLATING MATERIAL FOR STEAM PIPES.—The committee for the trial and inspection of boilers of the State of Saxe-Anhalt, Germany, recommend the following composition for the above purpose: 132 pounds limestone, 335 pounds coal, 275 pounds clay, and 330 pounds sifted coal ashes. This is finely pulverized and mixed with 660 pounds of water, 11 pounds sulphuric acid at 50° B., and 160 pounds of calves' hair or hog bristles. The compound is applied to the pipes in coats of 0·4 inch thickness, repeated until a thickness of an inch and a half is obtained, when a light covering of oil is given.

THE spring or summer season opened with unusually hot weather in Europe, but soon afterwards severe cold seems to have set in. The sudden change is accounted for by M. De Fonvielle, a French savant, by the fact that the earth is passing behind a ring of asteroids, which absorb a portion of the sun's warmth, due to us while it remains above the horizon. The temperature will not resume its ascensional movement until the annual rotation shall have carried our sphere from the shadow of the multitude of small planets which is always projected on the same point of our orb.

M. PASTEUR, the distinguished French chemist, has recently been awarded the sum of $2,400 by the National Assembly of France in recognition of his eminent services and discoveries.

THE man who has thoroughly mastered a scientific principle holds a key which opens many locks.—*Tyndall.*