excavated material from the Limon channel being pumped onto the site of the dam, where the water will run off, leaving the solids compacted into a firm, impermeable mass. Moreover, before this pumping process commences, the surface of the valley over the area to be covered by the dam will be entirely cleared of its vegetation and top soil, until, at a depth of eight to twelve feet, the clean sand and silt is everywhere laid bare.

All things considered, while we fully appreciate the conservatism which led the majority of the consulting board to reject the Gatun dam proposal, we think that the success of the San Leandro dam, the Wachusett reservoir dyke, and of a dam of pure sand which has proved successful at Jeypore, India, coupled with the elaborate experiments made by the Commission to establish the impermeability of the material upon which the Gatun dam is to be built, to say nothing of the willingness of some of our foremost hydraulic engineers to stake their own reputation and the interests of the people of the United States upon the venture, fully justify the Canal Commission and the President in their acceptance of a high-level lock canal.

MIKKELSEN'S ARCTIC EXPEDITION.

In the Arctic Ocean there lies a group of islands which is known to geographers as the Parry Archipelago. The most extreme western lands of this group are the two large islands called Banks Land and Prince Patrick Island. Lying to the west of this archipelago, discovered over half a century ago by one of the Franklin search parties, lies the great unexplored Arctic Ocean, undoubtedly the largest unknown area in the frigid zone.

For the purpose of exploring Beaufort Sea, the most southern part of this ice-covered ocean, and for the purpose of mapping islands which are supposed to exist there, Capt. Ejnar Mikkelsen has left with an expedition fitted out by the Royal Geographical Society of England and the American Geographic Society.

There is reason for believing that Capt. Mikkelsen's expedition will be crowned, if not with complete success, at least with sufficient success to repay the time, trouble, and money which have been expended in his behalf. Although he may fail completely in exploring the entire region, he should at least succeed in plotting the formation of the continental shelf, in other words, that part of the sea floor extending from the edge of the continent at depths of from 600 to 1,000 feet before the bottom suddenly drops.

That such a shelf does exist most geographers are certain. They base their belief on the experiences of previous expeditions. Shallow waters caused the "Jeannette" to drift for two years in a course which took her far west and but little north. The "Fram" was also carried west but far to the north, simply because she floated over the ocean in regions where there were no lands to set up currents that prevented her from drifting in that direction.

Unknown lands probably arise from the continental shelf, and impede the free movement of the currents. Hence the drifting of the "Jeannette" and other vessels. If Capt. Mikkelsen succeeds in definitely fixing the outlines of this shelf and its position, his expedition will be considered eminently successful.

In the hope of discovering the lands which project from the shelf, Capt. Mikkelsen will make long sledge journeys westward from Banks Land over Beaufort Sea, skirting well within the continental shelf. Actual exploration, however, will not begin until the spring of 1908.

THE MOTH AND THE FLAME.

Why does a moth fly toward a flame? Because it is inquisitive, was the rather puerile answer given by the great Romanes. Because of some inexplicable inherited instinct, was the reason advanced by other naturalists. Because it is the nature of the insect, was a third and equally unsatisfactory reply. One reason was as good as another, but that of Romanes undoubtedly carried off the popular palm. Perhaps we owe it to him that the moth and the flame have pointed many a moral and adorned many a sad tale of curiosity tragically satisfied.

The investigations of Prof. Jacques Loeb bid fair to relieve the moth of the moral burden that has rested on his wings. Prof. Loeb has proved very conclusively that a moth, in common with many insects, flies toward a flame for the same reason that some plants turn their leaves toward the light. "Heliotropism" is the awesome name in which this tendency of plants and animals rejoices.

It happens that there are two kinds of heliotropism. If your moth or bug flies toward the light, it is positively heliotropic; if, like the earthworm, it shrinks from the glare, it is negatively heliotropic. Plants, too, may be classified into these divisions. Just as some flowers open only by day and others only by night, so some moths fly only by day and others only by night.

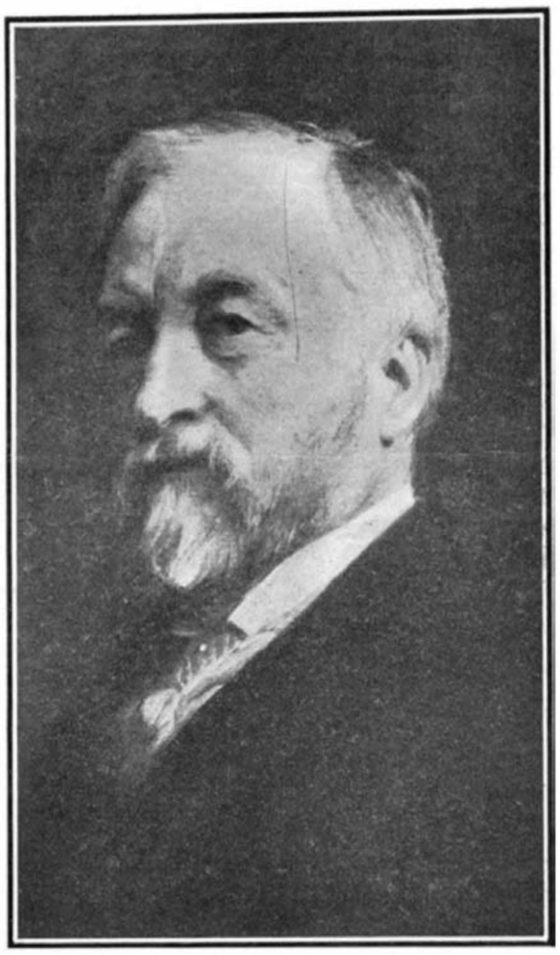
The results of Prof. Loeb's experiments explain with astonishing simplicity the causes of a June bug's merry antics as well as the apparently aimless movements of squirming, new-born vermin. Insects, it seems, move in the direction of the light rays that fall upon them. Change the position of the light, and the insect changes his course likewise. But the light must be of a certain intensity to produce a very marked effect. Suppose that in your experiments you exposed your bug to diffused light. He would move toward the light, to be sure; but he would creep toward it rather leisurely. Expose him to a bright glare, however, and he will hasten toward it with cheerful rapidity. That is why winged insects flutter gayly about in direct sunlight. Curiously enough, the influence of light is limited by atmospheric temperature.

From the circumstance that insects tend to arrange themselves and to move in the direction of light, it would almost follow that their structure must have something to do with their heliotropism. And such Prof. Loeb's experiments prove to be the case. The head of an insect is much more sensitive than the tail. Here the omnipresent skeptic will probably remark that an insect sees with his head and not with his tail, and that Romanes may be right after all. But such notoriously blind animals as the earthworm and other eyeless creatures are far more responsive to light at the head than at the tail. The mere possession of sight cannot, therefore, account for the earthworm's avoidance of light or for the moth's apparent liking for it.

Sometimes it happens that an insect is stimulated by light only at certain periods of its existence. In winged ants, for example, the period coincides with the time of the nuptial flight; in plant lice, with the appearance of wings; and in some larvæ, when full growth has been attained. Occasionally a caterpillar may crawl toward a flame, while the butterfly to which it gives rise may be repelled by light.

What is the cause of this curious effect? It must be confessed that science can give no satisfactory explanation. We might just as well ask, What is the cause of gravitation? The phenomenon is exactly the same as that which is produced in plant life. And that, in animals, it cannot be due to the nervous system is evident from the fact that leaves and branches have no nerves.

To be paralyzed by light, to be confined to a certain path, or to be incarcerated in an impalpable luminous prison would seem a serious limitation in the search for food. Yet it so happens that heliotropism may actually assist an insect in its struggle for existence. Certain caterpillars just after they are hatched, and when they are ravenously hungry, are compelled by the mechanical effect of light to crawl to the tips of branches, where they find their first nourishment in tender buds. After their first meal, the caterpillars lose much of their sensitiveness to light. Their heliotropism explains what has heretofore been vaguely attributed to instinct. Prof. Loeb even ventures the suggestion that the periodic migrations of many animals, such as those of birds of passage, may also be explained in part by heliotropic irritability.



S. P. Langley

SAMUEL PIERPONT LANGLEY.

With the death of Prof. Samuel P. Langley on February 27 there has passed away not only one of the most distinguished American workers in the field of pure science, but a physicist of world-wide reputation.

Prof. Langley was born in Roxbury, Mass., on August 22, 1834. Although astronomy was the study which most attracted him, even from his boyhood days, he drifted into the profession of civil engineering, where his mathematical taste found employment and likewise his manual dexterity. He soon gave up civil engineering for the allied profession of architecture. For seven years he worked patiently and then decided to abandon the profession. With no certain plans for the future he began to take up the study of astronomy in earnest. After a brief visit to European countries he obtained a position at the observatory at Cambridge, and was thus launched in his life work at the age of thirty. After a brief service at Cambridge, and at Annapolis, he became director of the Allegheny Observatory.

When Prof. Langley went to Pittsburg in 1867 he found there only an observatory in name. The equipment was inadequate, the endowment small. It was imperatively necessary that some means should be found whereby the work could be carried on. It was from the very poverty of the Allegheny Observatory that the greatest results came. In order to obtain money, Langley inaugurated "time-service systems" on a scale never before attempted. He first began by regulating the clocks of the Pennsylvania Central and other railroads associated with it, a system then comprising over 2,500 miles of railroad east and west of Pittsburg and along which 300 telegraph offices were located. Accurate time signals were communicated twice daily to each of these offices. Eventually some 8,000 miles of railway were run by this single Allegheny Observatory clock. The present system by which the railroad system of the whole continent is regulated may be said to be an outgrowth of that developed nearly forty years ago at Allegheny by Prof. Langley. The income thus derived was applied exclusively to the uses of the observatory.

In the course of two or three years the observatory affairs had prospered to such an extent that original work could be undertaken. Langley's first work was a laborious and minute study of the sun's disk, which study he completed in 1873. He revealed the true character of the "granules" upon its disk, discovered that the polarization of the corona is radial, and gave us the first complete account of the structure of a sun spot. A detailed study of the distribution of heat on the solar surface, begun in 1870, resulted in the previously unknown thermochroic action in the solar atmosphere, by reason of which, owing to the difference in wave length, it transmits heat more readily than light.

This early work upon solar heat was accomplished with the aid of the thermopile, an instrument not sufficiently sensitive for the more minute work which it was his desire to undertake. He invented a new instrument which he called the bolometer—a thermometer of almost infinite tenuity, which measured radiant heat with an accuracy that has never been excelled. In its more recent forms the instrument can detect differences of temperature amounting to no more than the one-millionth part of a degree on an ordinary thermometer.

In the hands of Langley, the bolometer demonstrated experimentally that the maximum heat in the normal spectrum lies in the orange and not in the infra-red spectrum, as commonly supposed. Before the invention of the bolometer the distribution of heat in the spectrum was almost entirely unknown. In the course of three years' patient work, however, Langley completed a map of the principal lines of the heat spectrum and thereby furnished new material for a study of the interaction of solar heat and terrestrial atmosphere. What Kirchhoff did for the upper rays of the spectrum Langley accomplished for the lower spectrum.

One important result of all these bolometric investigations was the discovery that the earth's atmosphere acted with selective absorption to a remarkable degree, keeping back an immense proportion of blue and green, so that which was originally the strongest became, when it reached us, the weakest of all, and what was originally weak became relatively strong. The action of the atmosphere is just the converse of that of an ordinary sieve, or like that of a sieve which should keep back small particles analogous to the short wave lengths (blue and green) and allow freely to pass the larger ones (the dark heat rays). Langley, therefore, proved that white is not the sum of all radiations as we used to be taught, but that it resembles pure original sunlight less than the electric beam which has come to us through reddish-colored glasses resembles the original brightness.

An expedition to the top of Mount Whitney resulted in the discovery of an entirely unsuspected extension of the solar spectrum; in a calculation of the relative intensity of the different rays of the sun before they

(Continued on page 211.)

SAMUEL PIERPONT LANGLEY.

(*Continued from page* 207.)

have entered the earth's atmosphere; in the indication that scarcely sixty per cent of the solar rays penetrate to the earth's surface because of the atmosphere's selective absorption; and finally in a new and important estimate of the solar constant.

In later years Langley occupied much of his time with the problem of artificial flight. He took up the subject not so much from the standpoint of the ordinary inventor, but as a branch of atmospheric physics. In his papers "Experiments in Aero-dynamics" and "The Internal Work of the Wind" he laid down for the first time a really sound and trustworthy scientific basis for the study of aerial locomotion.

The result of his investigations was the construction of a small aeroplane model, an aerodrome, which demonstrated the correctness of his theoretical principles. His models made successful flights of about three-quarters of a mile. This was the first time in the history of aerial navigation that an aeroplane was driven by its own power through the air. The success of these smaller models prompted him to construct a larger machine to carry a man. In 1904, experiments with this contrivance were made on the Potomac River. They failed, unfortunately, not because of any inherent defect of the aeroplane itself, but because of faulty launching devices.

As the secretary of the Smithsonian Institution. Prof. Langley will be chiefly remembered as the founder of the Smithsonian Astrophysical Observatory and the founder of the National Zoological Park.

Prof. Langley possessed a cultivated literary taste, ripened by an acquaintance with the art of the old world, the effect of which was at once evident when he began to write for publication. He had skill in the manipulation of tools, machinery, and instruments of precision. He was a practical engineer, familiar with the computations and the applications of mechanics and physics. He was a skillful mechanical draftsman and a trained man of business, thrifty, alert, and progressive. His thoughts were almost prophetic in regard to the probable results of experiments which he was about to begin.

His written work is characterized by a charm of style and lucidity of presentation that would do credit to a finished essayist. His "New Astronomy" will ever stand as a splendid example of what can be done in the way of popular scientific writing. His more technical publications have that hardly definable quality by which we become aware that they are written from a full mind. Every statement of fact or expression of opinion is based upon a hundred single instances, or upon a hundred concurring judgments.

The Current Supplement.

The current Supplement, No. 1575, opens with a biographical sketch of the late Samuel Pierpont Langley, accompanied by an excellent full-page portrait. Mr. G. T. Beilby writes on Gold and its Chemistry. Recent investigations of polonium by Mme. Curie are reviewed. Some notes on steam turbines by Capt. H. Riall Sankey are published. These deal with the production of motion energy in steam turbines of various types and the conversion of this energy into mechanical work. The Manufacture of Hydraulic Cements is excellently discussed by L. L. Stone. Mr. Philip L. Wormley, Jr., writes on "Cement Mortar and Concrete: Their Preparation and Use for Farm Purposes." Mr. William B. Strang has perfected a system that is destined perhaps to meet all the requirements of an independent electric car. This system is a combination of a gasoline engine, a dynamo, and storage battery. A thorough description of the car is given in the Supplement. Dr. W. A. Cascari gives some notes on gutta-percha and balata. An excellent article on a convenient camera, by the late George M. Hopkins, is published. To those who wish a good review of the recent progress in radio-activity a paper by Mr. Frederick Soddy may be recommended. The Science Notes, Engineering Notes, and Trade Notes and Formulæ will be found in their accustomed places.

Human Motive Force.

According to the researches of Fischer, the latent calorific energy stored in the food absorbed by an adult man a day is 3,000 to 3,500 calories of heat. A notable part of this energy is used within the body for determining animal activity, respiration, digestion, elimination, etc. The excess may be expended in mechanical work. A day of eight hours and average and continuous work is equivalent to a work of 127,000 kilogramme-meters, or 300 calories, or a little less than one-half horse-power. Under these conditions the cost price of 100 horse-power may be thus calculated: Man, 250 workmen at 3 francs per day, 750 francs; horse-power, 10 horse-power, all expenses included, 60 francs; engine, steam, 6 francs; engine, gas, 3.50 francs. Human motive force is, therefore, one hundred times dearer than mechanical motive force.

Correspondence.

A Standard of Light.

To the Editor of the Scientific American:

The idea of establishing a standard for light, as suggested by Mr. Butzing in your issue of January 27, is a good one. This we have long needed, and I hope he will take it in good part if, in furtherance of our object, I somewhat severely criticise his plan.

Though the sun is our great source of light, its intensity upon the earth is subject to so many variations that it is inconvenient for a standard, and difficult to connect with any standard already in use. It seems to me that some simple, exact connection with an established standard is essential for a new standard.

Photo salts are too unstable to satisfactorily serve as means of measurement.

Consider the following suggestions: Many elements and substances, upon being heated to certain temperatures, are seen to emit light without chemical change, and the light increases with increase of temperature. Being only an amateur scientist, I will not suggest the proper material for a standard, but a metal or alloy which begins to glow at a comparatively low heat, and reaches a high intensity of light before inconvenient softness appears, would seem to offer most suitability. The emitted light should resemble sunlight as closely as possible in those characteristic qualities by the effect of which it is to be measured.

By any good device adapted to the chosen way of heating, suspend a standard ball of the alloy, say of 1 decimeter diameter, within a tube of 2 decimeters diameter, made of non-heat-conducting material, and having directly in front of the ball a circular opening of 1 decimeter diameter. At a distance of 1 meter directly in front of the ball place the light-measuring medium. At a prescribed place within the ball, perhaps best at the center, place the bulb of such a standard self-registering thermometer as shall be capable of effectively resisting the high temperatures, and the scale of which can be conveniently read by the light of the glowing ball. I suggest an electric furnace method of heating the ball. The experiments must be conducted in a light-tight room.

By such a method, exact ratios of Centigrade degrees to adopted light units can be determined. At once difficulties occur to me and, no doubt, some of your readers will see many more. Reliable thermometers for high temperatures have hardly yet been made, but by many experiments with a number of instruments, a working approximation of accuracy can be wrought out, which researches with the better instruments of the future can correct.

How would selenium answer as a measuring medium? I am not acquainted with the element, only that, by report, its electrical conductivity changes in relation to the intensity of the light to which it is exposed. To what particular rays of light it is sensitive, I am not informed. If to the actinic rays only, it will be suitable for measuring photo rays and sunlight, but not so well for other illuminants. If selenium be used, the measuring instruments can be made of a standard selenium cell, a small and simple dynamo run by clockwork and a weight, and a good galvanometer. If, as is not likely, selenium is sensitive to polychromatic light, then by making the ball of an alloy whose rays will fairly well cover the solar spectrum, we will have the elements for the making of a good all-around instrument. It is, of course, evident that the light of the glowing ball must be adapted to the measuring medium.

I hope the many readers of the Scientific American will give us full criticisms and further information.

Irving G. Chatfield.

Forestville, Conn., February 10, 1906.

[Greenish-yellow rays of light produce the greatest effect on selenium.—Ed.]

Lubrication of the Under-Water Surface of Ships.

To the Editor of the Scientific American:

Being a subscriber to your periodical, I read certain letters in your issues of January 6 and 27 concerning the lubrication of the under-water surface of ships; but it was only a few days ago that my attention was called to a letter on the same subject, published December 23, 1905, signed D. B. I have read these letters with the utmost interest, particularly because I have busied myself with the discussion of this question for the last two years.

Some twenty years ago, it occurred to me that it would be possible to lessen the friction between a ship's skin and the surrounding water by means of air bubbles; but as I had at that time no leisure for experiments, I was unable to attempt the exploitation of my idea. However, since I have retired from business I have again taken up the question, and have carried out some experiments with the model of a vessel on nearly the same lines as mentioned in the letter of T. W. H. in your issue of January 27. These experiments were not at all satisfying, and there was no apparent diminution of the friction observable, even when the under-water part of the model was wholly surrounded by air bubbles.

Notwithstanding these unsatisfactory results, I am still convinced that the idea is of value. As I did not have the opportunity nor the means to experiment on a large scale I used a small model, and it appears to be possible that the air bubbles in this case reached the surface of the water before coming in full contact with the under-water surface of the model, or that there were other circumstances which gave rise to these poor results. I thought it best to solve this question by experimenting on a large scale, but before undertaking this it appeared wise to study the motion, size, shape, etc., of air bubbles containing different quantities of air at different depths, rising along different planes of different structures, at different inclines, and so on.

If the idea were correct, it would undoubtedly be of the utmost economical value, and worthy of thorough investigation. From these considerations I began early last year to project and construct a series of physical instruments for the purposes of this investigation, and have already obtained some remarkable results. It will take a considerable time, however, before my researches are completed. At all events, the idea of lessening the friction between a ship's skin and the surrounding water is not new, nor is it as simple as it appears at first glance to be. Possibly it was not even novel twenty years ago, when it first occurred to me.

J. K. E. Triebart.

Nymegen, Holland, February 14, 1906.

Wrought Iron for Pipes.

About 1890 several cast-iron conduits at Berlin, from 3.5 to 10 centimeters in diameter, were ruptured, which led the authorities to replace the cast-iron pipes with those of wrought iron, covered with the following composition for protection: 65 kilogrammes of tar, 3 kilogrammes of rosin, 15 liters of sand, 7 liters of loamy clay, and 4 liters of powdered lime. A coating of this mixture, 3 or 4 millimeters thick, was applied. In more than a dozen years of service, these pipes have been preserved from rust and have undergone no change.—Rev. des Eclairages.

There has been recently completed in New York city the largest strictly private electrical plant in the world. This plant, situated in the basement of the Mutual Life building, is designed to furnish light and power to an entire city square and its tenants. The plant consists of four 600-horse-power Watts-Campbell Corliss engines and four 350-kilowatt 110-volt generators. The engines are of the Tangye or heavy "rolling-mill frame" type, supplied with Corliss valve gear. The generators are provided with a special feature in the form of an automatic brush-shifting device, which moves the brushes back and forth across the face of the commutator, thus eliminating the possibility of wearing ridges.

This plant is designed to replace the old equipment of four 100-kilowatt Siemens & Halske generators, direct coupled to straight-line engines. The work of installation began about two years ago with the removal of the old boilers originally supplying steam to the Mutual Life building. The present boilers are designed to furnish steam at 300 pounds pressure if necessary.

The foundation for the plant had to be specially constructed, the location of the new units being limited to the space occupied as a court between the various buildings. The difficulty of constructing the foundations was enhanced by the fact that the concrete slabs supporting the structural steel columns of the building's framework rested on sand, which had to be excavated from between the columns with the greatest care. A sufficient space having been cleared out, beams were laid in such a manner as to form a closely bolted network, concrete was poured on and about them to fill in the entire excavation, and the various units of the plant were bolted securely to this firmly-knit mass. The plant is designed to operate 20,000 incandescent lamps, 10 or 12 electric elevators, 8 motors of from 2 to 6 horse-power, including an electric pump, and 6 blowers, with fans ranging from 36 to 60 inches diameter.

Tomato growers in the English county of Kent are perplexed by a strange bacterial disease which appears among the fruit every five years. The disease first made its appearance in 1888, defied all efforts that were made to eradicate it, and ruined the crop. The following year, however, there was no trace of it. In 1892 and 1897 it appeared again, though with diminishing prevalence, while its last attack was in 1901-02. From the careful studies that have been made, the disease appears regularly in five-year cycles. Every possible effort to exterminate the pest has been made, but without success. The disease is of a most virulent and epidemical character. The crops are entirely ruined, and serious losses have resulted.