solutions. Each tank could be shifted about on five iron wheels moving along rails 16 meters (52.48 feet) in length. A gigantic water tank, 15 meters (49.2 feet) in length, 2 meters (6.56 feet) in breadth, and ¾ meter (2.46 feet) in height, having a total capacity as high as 476.68 cubic feet, was further used.

On account of the large developing wheel employed, the paper was developed by night in the open air. Before developing the picture, the exposed paper, fitted with a protecting cover, was laid over the slats of the wheel. The wheel was then set rotating. As it turned, it dipped the lower part of the paper into the developing liquid. The light portions were especially treated with sponges impregnated with energetic developers. Portions whose development was too rapid were checked by means of iced acetic acid solutions. An iron oxalate developer was used.

After first interrupting the developing process by projecting iced acetic acid on the photograph by means of a hand pump, the paper was conveyed into an acetic acid bath, where the clearing process was completed after twenty minutes' time. The picture, after an intense rinsing, was transferred into the fixing bath, where it remained three-quarters of an hour. After another rinsing the photograph was thence conveyed into the large washing tank above mentioned, where it remained for about eight hours, while a continuous supply and withdrawal of water took place. The total consumption of water used in washing the print was about 10,593 cubic feet.

After the water was drawn off, the picture was stretched out on wooden bars attached to the upper edge of the tank, where it remained for about ten hours before it was completely dried.

SAMUEL PIERPONT LANGLEY.

It is safe to say that no just estimate of the very eminent and useful pioneers of the physical sciences for the past several decades would fail to include Samuel Pierpont Langley.

Born in Roxbury, Mass., August 22, 1834, Mr. Langley was graduated from the Boston High School in 1851, thereafter took up the study of civil engineering and architecture, and subsequently practiced these professions, furnishing an instance of a certain tendency among men of attainment to believe in and utilize a minor talent in the beginning as the working field for a career. But his interest in astronomy was innate, and the time saved from the demands of engineering and architecture went to the study of that science. Parts of the years 1864 and 1865 he spent in European travel, visiting foreign observatories and learned institutions, to return bent upon devoting his life to scientific pursuits. The practice of architecture had imbued him with a keen æsthetic sense and powerful constructive imagination. No one better enjoys the beautiful solution of a problem. This fine sense of proportion, but more especially the faculty of creative imagination, modern astronomy and physics both demand as the working basis for success.

In 1865 he became an assistant at the Harvard College Observatory, and the following year was appointed Assistant Professor of Mathematics in the United States Naval Academy at Annapolis. Within the same year he became the director of the new Allegheny Observatory at Pittsburg.

It was here that he found opportunity for one of the few directly utilitarian services ever rendered by astronomy—the establishment in connection with the Pennsylvania Railroad Company's telegraphs, of the now familiar system of the standard time service by telegraphic signals. At that time (1868) the use of local times was universal in this country, even by the railways, and confusion or accident was frequent and inevitable. By these signals this confusion was stopped over the whole area from the Atlantic seaboard to the Great Lakes. The system was at once widely imitated.

Mr. Langley's interest in pure astronomy was now rapidly developing into a greater interest in astrophysics, and he began the well-known series of researches upon the sun and the physics of the solar radiation with which his name has been most intimately associated. In 1869, in 1870, and in 1878 he had charge of government eclipse expeditions, of which the latter, to Pike's Peak, resulted in determining a hitherto unsuspected extent of the corona. His work upon sun spots, extending over this period, is too well known to need mention here, except to call attention to the remarkable accuracy of observation, as well as the skill of draftsmanship, which renders his drawings of sun-spot phenomena made before the days of solar photography, perhaps the final statement of what the eye can see of the surface of the sun.

About 1875 he began to devote much attention to the heat spectra of the sun and other hot bodies, and as an aid to that research he in 1880 devised the bolometer, probably the most useful and delicate instrument for the measurement of radiation.

To this period, and as part of the general research upon the sun's physical relation to the earth, belong the important preliminary papers on the energy spectrum of the sun, the transmission of the earth's atmosphere, on the Solar Constant, the behavior of prisms toward radiations of long wave-length from bodies at low temperatures, the energy-spectra of heated terrestrial objects, and the energy spectrum of the moon. The moon's heat had hitherto been barely recognized by the thermopile, but with the bolometer Mr. Langley was able to analyze minutely the details of its spectrum.

During these researches at Allegheny he had become convinced that there was a great, and then unsuspected, selective absorption of the sun's energy both in the sun's and the earth's atmosphere. Again successful in obtaining the aid of the government, he organized in 1881 an expedition to the top of Mount Whitney, in California, the abrupt heights of that lofty peak permitting observations to be made from two stations geographically close together, but separated by more than two miles of altitude. The result of the observations made became the basis for an entire change in the hitherto accepted value of the Solar Constant, as determined by Pouillet's methods, and the reversal of the old belief that the atmospheric absorption was greatest in the red end of the spectrum.

Mr. Langley was now fairly embarked upon a monumental task, not yet fully completed, requiring unusual niceties of observation and deduction. This was the exploration and mapping of the great unknown region of the solar spectrum lying beyond the visible red light, and in which region fall the wave-lengths of the far greater part of the heat-energy lavished upon the solar system. To the study of the visible spectrum the science of chemistry is under a vast debt, and upon it is largely founded all modern knowledge of stellar systems other than our own. Photography had revealed the invisible region beyond the violet, but wave-lengths of only one-tenth the range he had by 1885 demonstrated to exist were under study by these means.

In 1887, at the beginning of this research, Mr. Langley became secretary of the Smithsonian Institution, which officially represents the interests of the United States in pure science.

It is here that Mr. Langley has most conspicuously shown the characteristics which had early marked him for an eminent career. Without an executive intelligence of a high order, the workings of the institution must have suffered a decline from the high plane of usefulness inaugurated for it by Prof. Joseph Henry, and carried on by Prof. S. F. Baird, whose administration had preceded Mr. Langley's. The institution has expanded in all of its activities under his charge, and his fitness to control a complex system of subordinate bureaus and men has been salient. As the head of the institution, his ability to present to Congress the needs of the sciences in this country has been of great service, and it is due largely to his efforts that the institution also administers private appropriations for scientific purposes, and has attracted large bequests to be devoted to similar ends.

These duties have necessarily occupied much of his time, but he has continued to give his personal direction to the Astrophysical Observatory, which has been most steadily engaged in the investigation of the infra-red spectrum. Here also were carried out a series of comparisons (with the bolometer) of the heat-energy emitted by various natural and artificial sources of light, with that of fire-flies and glow-worms, to demonstrate their relative efficiencies. It was here that, in 1892, the instrumental equipment was brought to include the automatic mechanism whereby the relative movement of the bolometer in the spectrum, and of a photographic plate past the beam of light reflected from the mirror of the galvanometer, were very accurately related, so that the infra-red spectrum could be quickly explored, and a photographic image of its energy-curve recorded. Much valuable minor research in optical physics, as well as in instrumental design, has been here accomplished. Mr. Langley directed a very completely equipped expedition from this observatory to Wadesboro, N. C., for the observation of the eclipse of 1900, which resulted in an interesting determination of a value for the radiation from the corona, and some very remarkable photographic observations.

After Mr. Langley became the head of the Smithsonian Institution, he was enabled to begin that series of efforts to solve one of the greatest of human problems—that of mechanical flight—which has lately attracted such widespread popular interest in this country. His interest in flight dates from boyhood, and it has long been his belief that the true course for the solution of this problem lies initially in the result of a research into the conditions surrounding the behavior of heavy bodies in motion through the air, rather than in immediate experimental attempts at flight. It has been his aim then, in inaugurating any work whatever in this direction, to establish, first of all, with such accuracy as the resources of refined physical measurement and diligent experiment could produce, the conditions which would surround the final mechanical solution. He took up the subject seriously in 1889, and in 1891 published his "Experiments in Aerodynamics"* and later, after unceasing ... ment he was enabled to print the larger theory ... paper entitled "The Internal Work of the Wind."† This preliminary work satisfied him of the possibilities of mechanical flight, and under the great discouragements of what will perhaps ultimately be recognized as the most difficult branch of mechanical engineering, he commenced and for several years carried on the actual construction of experimental flying machines based upon the principles which had been developed in his private workshop at the Institution. In 1896, for the first time in history, a mechanical structure, free of any attachment to the ground and wholly without any supporting power but its own engines, made several flights of over one-half mile each. Mr. Langley had at this point reached the original aim of his researches in this direction—that of demonstrating, as a question of mechanical engineering, first, the conditions for, and second, the possibility of accomplishing, mechanical flight. It was only later, the necessities of the military branch of the government indicating the need of a demonstration of the practical possibilities of flight, that Mr. Langley determined to go on with those experiments, which are so well known to the newspaper-reading public, and which have so far brought only negative results. It may be said in passing that it requires moral courage of a high order for a man already secure in popular estimation as a savant to attempt to build a flying machine, since the effort is sure of ridicule by a large section of the unthinking public, which sees no merit save in absolute success.

It is difficult to speak of Mr. Langley apart from his work. The two are inseparable. Yet the esthetic sense mentioned as one of his chief characteristics finds outlet in a very wide reading, by no means confined to scientific literature. Added to his capacity to recuperate from the cares of his work by travel, which is perhaps his chief amusement, Mr. Langley is a member of the Metropolitan and Cosmos clubs in Washington, of the Metropolitan and Century clubs in New York, and of the St. Botolph Club in Boston, and may frequently be found at one or the other of their houses, or enjoying the game of golf at some country club.

Foreign institutions and scientific bodies have showered upon him degrees and honors. He has received the degrees, D.C.L., of Oxford; D.Sc., of Cambridge; is a foreign member of the Royal Society of Great Britain, correspondent of the Academy of Sciences, Institute of France, and Fellow of the Royal Astronomical Society, and Member of the Royal Institution; he has been awarded the Janssen medal by the Institute of France, and the medal of the Scientific Society of France, and the Rumford medal by the Royal Society of London; while at home the universities of Harvard, Princeton, Michigan, and Wisconsin have given him the degree of LL.D. He was president of the American Association for the Advancement of Science (1887), and has been awarded the Henry Draper medal and the Rumford medal by the National Academy of Sciences of the United States, of which body he is a member.

Mr. Langley's published writings include over one hundred titles. It is not the least of his important qualifications as an investigator, that he writes with conspicuous clearness and in an English style which enlivens the driest statement.

A 63-Mile Fence.

According to the Kansas City Journal, one of the longest fences in the Northwest is being constructed, running entirely around the Lower Brule Indian Reservation, on the Missouri River, in the central portion of South Dakota. This remarkable fence will be sixty-three miles in length. It is composed of four wires placed on posts set a rod apart, cedar and ash posts alternating. In its construction 250 miles of wire will be used, or 76,000 pounds. To erect the fence required an aggregate of 19,000 posts. In this long fence there will be only three gateways, which will be guarded when the fence is completed.

The fence is being constructed by the Indians themselves under the direction of the agency authorities, the Indians receiving $2.50 per day for man and team and $1.25 per day for men. It is understood that next spring the government will issue stock cattle to the Indians, to be grazed inside this huge inclosure, the purpose of the government being to encourage the Indians in stock-raising so that they can ultimately support themselves.

Andrew H. Bergstrom, of a firm of contractors at St. Louis, has agreed with the Swedish World's Fair commission, to put together their national pavilion free of all cost. The building was erected at Stockholm and has been shipped to St. Louis in sections. Mr. Bergstrom estimates that it will require the services of 150 men three days to put the building together.

* Smithsonian Publication No. 801.
† Smithsonian Publication No. 884.