at which they are burned. From another long series of experiments he finds the life of the lamps corresponding to the different efficiencies. With these results, and assuming different prices of current and lamps, Mr. Howell plots curves representing the total cost of operating one hundred sixteen-candle power lamps for one thousand hours; the points of the curves being obtained by varying the efficiency at which the lamps are run, and calculating the total cost from the data he has obtained and assumed. These curves give a definite minimum corresponding to some definite efficiency, the latter varying with the price of current and lamps. These curves are important, as they enable us at once, knowing how much the current costs, to select lamps that will give the best results. On comparing the cost of lamps with the total cost, Mr. Howell finds that in every case the total cost is a minimum when the cost of lamps is about fifteen per cent of the total cost, — a curious and important result.

ELECTRIC LIGHTING AND INSURANCE. — A reduction in insurance rates, where electric lights are exclusively used, has just been voted by the New England Insurance Exchange. The reduction is, however, only allowed where the rules of the exchange are followed in installing the plant, and where the company whose apparatus is used shall pay "any sum assessed as its proportion to defray the cost of inspection." This move has several things to recommend it: it gives to electric lighting the advantage which its superior safety warrants, and it insures the careful installing and regular inspection of the plant. It is in this last that the benefit is greatest. The few fires for which electric lighting is responsible have been the result of cheap and careless work, and with efficient inspection this is impossible. With the wires and appliances that can be purchased to-day, electric lights can be put in buildings in a way to make accident impossible, and electricians can thank their own ill-advised 'economy' for the ill repute in which some people hold the system.

THE DE BERNADO ACCUMULATOR. — It is possible that in the final perfected type of accumulator, different patterns will be used for different purposes. At present the 'grid' type of battery-plate used for lighting-purposes is much thicker and heavier than that used for traction-work. It has long been acknowledged, that, where a very heavy current is to be taken from a cell, the Planté form of plate is preferable to the former, in which the active material is pasted into perforations in cast-lead plates; and there seems a tendency, especially in France, to return to some modification of Planté's original idea. De Bernado requires in his welding process a heavy current of electricity; and to obtain it he has devised a new form of accumulator, which will stand the discharge rate required without any very rapid deterioration. The cell does not differ greatly from the Kabath accumulator, which attracted attention some years ago, but which is now little used. The plate consists of a frame of lead, with lead strips passing from one side to the other of the framework. The alternate strips are corrugated obliquely to give circulation, and all of them are burned at their ends to the frame. The plates so made are 'formed' by the Planté process; that is, by reversing the direction of the current passing between two sets of plates immersed in sulphuric acid, at intervals, until an 'active' coating of sufficient depth is produced. There is nothing especially new about this battery, — it differs but little from the Kabath accumulator, — but it is of interest as indicating the gradual return to the original Planté form, or some modification of it, that is gradually taking place, especially where rough usage is necessary.

HEALTH MATTERS.

Lung-Expansion and Consumption.

DR. THOMAS J. MAYS of Philadelphia, in a paper read before the Philadelphia County Medical Society, still further elaborates the theory which he has repeatedly expressed, and to which *Science* has before referred. This theory is, that an insufficient expansion of the lungs, especially of their apices, has more to do with the development of consumption than the breathing of impure air, and that, for the prevention of the disease, complete expansion of these organs is more important than the breathing of pure air. The title of his paper is 'Apex-Expansion *versus* Pure Air in Pulmonary Consumption.'

Although Dr. Mays acknowledges that wholesome air is of value in the prevention and treatment of consumption, still he is convinced that the purity of the atmosphere plays but a small part in the result. He cites the almost complete exemption from pulmonary consumption of the inhabitants of Iceland, Greenland, and Lapland, whose habitations are notoriously wanting in ventilation, as proof that this disease is not the result of breathing a vitiated and impure atmosphere. On the other hand, people living in tropical regions, who are out of doors most of the time, are by no means free from consumption. Miners and laborers in coal-mines, although continually respiring an atmosphere loaded with impurities, and damp and musty, suffer but very little from this disease.

That which has been an important factor in establishing the belief that pure air is such an essential element in limiting the ravages of consumption, is that those who occupy elevated or mountainous regions are less liable to this disease than those who live near the sea-level. In reference to this fact, Dr. Mays says that it is estimated that at an elevation of six thousand feet the surface of the body is relieved of nearly seven thousand pounds' pressure. When such an enormous weight is lifted from the body, it is quite evident that its interior must also be markedly affected: the pulse is accelerated from fifteen to twenty beats per minute; the respiration is quickened from ten to fifteen breaths per minute; and evaporation from the skin and lungs is increased. These are some of the immediate effects. Protracted residence in such a high region enlarges the chest capacity. The Quichua Indians, who dwell on the elevated tablelands of Peru, have enormous-sized chests, containing capacious lungs with large air-cells. The Mexican Indians possess chests which are out of proportion to the sizes of the individuals. Dr. Denison says that children born in the Rocky Mountains have chests of unusually large capacity, and M. Jaccoud states that at St. Moritz the respirations are not only more frequent, but fuller.

The reason why the number of respirations increases while ascending a high elevation becomes clear when we take into consideration the fact that at the sea-level a cubic foot of dry air contains about 130 grains of oxygen, while at an elevation of six thousand feet it contains only about 106 grains, — nearly twenty-five per cent less than the body is accustomed to breathe at or near the seaboard.

Professor Mosso has recently proven experimentally that man possesses a lung capacity which is nearly one-fourth larger than the actual necessities of life at the sea-level demand; hence by employing his whole lung capacity he can extract a sufficient amount of oxygen from this attenuated atmosphere without difficulty. And herein lies the secret why so many consumptives, and others with weak lungs, derive such a great benefit when they resort to a mountain climate. Every available space in the chest is brought into requisition to furnish the needed amount of oxygen, the apices are called out of their lethargic state, and the alveoli are inflated; and, if the infiltrated areas are not dispersed, the surrounding alveoli are kept permeable, and so the disease is at least limited, and called into abeyance.

In concluding his paper, Dr. Mays says, "Now, after reviewing the whole subject, we are driven to the conclusion that the line of immunity from consumption, which in the early history of our country was located at the Atlantic seaboard, and which has gradually receded westward with the tide of civilization, until at present it has reached the latitude of Colorado, will not stop in its course until it touches the shores of the Pacific; that the question of curing the disease does not depend on the purity or freshness of the air, or upon the number of bacilli which the atmosphere may contain, or upon the amount of oxygen which may be introduced into the body, for these are all secondary considerations; but it is simply a mechanical question, — a question as to the best mode of expanding the lungs, and especially the apices of our round-shouldered and flat-chested patients, of removing the infiltrated products already existing, and of enhancing the constitutional resistance."

LEPROSY IN AMERICA. — The recent cases of leprosy in Philadelphia have been the means of awakening a new interest in that loathsome disease. Dr. Charles W. Allen, in the *New York Medical Journal*, gives a most complete account of the disease, and the views of the best authorities regarding its communicability.

His conclusions are as follows: 1. Leprosy has existed to a considerable extent in this country during the past twenty years; 2. The tendency is for the disease to increase, not only from immigration, but also from the occurrence of sporadic cases; 3. It is a contagious disease, and may be transmitted from parent to offspring; 4. Transmission probably takes place, in some instances at least, through inoculation; 5. Segregation has been proved to be the only sure means of freeing a country from its ravages; 6. It is the duty of the government to establish central leper-hospitals or isolated settlements for the treatment of those afflicted, and for the protection of the community at large.

BURNING GARBAGE. — Sanitarians in this country have for many years been considering the practicability of destroying the garbage of a city by fire. The city of Milwaukee has been a pioneer in the movement to demonstrate the feasibility of this method of disposal. The commissioner of health of that city, in a recent letter to the *Sanitary News*, gives some interesting facts concerning the experience of that city. "For more than five months our garbage has been consumed to a dry, inodorous ash. A test of the cost of consuming the garbage was made on Dec. 27, with the following result: the amount received and consumed was 40,215 pounds, and the fuel required was 5,000 pounds, being 4.3 cents per hundred pounds of garbage consumed, — a result highly gratifying when we consider that on that date there was a large quantity of snow and ice mixed with the garbage."

BOOK-REVIEWS.

Volcanoes and Earthquakes. By SAMUEL KNEELAND. Boston, Lothrop. 8°.

THE present volume is mostly a description of ascents of volcanoes and of remarkable eruptions which the author has witnessed, or the description of which he has taken from reliable sources. Thus the book has some value as a book of travel, or for making clear the phenomena of volcanic action to the general reader. The author has visited so many volcanic regions, — the Hawaiian Islands, Iceland, the Mediterranean Sea, Japan, and the islands of south-eastern Asia, — that he is well able to give a description of the peculiarities of the various volcanoes; and the principal value of the book lies in the vividness of the descriptions, which is due to the personal knowledge of the author of so great a part of the earth's surface. He wisely abstains from a long discussion of the theory of volcanic phenomena, as this would be out of place in a popular book like this, but merely enumerates the various theories that are now held by geologists. The latter part of the book contains descriptions of remarkable earthquakes.

Lectures on the Physiology of Plants. By JULIUS VON SACHS. Tr. by H. Marshall Ward. Oxford, Clarendon Pr. 8°. (New York, Macmillan, $8.)

VON SACHS'S text-book of botany has always been regarded as one of the best in any language, and no better proof of this can be given than the fact that four editions have been published and exhausted. Dr. Sachs was requested by the publishers of his text-book, and also by his botanical friends, to prepare a fifth edition. This he declined to do, and gives his reasons therefor in the following language: "It is an old experience, that, while one works up with pleasure a second and even third edition of a comprehensive work, frequent repetition eventually becomes inconvenient or even painful to the author. Having experienced this sufficiently with the fourth edition, I was unable to make up my mind to a fifth. Apart from other circumstances, I was driven to this, to an important extent, by the progressive development of my scientific convictions." He adds, that his mode of comprehending important questions of the physiology of plants had undergone changes in various directions, and that for several years the wish had been taking a more and more definite form, in his mind, to set forth the most important results of the physiology of plants in such a manner that not only students, but also wider circles, should be interested in them. Believing that this object could be better attained by a freer form of exposition than that of a text-book, he determined to present the subject in the form of lectures. This determination has resulted in the 'Vorlesungen über Pflanzen-physiologie, which Professor Ward has translated in a most admirable manner.

The volume consists of forty-six lectures, arranged in six parts. These latter are, 1. Organography; 2. The external conditions of vegetable life, and the properties of plants; 3. Nutrition; 4. Growth; 5. Irritability; 6. Reproduction. It is impossible to give more than this brief outline of a book which embraces so many and such varied topics as are treated in the eight hundred and two pages of text. Professor Sachs has succeeded in his undertaking, to a degree which is exceptional, to produce in this series of lectures a treatise adapted to the wants of the skilled botanist and the educated man, whose studies have been in other directions, but whose desire for a knowledge of the physiology of plants has hitherto been unsatisfied. The subject is made much more intelligible by the four hundred and fifty-five woodcuts with which the book is embellished; while the elaborate index, covering thirty-three pages, makes it exceedingly valuable for reference.

Photography applied to Surveying. By HENRY A. REED, U.S.A. New York, Wiley. 4°. $2.50.

THE author gives a concise sketch of the successful experiments made in photographic surveying, and sets forth the methods now in use. The book is principally founded on the publications of Frenchmen who have paid particular attention to developing this branch of the art of surveying. The author's discussions of the various methods are clear and concise. The principle of photographic surveying is the same as that of ordinary surveying. Stations are occupied by the photographer; and the angles, which are generally measured by the theodolite, are measured on the photographic negative. For this purpose the camera is provided with a level, and the distance between the sensitive plate and the object-glass is kept constant. The horizon is marked on the negative, and a measurement of distances serves for finding the azimuths and elevations of objects. In making the photographs, various instruments are used, — the ordinary camera, with a wide-angle objective; a camera in which a cylindrical sheet of sensitive paper takes the place of the plate, and in which the photograph is produced by turning the camera around its axis; or the photographic plane table. In the latter the photographic view is represented on a horizontal surface, the rays from the object being reflected either by a triangular glass prism or by a spherical convex reflector. The author justly claims great advantages for these methods, among which the most valuable are the cheapness of field-work, and the great amount of information contained in the photographic views. Setting aside geodetic operations, photographic surveying is undoubtedly the cheapest and best method wherever the principal object is to attain, not the greatest possible accuracy, but the fullest amount of information in the shortest possible time. Therefore the publication is very valuable and welcome, giving a concise review of the advantages and results of this method, which is still very little used in this country. We may be allowed to add a few remarks on this subject, in addition to Lieutenant Reed's full discussion. Photographic surveying cannot attain the same accuracy as ordinary surveying; but the errors are so small, that for tertiary, and even for secondary triangulation, it meets all demands. Its greatest value, however, lies in the full material it furnishes for constructing the orographic features of a country. No topographer, however experienced he may be, can draw contour lines as well from sketches and a few fixed points as he can construct them from photographic surveys. The number of elevations that may be determined by this method is practically without limit. Another important use of photographic work is the facility it affords for re-surveying tracts of land, particularly in regard to changes in culture. Deforestation, roads, the extent of agricultural land, etc., are shown on the photographs, and may readily be inserted in maps without fear of omissions. Thus it will be of the greatest utility for the questions of a census. Lieutenant Reed touches only slightly upon its use in reconnaissance work. For this purpose the cylindric arrangement gives the greatest satisfaction, principally as it dispenses with the use of bulky and heavy photographic plates, which are difficult to carry. For topographic work of this kind, the use of photography, supplemented by sketches made by the *camera lucida*, gives by far the best results. A concluding chapter of the book