selfish isolation. To know truth that we may tell it, apply it, make it fruitful, is the key note of science; and the truth about ores and minerals, fire clay, fluxes, and blasting powders is as worthy of knowledge as the atmosphere of a fixed star."

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Contents.

(Illustrated articles are marked with an asterisk.)

THE INTELLECTUAL ENJOYMENTS OF SCIENCE.

Those who, for several years past, have been advocating the more generous introduction of scientific training into our schools and colleges, at the expense, if necessary, of giving less attention to philological studies, have, as a main argument, insisted on the greater utility of the knowledge of scientific truths as compared with the knowledge of the ancient Greek and Roman authors, so liberally imparted to our college-going youth. They have pointed out the glorious results with which science has enriched human society in the nineteenth century, and the comparative sterility of the so-called classical studies; they have pointed out the success in practical life of those men who have received a scientific education, while those whose whole training was merely philological have, in many cases, been starving for want of capacity to earn an honest living by useful practical labor, either mental or mechanical. In short, they have confined themselves to the task of praising science from a mere utilitarian point of view, forgetting that it may have higher claims, not only equal to those on which the friends of the old and time honored custom of studying the classics base their defense, but even surpassing anything which may be asserted in favor of the effect of studies of the dead languages and literature on the development of the human mind.

The higher classes of society, especially in England, consider labor, if not directly degrading, at least below their special domain. They are apt to regard that kind of knowledge which is merely useful and such as men in practical business are in need of as without interest; and in place of attempting to acquire, for instance, so much knowledge of light and electricity as to be able to understand some optical apparatus or the electric telegraph, they prefer to concentrate their attention upon the writings of Virgil or the poems of Homer. A knowledge of Latin and Greek is supposed to be about the highest enjoyment reserved fo a man of high culture, for the reason that these studies are pursued, not for a secondary, base, utilitarian purpose, but out of pure love for what is beautiful and true.

Those lovers of science who feel and know that in the study of God's handiwork, Nature, there is much more enjoyment, beauty and truth than in the study of literature, which is a mere human production, have therefore recently been raising their voices so as to persuade the most cultivated classes, if possible, that the pursuit of scientific studies is at least as much worth their notice as the pursuit of philology; that that they should not abhor a chemical laboratory, or philosophical cabinet, as dull and dry; that there are fascinations hidden in these sacred precincts of science, which have only to be tested, with the purpose of impartial investigation, in order to be appreciated. This order of defenders of science have found a powerful advocate in Professor Tyndall, who, in his recent lectures, so often insisted that the classes of people for whom he spoke "should take science to their bosoms, not as the servant of Mammon, but as the supporter and enlightener of the mind of man." And the effect of his often repeated appeals has been something marvelous; people of high standing in society, and of corresponding cultivation of mind, who have been accustomed to occupy themselves in their spare hours with reading poetry and works of fiction or, at the very best, the so called classics, have furnished their libraries with works on science, and are studying optics, the polarization of light, etc.; and some have even gone so far as to buy, in place of useless ornaments, prisms, microscopes, and polariscopes, and are delighting themselves and their friends with the revelations made by those instruments, which seem to give us additional organs of sense.

We make no objection to Professor Raymond's remarks (republished elsewhere in this number) made lately before the Institute of Mining Engineers at Boston, and again taking up the defence of scientific pursuit from the utilitarian point of view; we wish only to defend the position of Professor Tyndall, who in aristocratic England has, by his social status, during his whole life been compelled to appeal to the feelings of the higher classes in regard to that which is worthy of their attention, and who by his untiring efforts has elevated the standing of science and of the men of science, in the eyes of the rulers of society and of the whole world, to a hight never before reached.

PILE DRIVING AND THE LAWS OF IMPACT.

A subscriber propounds the following question: "A pile driver, weighing 2,500 pounds, falls through guides 25 feet high. With what force will it strike the last blow, friction not being considered?" The reply to this is that the striking force may be any amount from 2,500 pounds upward. The question, as asked, does not give sufficient data for its solution. When a heavy body falls, an amount of energy is stored up in it which is proportional both to the weight of the body and the distance fallen through. It is generally estimated in units called foot pounds. In the given case, the energy accumulated in falling, or the work done on the ram by gravity, is equal to $2,500 \times 25 = 62,500$ foot pounds. Before the ram can be stopped, an equal amount of work must be done in retarding it, since it is a well ascertained law of nature that the energy stored in a body while putting it in motion, is precisely equal to that which it gives out in resisting arrest. This amount of work, 62,500 foot pounds, can be done either by a force of one pound acting through 62,500 feet, by 62,500 pounds acting through one foot, or by any force acting through such a distance that the product of force into distance shall be equal to 62,500 foot pounds.

Before we can answer the question asked, therefore, we must know how far the pile moves while resisting the falling weight. Again, if we were told the mean resisting power of the pile, we could calculate precisely how far it would be driven by the last blow. Were the ram to strike the pile after falling $23\frac{1}{2}$ feet and to come to rest at 25 feet, the mean force exerted would be $62,500 \div 1\frac{1}{2} = 41,666\frac{2}{3}$ pounds. Were the pile driven 3 feet at the last blow, the ram still having a total fall of 25 feet, the mean pressure would be $62,500 \div 3 = 20,833\frac{1}{3}$. If the pile moved but an inch, the force developed would be $62,500 \div \frac{1}{12} = 750,000$. In actual practice the pressures would be less than those calculated, because part of the work done would be expended in crushing the head of the pile, and in overcoming the friction in the guides. Our figures are maximum values, which may be approached but never quite reached.

Knowing the distance moved by the pile under the last blow of the ram, and calculating, as we have done, the mean resistance offered by it, it is customary, with some engineers, to take one eighth the latter figure as the safe load which can be put on that individual pile without danger of its sinking. In ordinary soil this rule is sufficiently correct, but it sometimes happens that a heavy pressure, suddenly applied, will move a pile almost imperceptibly, while it will gradually sink to an indefinite distance under a very light load. In other cases, as along our docks, a pile may be set with apparently very feeble carrying power; and yet, after the mud has become well packed about it, and has been rendered somewhat compact and adherent by the superincumbent pressure, the pile will carry a heavy load. Experience and judgment only can be safely trusted in such cases. The load carried by a pile in the stiffest soil has been, in some cases, made as great as 80 tuns, but a usual load is 20 or 25 tuns.

The velocity of striking is calculated by multiplying the hight of fall by 64·3 and extracting the square root of the product. The coefficient, 64·3, has been determined by careful and a thousand times repeated experiment.

WATER AS FUEL.

"On Monday and Tuesday afternoon," says the San Francisco *Alta*, "a large number of citizens, by invitation, visited the brass foundery on Fremont street, for the purpose of witnessing some experiments with a new fuel recently invented. They were shown into that portion of the establishment occupied by the furnaces, and in one corner found a brick furnace, some eight feet long and six feet high. On the top of this was an iron tank holding about ten gallons, which was filled with crude petroleum. From this tank a pipe about an inch and a half in diameter led into the side of the furnace. A small jet of oil, not larger than a small goose-quill, was permitted to flow out of this tube; a light is placed beneath this jet, and it immediately ignites. Another pipe, about an inch in diameter, leads from a steam boiler stationed some fifteen feet away. This pipe leads a small jet of steam upon the burning oil, and the moment the steam strikes the oil the oxygen in the water is set free and ignites with a tremendous roar, generating in a very few moments a most intense white heat.

"From this small source the entire chamber of the furnace, which is some two feet by five feet, is filled with a flame so brilliant and dazzling that one cannot gaze on it for more than a moment at a time. This flame possesses all the heat of an oxyhydrogen flame, and beneath its fierce power the hardest metals melt in a few moments. The inventor of the apparatus by which the elements of heat, which nature so generously provides, can be utilized is a very modest man, saying that he did not want to bring his discovery before the public until he had fully demonstrated that it would do all he claimed for it. He says that the cost of his furnaces will be only a nominal sum that will be within the reach of every one who owns a quartz ledge, while the amount of oil consumed in twenty-four hours will not exceed ten gallons, at a cost of two dollars.

"The inventor has every confidence in his discovery, and declares his ability to furnish fuel for a voyage of one of the Panama steamers to and from Panama for the insignificant sum of $200, while the entire quantity will weigh not to exceed twenty-five tuns. He further says that, at an expense of five dollars per day, he can run furnaces that will smelt one tun of ore every thirty minutes. If only one half of what is claimed can be accomplished, the discovery will prove of incalculable advantage to the mining interests of the Pacific coast, and will create a revolution in steam travel throughout the world."

REMARKS BY THE EDITOR.—There are, in the above article, a number of points upon which we propose to make a few comments: Many attempts have been made to construct furnaces for burning petroleum, but none of them have gained enough favor to be universally adopted. There are a few establishments in the country where it is claimed that the fuel is crude petroleum, but authentic reports of the economy of the furnaces are wanting. In Paris an ingenious contrivance was invented by the well known philosophical instrument maker Wiesnegg, which, in a small way, yielded good results. The appliance for distributing the oil consists of a pipe with branches and of a grooved grate along which the oil flows after dropping from these tubes. A wrought iron cistern contains the supply of petroleum, and is connected with the distribution by an india rubber tube. The grate is placed vertically; the air, being admitted between the bars, supplies the oxygen for the combustion of the petroleum vaporized by the heat of the fire. The petroleum is supplied to the grate a little in excess of the requirements of the furnace, and the surplus drops into a receiver and is volatilized by the heat of the furnace and the vapor is consumed. No blast is necessary. A somewhat similar contrivance was suggested by Deville for use on locomotives and on steam ships. This savant was employed by the French government to conduct a series of experiments looking to the employment of petroleum as fuel. Samples from all parts of the world were tested and the heating effect was determined by the number of kilogrammes of water that could be raised from zero to one degree centigrade by one kilogramme of oil. A trial was made by Deville upon locomotive engines arranged to permit the use of liquid fuel. One of these consumed about thirteen pounds of oil for every eleven hundred yards of distance traveled; while the coal burning engines of the same class required for the same work more than twenty pounds of solid fuel. The Deville furnaces for burning petroleum have been tried in this country, but little is known about them and it is a question whether, at the present low rates for crude material, they could not be advantageously introduced for many purposes. Deville and Wiesnegg accomplished the combustion of petroleum by introducing the oxygen of the air through peculiarly constructed grates. Neither of them could have been so unphilosophical as to try steam, for they would have known that, in order to generate the steam, so much fuel would be required as to take away the entire economy of the application. One furnace would have to be built to generate the steam to carry on the combustion of the petroleum in the second furnace. We have here again the perpetual motion of combustion lurking in the minds of the careless spectator, and there is something so captivating in the thought of burning both water and petroleum as fuel that everybody is at once ready to adopt the new invention as a wonder of the age. We do not say that water cannot be burned; every scientific man knows that it can, but we assert that cannot be burned economically. In order to bring water to the condition of fuel, other fuel must be consumed. If this result is attained by means of a galvanic battery, zinc and sulphuric acid are the fuel; if by a magneto-electric machine, the machine must be driven by a steam engine. If steam is burned in a grate by coals or by petroleum, we must first use fuel to get the steam. It generally happens that the original fuel burned costs more than the fuel produced by the water, so that there is a clear loss. If the two fuels have the same value, the process is not economical, as the cost of machinery and the wear and tear of manipulation must be taken into consideration; and what would be the use of transforming one fuel into another which is no better?

This water burning business has become a nuisance that can only be abated by the dissemination of correct scientific principles. Pumping water into a reservoir by a costly engine in order that it may drive a small wheel at the bottom is fully as economical as any of the contrivances for burning water with which we are acquainted.

CHEMISTRY IN LEIPSIC.

The university of Leipsic possesses one of the finest and best equipped laboratories in Germany, with no less a person than Professor Kolbe as lecturer on chemistry. Recently a thick octavo volume of nearly 700 pages has been published, giving a detailed account of the original investigations made in that laboratory for the past six years. The results of