number if the man is the right man for the higher place; more men are needed than can be found to take the higher positions of responsibility and of commensurate compensation. The wise young professional seeks opportunity for profitable experience without much regard to compensation. I have known a man to refuse a good salary and to accept fifty cents a day, where he saw an opportunity to secure practical experience and training such as, in his estimation, was what he most needed. His spirit was that of Agassiz, who, when asked why he refused an important and lucrative business position, is said to have replied: "I cannot afford to give my time to money-making." Both had their rewards, each in his own way, in that form of professional success which was the highest ambition of each. Many young college men are to-day working for the great railroad companies, for the electrical companies, and for industrial enterprises of all kinds, accepting insignificant pecuniary reward for the time, in order that, by securing that special experience and expert knowledge needed to supplement their special education, they may prepare themselves for positions of honor, of responsibility, and of financial value. Here "the last shall be first."

It is of little consequence what line of work the young man enters, provided it be that for which he is individually well fitted by nature and training. In mechanical and electrical engineering, in shipbuilding and in the railway system, in mining or in public works, great opportunities are all the time, and more and more frequently, offering. It matters little what line the man selects, provided he is naturally fitted to do the work, by talent and by inclination, and that he acquires promptly the needed professional training and a later experience. If able and reliable and loyal to his employers, he is far more likely to be promoted faster than is desirable than to remain unrecognized in any important organization. His early years should be devoted to securing professional knowledge and practical experience, efficiency in his business and ability to deal with other men. Opportunity, responsibility, and financial returns will come later, once he reaches the age at which older men holding such positions begin to drop out. If suited to the work he will find his place.

Meantime, the work of the world is falling into the hands of these able, expert, experienced, and efficient men of the new generation in rapidly increasing proportion, and the professionally trained engineer now finds himself wanted wherever learning, ability, and experience are essential to the success of a great enterprise.

In this great work the student for whom all these sacrifices are made has his part, and his duty is quite as imperative in the utilization of these opportunities as is that of the State to provide them. His first privilege and duty is that of playing his part conscientiously and well. If unable to do the work well that is set before him he should retire to make place for a more competent candidate for opportunity; if found lacking in conscientiousness, he should be retired.

Stradivarius, whose violins to-day will fetch large sums, though they cost but little two centuries ago, in answer to a charge that he worked only for pelf, replied:

"Who draws a line and satisfies his soul,
Making it crooked where it should be straight?
An idiot with an oyster shell may draw
His lines along the sand, all wavering,
Fixing no point or pathway to a point.
An idiot one remove may choose his line,
Straggle and be content; but, God be praised,
Antonio Stradivari has an eye
That winces at false work and loves the true,
With hand and arm that play upon the tool,
As willingly as any singing bird
Sets him to sing his morning roundelay,
Because he likes to sing and likes the song."

The spirit of Stradivarius is that which underlies all success, and not only should the protégé of the State illustrate this spirit as justifying his adoption by the State; but he should understand that the interest and pride and ambition of Stradivarius are essentials of his own later advancement. Thoroughness in college work is no less essential and fundamental an element of success with the individual than is the success of the outgoing army of alumni vital to the progress of the country and the growth of the State in all that makes success for the people, or that makes life worth living for the dweller in their midst. Given this spirit of wholesome and cheerful ambition and the atmosphere which it engenders, and the world will be the better and the brighter each day.

Our own progress as a nation depends upon the wisdom and foresight, the patriotism and courage and persistence of our own educators and statesmen and industrial leaders. With wise statesmanship, our own nation may become the leader of the world and our country may always move onward in the van of modern progress. At the moment, what is most needed is the awakening of our legislative and executive officials to the duties and opportunities of the times. It is the fossilized educator and the ignorant and unpatriotic politician, and the demagogue who aspires to lead "labor," and the educated man with his head in the clouds, who are the most serious obstacles to the progress of education, and to that of the nation toward higher and better things. These classes being either enlightened and purified, or extinguished, we may trust the American people to take full advantage of their opportunities and to hold a foremost place in the peaceful rivalry of the nations.

THE RELATION OF SCIENCE TO COMMON LIFE.*

By J. M. MACFARLANE.

MY theme is "The Relation of Science to Common Life," the life of the mass of individuals, of the nation, if you will. A very unacademic subject, you will say, as measured by the older standards. I chose it on that account. In not a few university centers, the time has not long gone when such a subject would have been curtly dismissed with the remark, "We have nothing to do with common life; we follow our own high educational aims." Too often the universities have stood aside in cold and unsympathetic isolation—shall I not also say in helpless disfavor—while the busy thinking world outside has carried forward the beacon lights of truth and progress. Listen to Whewell when, as master of Trinity College (Cambridge), he went up to London fifty years ago to deliver his notable address before the Royal Institution. Speaking on "The Influence of the History of Science Upon Intellectual Education," he said: "I venture to address you, relying upon an indulgence which I have more than once experienced. Of such indulgence I strongly feel the need, on various accounts, but especially that, being so unfrequently in this metropolis, I do not know what trains of thought are passing in the minds of the greater part of my audience who live in the midst of a stimulation produced by the lively interchange of opinion and discussion on the prominent questions of the day." Uttered soon after the exhibition of 1851, and when the scientific world was entering on new conquests, such an apology may seem unaccountable. Happily, our university presidents of to-day are more in touch with the throbbing, vibrating life of humanity, even though they may not claim the profundity of thought that lived in the master of Trinity.

If there be one characteristic more than another of our age and day, it is the steady welding and co-operative development proceeding among the leading races of the world. Nowhere is this seen on so phenomenal a scale as in our country, where with the Anglo-Celt, Jew and Greek, Frank and German, Italian and Norseman together ply the arts of peace. And why such a commingling of human lives? The answer may be given, and so far well, that here liberty is assured to all, that equal rights and equal opportunities come to all. Back of this, however, is the basic fact that in this country scientific progress has been comparatively unhampered by costly patent laws, by hereditary vested rights, by lands being held in the hands of a few. But perhaps above all, and permeating all, though often silently working, there exists a keen and rapid method of inductive reasoning that carries forward the individual and the community on progressive and yet safe lines. It is this method, applied to all branches of science with increasing exactness, as human freedom increasingly asserted itself during the bygone century, which has culminated in the marvelous scientific position occupied by the country to-day.

What relation then has science, and should it have, to our universities on the one hand, and to common life—to the mass of free, earnest thinking people—on the other? In attempting to answer we must constantly keep in view tradition and history—our relation to our ancestors, real or imaginary. We all, like the Chinese, worship these ancestors—at least in their relations—and they worship them most powerfully who are furthest removed from the land that gave them birth. So it is that we fear to break with the past, and inherit incongruous combinations. Says Whewell: "You will not be surprised to be told that our modern education has derived something from the ancient Greek education, because you know that our modern science has derived much from the ancient Greek science. You know that our science—in the ordinary sense of the term—has derived little from the ancient Romans. . . . But if we take the term science in a somewhat 'wide' acceptation, we shall derive from the Roman history not a negative but a positive exemplification of our proposition. For in that wider sense there is a science of which Rome was the mother, as Greece was of geometry and mathematics. The term science may be extended so widely as to allow us to speak of the science of law—meaning the doctrine of rights and obligations, in its most definite and yet most comprehensive form; in short the science of jurisprudence. . . . And thus two of the great elements of a thorough intellectual culture—mathematics and jurisprudence—are an inheritance which we derive from ages long gone by; from the two great nations of antiquity."

So far Whewell, who in attempting to elevate Roman law to the dignity of a science forgot that much of it was unscientific to the last degree, and tended to produce, not organic national equilibrium, but to set the patricians against the plebeians, and both against the bondmen, who often showed finer qualities than either. Little wonder is it that Rome fell, unsaved by her laws.

Let us see whether a different viewpoint and source of origin for the science of law and equally for all scientific relations might not be obtained. Huxley thus puts it: "It is a very plain and elementary truth that the life, the fortune, and the happiness of every one of us and, more or less, of those who are connected with us, do depend upon our knowing something of the rules of a game infinitely more difficult and complicated than chess. It is a game which has been played for untold ages, every man and woman of us being one of the two players in a game of his or her own. The chess board is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of nature. . . . Education is learning the rules of this mighty game. In other words, education is the instruction of the intellect in the laws of nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws. . . . The object of what we commonly call education—that education in which man intervenes and which I shall distinguish as artificial education—is to make good defects in nature's methods, to prepare the child to receive nature's education. . . . In short, all artificial education ought to be an anticipation of natural education. And a liberal education is an artificial education which has not only prepared a man to escape the great evils of disobedience to natural laws, but has trained him to appreciate and to seize upon the rewards which nature scatters with as free a hand as her penalties." To pursue Huxley's reasoning to its ultimate limit, advanced teaching in all the laws of nature is the highest function of the university in relation to our common life. In other words, to make each man who leaves its portals most highly qualified for useful, intellectual, manly life. But, as I hope to show later, this qualification is to enable him to use wisely—not meanly—the forces around him, so as to build society into an organism.

Therefore, every upright pursuit in life which man enters on should have the highest principles and practice governing it represented and taught in our universities, by the best men in the most perfectly equipped manner. This may be an ideal at present. Granted, it is nevertheless one toward which, I am persuaded, every university must move. In this manner science will confer the dignity that is deserved on the physician's scalpel, the bricklayer's trowel, the chemist's test-tube, the engineer's lathe, the biologist's microscope, the agriculturist's spade or plowshare.

It is a property of most scientific questions that they project themselves into the future. Whether we accept the teachings of Kidd's suggestive couple of volumes or not, his prophetic outlook into the future is inspiring, and despite destructive criticisms his principle of "projected efficiency" is one that every true scientist tacitly believes in and works up to.

While it will gladly be conceded that few if any countries foster scientific advance more than America, it will as readily be conceded that this has been mainly on the applied side, and that much remains for accomplishment in non-remunerative educational equipment. Here I place in front rank the need for spacious and splendidly furnished museums for all the sciences. Those of us who have walked, time and again, through the mechanical, the chemical, the zoological, the mineralogical, and other sections of the South Kensington Museum, or corresponding ones of the Continent—not to speak of many local museums of lesser repute—know that we have nothing to compare with them. Suppose we make observations for a time in the mechanical section, where accurate models may be even seen at work. There the schoolboy lingers inquiringly before them, and he thus forms great conceptions of man's inventive relation to the world forces around him. The factory worker learns how his machines have grown, have been evolved, and how he may possibly perfect them further. For the college and university teacher these collections furnish comparative and concrete illustrations by which a lasting picture is fixed in the mind. Such institutions are costly to erect, to furnish, to man, and to support annually. Their high educational worth must be gaged not by the fruits of years, but of decades and centuries, for the mental stimulus they afford is often hidden away and silent. The question of cost should be a minor consideration in planning such undertakings, amid the corporate and individual wealth that characterizes such centers as our own. Civic pride and loyalty, material pride and loyalty, pride in and loyalty to our highest human development should be sufficient impelling force. Here let me say, with all caution and reserve, but yet with perfect conviction of purpose, that when we read or learn of lavish individual expenditures, for individual gratification alone, it should arouse in every one of us the desire to so mold public opinion that such superfluous ostentations shall cease. If the owner of the wealth thus diverted can be shown that his wealth can most patriotically be expended in building up the country's institutions, then we have successfully done battle for the right.

A note of warning is sounded against the dangers of specialization. I trust that every one directly or indirectly connected with our institutions realizes its dangers. Though Darwin pathetically confessed as to its effects, no one has put it more forcefully than Stuart Mill, who says: "The increasing specialization of all employments; the division of mankind into innumerable small fractions, each engrossed by an extremely minute fragment of the business of society, is not without inconveniences, as well moral as intellectual, which if they could not be remedied, would be a serious abatement from the benefits of advanced civilization. The interests of the whole—the bearings of things on the ends of the social union—are less and less present to the minds of men who have so contracted a sphere of activity. . . . This lowering effect of the extreme division of labor tells most of all on those who are set up as the lights and teachers of the rest. A man's mind is as fatally narrowed and his feelings toward the great ends of humanity as miserably stunted, by giving all his thoughts to the classification of a few insects, or the resolution of a few equations, as to sharpening the points or putting on the heads of pins. The 'dispersive specialty' of the present race of scientific men, who, unlike their predecessors, have a positive aversion to enlarged views, and seldom either know or care for any of the interests of mankind beyond the narrow limits of their pursuits, is dwelt on by M. Comte as one of the great and growing evils of the time, and the one which most retards moral and intellectual regeneration. . . . He demands a moral and intellectual authority charged with the duty of guiding men's opinions and enlightening and warning their consciences; a spiritual power whose judgments on all matters of high moment should deserve and receive the same universal respect and deference which is paid to the united judgment of astronomers in matters astronomical." We must acknowledge to a large degree, the saneness of Mill's position, but if we all cease specializing one day in the seven at least, the spiritual power desiderated will have opportunity to dwell in our midst. The Jewish Sabbath is by no means the worn-out institution that some would have us believe.

Another rock ahead in the channel of progress demands most careful consideration and steady action. Our present-day political and economic systems often foster methods by which science and scientific discovery are degraded or robbed of their true value, while the scientific worker is often defrauded of that reward that should come from sturdy effort of mind and hand. It has truly been said that "crafty men contemn studies, simple men admire them, wise men use them." The founding by Besant of what might be called "the authors' mutual protection society" marked an epoch in the history of English literature. No such organization has yet been evolved to foster and protect scientific discovery. But to put the whole question on a much higher plane than that of mere financial well-being, I venture to say that since science

* Abstract of Sigma Xi Society address, June 18, 1903, before the chapter of the University of Pennsylvania.

stands for accuracy, probity, clear statement of fact, unveiling of error of every kind—whether intentional or unintentional—it can have no sympathy with the deceit and chicanery that are so rampant around us, and that threaten at times even to swamp the high ideals of our universities.

Are the laws of science then, as we ordinarily understand these, to be our sole guide and rule in life? This inquiry causes me to recur to Huxley's picture of life already quoted. Are all the moves on the human chessboard to be dictated only by thoughts of self-interest and self-preservation, or even by thoughts on behalf of our friends and offspring, as Huxley, in the later days, attempted to prove. Some of the "moves" operated repeatedly in the world's past have given us an environmental human outcome, products that we call "strong lives," "strenuous lives," "unscrupulous lives," "useful lives," "instructive lives." But the greatest type, and the one that we almost unconsciously worship is "the beautiful life."

Every organism from amœba to man lives by a process that we may call "organic molecular equilibrium." When the supplies of life energy and food integration exceed the dissipations and disintegration, growth and development proceed. When both are balanced maturity has been attained. When the converse to the first holds true, decay sets in. Applying this fundamental principle to our common human life, the highest human scientific aspiration might be expressed in the aphorism "society an organism." Such a condition society is far from having attained to. But like all organic bodies, if it is rightly to perform its functions, and to perpetuate its like, such it should become. At present, even in its highest expression, it consists of human molecules that often exhibit abundant energy, that undergo permutations and combinations, that show affinities and repulsions, but that lack some form of energy necessary to link them into an organic whole, to give them social equilibrium and stability. Society has been struggling through millennia to become an organism, has been searching for that energy and that source of energy that will give it life equilibrium. At times and in places the result seemed to have been achieved, only again to be impaired, or lost amid a chaos of discords, by the disrupting agency of one or of a few unscrupulous souls, who have acted like a disorganizing ferment on the organizing mass.

Though unfashionable with many to-day, and not least witb the followers of science, the only motive form of human energy that has stood the test, and that is stronger to-day than ever before, is the power, the force of love, of compassion, of sympathy, as communicated by the greatest social lawgiver the world has seen. The early founders of Christianity were charged with it, and for three centuries they shook and finally subdued the Roman empire. We have it in our midst and it lives through all the upheavals consequent on human competition, on commercial war. In our hospitals, in our college settlements, in our church and public beneficences, in our increased regard for human life, we feel the effects of this energy, though we see it not. The social settlements of Owen and others were truly preliminary nineteenth century scientific experiments to test the strength of the law of love, and the amount of this energy needed to vivify and unify the social organism. Like thousands of scientific experiments before and since they partially failed, but their failures and successes have been recorded, so that succeeding experimenters might carry the inquiry to a successful issue.

The fetish of unbridled commercial competition which has too long lorded over us, is in many ways inimical to our highest interests. It can be a helpful servant if kept in subjection, it becomes a harsh tyrant if worshiped as a god. It cannot retain supremacy alongside the gospel of peace and love. If so, the latter suffers or becomes effaced, and mankind becomes the loser.

THE DEMENY BODY CONTOUR-INDICATOR.

M. G. Demeny, who has for a long time been the superintendent of Prof. Marey's laboratory, exhibited to the Academy of Sciences, in 1888, a set of measuring apparatus designed for obtaining the form of the body by a graphic tracing. His thoracometer, and which for this reason merits the name of "universal conformer." The object of this instrument is to take a mold of a part of the body, and especially of the vertebral column and thorax, the dimensions and form of which are in very direct relation with the health and force of resistance.

The difficulties met with by orthopedic physicians in the mensuration of the vertical column are often due to the length of time required. When the physician has no apparatus, he is often obliged to proceed by points, taking in succession the different projections of the rachis by means of a rule and plumb line. As the subject may move during the operation, the measurement becomes illusory. With the conformer, the measurement is taken at once, and it is by a sort of molding that the conformation of a part of the body is obtained.

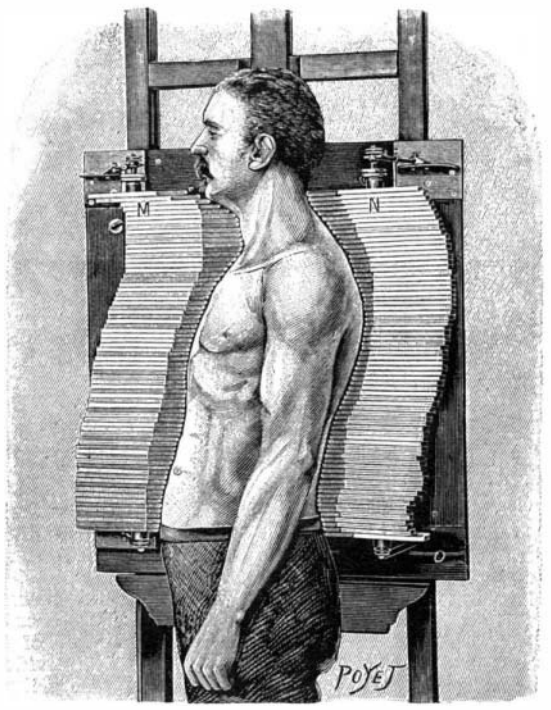

Fig. 1.—THE DEMENY CONFORMER ARRANGED FOR TAKING A SECTION OR VERTICAL PROFILE.

A series of strips of wood, *M* and *N* (Fig. 1), are movable around an axis which may be fixed upon a frame or even upon the back of the subject. The ends of these strips are brought into contact with the body and afterward rendered immovable by clamps. The axis is then detached in order that the sinuous contours made by the ends of the strips and representing the form of the body may be taken upon paper. The strips are capable of revolving around their axis and of thus molding themselves upon the sinuosities of the spinal column deflected by curvatures. Two drawings upon two rectangular planes will suffice to preserve a tracing of them in the case of a left curvature.

The instrument permits also of preserving a record of the form of the rachis as accurate as a genuine molding. With this object in view, M. Demeny employs strips of wood covered with a thin layer of dry glue. After making the mensuration, he moistens the strips with warm water, which causes them to stick together and preserve their respective positions, and constitute, after drying, a block exactly representing the contour desired.

With two apparatus held parallel, we obtain the form and vertical section of the trunk or the anterior, posterior, and lateral profiles of the body. For obtaining a horizontal section of the thorax, there are employed four rods provided with strips *A*, *B*, *C*, *D* (Fig. 2), and so arranged as to form a frame into which the subject to be measured is introduced. The ver-

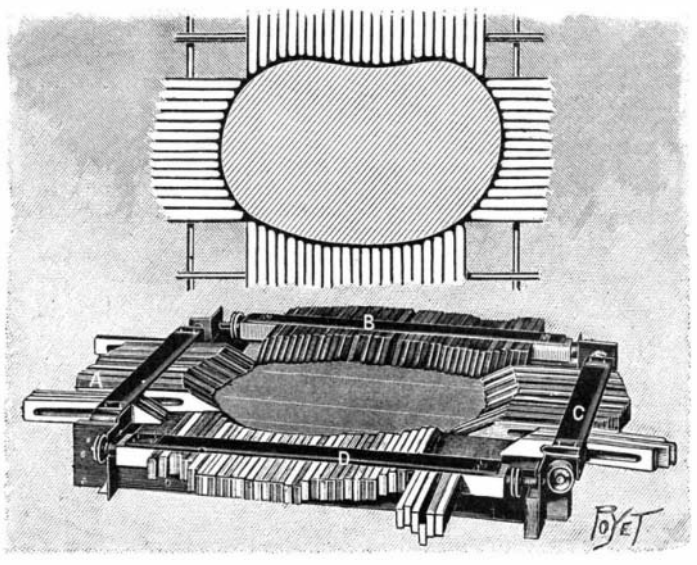

Fig. 2.—THE CONFORMER ARRANGED FOR TAKING A HORIZONTAL SECTION OF THE CHEST.

the profile inscriber, and rachigraph have been used in hospitals and large gymnastic establishments, and we have seen some of them in the athletic clubs of America, where this kind of observation is much in vogue. These apparatus give the form of the body by continuous tracings, but have the defect of being difficult to construct and consequently of being expensive. M. Demeny has recently devised a new measuring apparatus which is applicable to all cases, tical and horizontal conformers may be united upon the same support and permit of taking sections of the body at any height. It is thus easy, with the templets given by the apparatus, to construct true reliefs of the trunk in cardboard, and utilize them for the manufacture of normal or orthopedic corsets, as well as for the cutting of garments. We may note also an interesting application of the instrument, from a medical viewpoint. It permits of finding, immediately and without calculation, a defect in the symmetry of the body, a difference in height between the shoulders and hips, and the pitch of the curvature of the spinal column.

The apparatus folds together, and, since it presents no projection, may be arranged along a wall without occupying any more space than an artist's easel. —Translated from La Nature for the Scientific American Supplement.

SELF-ELECTRIFICATION OF RADIUM.

Quantitative measurements of radium rays as so far carried out, have been made only with a view to studying the electrostatic and magnetic deviations so as to determine the velocity of the charges emitted and the ratio of the charge of one particle to the mass of the same. Now as the positive particles discovered by Mr. Rutherford are absorbed to a much more appreciable degree than negative particles, a reservoir permeable to negative particles should take a positive charge in virtue of the positive particles it retains, the magnitude of this charge depending on the radiation emitted and being a measure of the latter. In order to base on this fact a quantitative measuring method for radium radiations, W. Wien (Physikalische Zeitschrift) has undertaken to investigate the self-electrification of radium. In order to obtain an adequate insulation of the radium, the author introduced 4 millimeters of radium bromide into a small platinum crucible, suspended by insulating glass wire. The radium bromide could emit its radiation toward the open side of the crucible, the walls of which on the contrary would retain the radiation. In virtue of the strong absorption, as shown by platinum, it was to be anticipated that both negative and positive rays should be stopped on their way. In the case of equal amounts of both classes of rays being emitted, no electrification of the crucible would take place. If, however, a selective emission in favor of either takes place, one of the electricities must be absorbed because of the radiation through the opening of the crucible. The difficulty met with in the realization of these experiments was the continual diminution in the insulating qualities of the vacuum as produced by the emanation. Radium bromide in fact develops a strongly conductive gas. The author has not been able to complete the development of this gas, even by maintaining radium bromide, previously heated, during six weeks in a vacuum as perfect as possible.

Although the vacuum was as perfect as possible, the most sensitive electrometer used by the author has not detected the least trace of electrification, even when the vacuum was maintained for hours. This negative result could be due to two causes: on one side, this could in fact be a proof of the non-existence of the phenomena anticipated, whereas on the other hand the emanation could still be too strong, imparting to the vacuum too considerable a conductivity. In order, therefore, to make any more accurate measurements, this emanation had to be perfectly eliminated. To this effect the author drew out a thin glass tube until its walls had a thickness of only some tenths of a millimeter; into this tube a platinum wire was sealed. The internal wall of the tube was, moreover, covered with aluminium foil touching the platinum wire. After introducing the radium bromide the tube was closed by sealing. Any electricity accumulated should then issue from the tube by passing through the platinum wire. The glass tube was suspended by similar glass wire, and introduced into the tube. As the small internal glass tube insured an air-tight closing, no emanation could get out of it and deteriorate the vacuum. By this means the author has been able to state electric effects in very satisfactory accord with those anticipated by theory. From these researches it follows that there is no possibility of determining the masses carried by the radiation by weighing, whereas the energy of the latter is by no means negligible. Apart from alterations in the mass, as produced by variations in the velocity, this energy as calculated by the author is 8.7 ergs per second for negative particles and 60 ergs in the case of positive particles.—A. G.

SYNTHETIC ALCOHOL.

Some very curious, semi-industrial experiments were recently made at Puteaux in the experimental laboratory of the Compagnie Urbaine d'Eclairage par le Gaz Acetylene, in the presence of its stockholders and a few favored persons, and the object of which was to demonstrate the possibility of manufacturing alcohol by starting with the elements carbon, hydrogen, and oxygen.

The problem seems to us to have been admirably solved, although there were presented to us only the problems of Berthelot, the inventor and father of organic synthesis, the modern improvers of whose theory, however, have profited by all the discoveries of science since 1855, and particularly those of the electric furnace, electrolysis, etc.; in a word, by all those innovations which, since 1881, have received the names of volts, amperes, watts, ohms, etc., and thus given a blow to that old grammar which forbade us to burden the proper names of great men with an S. But progress is making!

Despite this blow given to Noël and Chapsal, we must state that the progress made is indisputable. A new carbide (?), which is presented to us as *ethylogen*, undeniably possesses the property of disengaging ethylene gas, that is to say, the synthetic nucleus of alcohol, instead of acetylene gas, when it is plunged into water. Since this carbide is decomposed by water, at the works of production itself, in gasometers identical with those employed for the production of acetylene, there is nothing to prevent the residuum from being used anew, with the addition of carbon naturally, for indefinitely reproducing the same ethylogen carbide. This, in fact, is what occurs, save some insignificant losses of metallic substances, the final expense of the operation being summed up in the addition of carbon (represented here by coke-breeze), and much electric energy, which may be furnished by waterfalls, or, to use a modern term, "white coal."

The ethylene gas disengaged is received in a gasometer, whence it is pumped and made to bubble