

to the front of the outer guard, and playing freely in the opening of the rear of said guard, in combination with the adjusting screw, whereby the convexity of the spring shoe is increased and diminished with the elevation or depression of the cutter.

131. METHOD OF ENABLING MOVING RAILROAD TRAINS TO TELEGRAPH THEIR OWN PASSINGS AT CERTAIN STATIONS; Ernest Otto Pohl, Philadelphia, Pennsylvania.

Claim—The use of a self-acting electro-magnetic railway alarm telegraph, acting reliably of itself without the necessity of human intervention, and arranged and operating in the manner described.

132. PRINTING PRESSES; F. O. Degener, City of New York; ante-dated July 11, 1858.

Claim—Arranging or hanging an oscillating bed with an oscillating platen, in such manner that the motion of one will control the action of the other, so that by their forward movement they shall close and give an impression, and upon their reverse movement the form shall be inked, and the platen be brought into the proper position necessary for the reception of the sheet, and thus alternate from one of their positions to the other. Also, the arrangement of an oscillating bed and platen with the cam to cause the frisket to assume the desired position, so as to hold the sheet of paper while it is being conveyed from one position to the other.

133. NURSERY BOTTLES; W. B. Potter, Boston, Massachusetts.

Claim—A nursing bottle of glass, having a metallic cap screwed upon it, and a metallic lacteal tube, when said cap is provided with a flanch for the reception of the elastic nipple.

134. GRINDING MILLS; Alfred Proseus, Philadelphia, Pennsylvania.

Claim—Placing across the recesses formed by the teeth of the shells, or of those of the burrs, or of both, of conical grinding mills, any convenient number of obstructing strips.

135. MACHINE FOR DRESSING HOOPS; Augustus Prenatt, Buffalo, New York.

Claim—Placing the cutters in the cutter head in such position that the plane of their cutting edge will cross their axis of motion at an angle of 45° (or nearly so), and also stand inclined to the horizontal plane of their axis at an angle of 45° (or nearly so). Also, the arrangement of the cutter in the vertically moving grate, including the adjustable roller, for the purpose of dressing the edge of the hoop, and for giving the hoop any required width, as described.

MECHANICS, PHYSICS, AND CHEMISTRY.

*Science as a Branch of Education.** By PROFESSOR FARADAY, D.C.L., F.R.S.

[Abstract of a Lecture before the Royal Institution of Great Britain.]

The development of the applications of physical science in modern times has become so large and so essential to the well-being of man, that it may justly be used as illustrating the true character of pure science, as a department of knowledge, and the claims it may have for consideration by governments, universities, and all bodies to whom is confided the fostering care and direction of learning. As a branch of learning, men are beginning to recognise the claim of science to its own particular place; for, though flowing in channels utterly different in their course and end to those of literature, it conduces not less, as a means of instruction, to the discipline of the mind; whilst it ministers, more or less, to the wants, comforts, and proper pleasure, both mental and bodily, of every individual of every class in life. Until of late years, the education for, and recognition of, it by the bodies which may be considered as giving the general course of all education, have been chiefly directed to it only as it could serve professional services,—namely, those which are remunerated by society; but now the fitness of university degrees in science is under consideration, and many are taking a high view of it, as distinguished from literature, and think that it may be well studied for its own sake, *i. e.*, as a proper exercise of the human intelligence, able to bring into action and development all the powers of the mind. As a branch of learning, it has (without reference to its applications,) become as extensive and varied as literature; and it has this privilege, that it must ever go on increasing.

* From the London Mechanics' Magazine, July, 1858.

Thus it becomes a duty to foster, direct, and honor it, as literature is so guided and recognised; and the duty is the more imperative, as we find by the unguided progress of science and the experience it supplies, that, of those men who devote themselves to studious education, there are as many whose minds are constitutionally disposed to the studies supplied by it, as there are of others more fitted by inclination and power to pursue literature.

The value of the public recognition of science as a leading branch of education may be estimated in a very considerable degree by observation of the results of the education which it has obtained incidentally from those who, pursuing it, have educated themselves. Though men may be specially fitted by the nature of their minds for the attainment and advance of literature, science, or the fine arts, all these men, and all others, require first to be educated in that which is known in these respective mental paths; and, when they go beyond this preliminary teaching, they require a self-education directed (at least in science) to the highest reasoning power of the mind. Any part of pure science may be selected to show how much this private self-teaching has done, and by that to aid the present movement in favor of the recognition generally of scientific education in an equal degree with that which is literary, but perhaps electricity, as being the portion which has been left most to its own development, and has produced as its results the most enduring marks on the face of the globe, may be referred to. In 1800, Volta discovered the voltaic pile; giving a source and form of electricity before unknown. It was not an accident, but resulted from his own mental self-education: it was, at first, a feeble instrument, giving feeble results; but by the united mental exertions of other men, who educated themselves through the force of thought and experiment, it has been raised up to such a degree of power as to give us light, and heat, and magnetic and chemical action, in states more exalted than those supplied by any other means.

In 1819, Oersted discovered the magnetism of the electric current, and its relation to the magnetic needle; and, as an immediate consequence, other men, as Arago and Davy, instructing themselves by the partial laws and action of the bodies concerned, magnetized iron by the current. The results were so feeble at first as to be scarcely visible; but, by the exertion of self-taught men since then, they have been exalted so highly as to give us magnets of a force unimaginable in former times.

In 1831, the induction of electrical currents one by another, and the evolution of electricity from magnets, was observed,—at first in results so small and feeble that it required one much instructed in the pursuit to perceive and lay hold of them; but these feeble results, taken into the minds of men already partially educated and ever proceeding onwards in their self-education, have been so developed as to supply sources of electricity independent of the voltaic battery or the electric machine, yet having the power of both combined in a manner and degree which they neither separate nor together could ever have given it, and applicable to all the practical electrical purposes of life.

To consider all the departments of electricity fully, would be to lose the argument for its fitness in subserving education in the vastness of its extent; and it will be better to confine the attention to one application, as the electric telegraph, and even to one small part of that application, in the present case. Thoughts of an electric telegraph came over the minds of those who had been instructed in the nature of electricity, as soon as the conduction of that power with extreme swiftness through metals was known, and grew as the knowledge of that branch of science increased. The thought, as realized at the present day, includes a wonderful amount of study and development. As the end in view presented itself more and more distinctly, points at first apparently of no consequence to the knowledge of the science generally, rose into an importance which obtained for them the most careful culture and examination, and the almost exclusive exercise of minds whose powers of judgment and reasoning had been raised first by general education, and who, in addition, had acquired the special kind of education which the science in its previous state could give. Numerous and important as the points are which have been already recognised, others are continually coming into sight as the great development proceeds, and with a rapidity such as to make us believe that, much as there is known to us, the unknown far exceeds it, and that, extensive as is the teaching of method, facts, and law, which can be established at present, an education looking for far greater results should be favored and preserved.

The results already obtained are so large, as even in money value to be of very great importance;—as regards their higher influence upon the human mind, especially when that is considered in respect of cultivation, I trust they are, and ever will be, far greater. No intention exists here of comparing one telegraph with another, or of assigning their respective dates, merits, or special uses. Those of Mr. Wheatstone are selected for the visible illustration of a brief argument in favor of a large public recognition of scientific education, because he is a man both of science and practice, and was one of the very earliest in the field, and because certain large steps in the course of his telegraphic life will tell upon the general argument. Without referring to what he had done previously, it may be observed that in 1840 he took out patents for electric telegraphs which included, amongst other things, the use of the electricity from magnets at the communicator, —the dial face,—the step-by-step motion,—and the electro-magnet at the indicator. At the present time, 1858, he has taken out patents for instruments containing all these points; but these instruments are so altered and varied in character above the former, that an untaught person could not recognise them. The changes may be considered as the result of education upon the one mind which has been concerned with them, and are to me strong illustrations of the effects which general scientific education may be expected to produce.

In the first instruments powerful magnets were used, and keepers with heavy coils associated with them. When magnetic electricity was first discovered, the signs were feeble, and the mind of the student was

led to increase the results by increasing the force and size of the instruments. When the object was to obtain a current sufficient to give signals through long circuits, large apparatus were employed, but these involved the inconveniences of inertia and momentum; the keeper was not set in motion at once, nor instantly stopped; and, if connected directly with the reading indexes, these circumstances caused an occasional uncertainty of action. Prepared by its previous education, the mind could perceive the disadvantages of these influences, and could proceed to their removal; and now a small magnet is used to send sufficient currents through 12, 20, 50, a hundred, or several hundred miles; a keeper and helix is associated with it, which the hand can easily put in motion; and the currents are not sent out of the indicating instrument to tell their story until a key is depressed, and thus irregularity contingent upon first action is removed. A small magnet, ever ready for action and never wasting, can replace the voltaic battery; if powerful agencies be required, the electro-magnet can be employed without any change in principle or telegraphic practice; and, as magneto-electric currents have special advantages over voltaic currents, these are in every case retained. These advantages I consider as the results of scientific education, much of it not tutorial, but of self; but there is a special privilege about the science-branch of education, namely, that what is personal in the first instance immediately becomes an addition to the stock of scientific learning, and passes into the hands of the tutor, to be used by him in the education of others, and enable them in turn to educate themselves. How well may the young man entering upon his studies in electricity be taught by what is past to watch for the smallest signs of action, new or old; to nurse them up by any means until they have gained strength; then to study their laws, to eliminate the essential conditions from the non-essential, and at last to refine again, until the encumbering matter is as much as possible dismissed, and the power left in its highly developed and most exalted state.

The alterations or successions of currents produced by the movement of the keeper at the communicator pass along the wire to the indicator at a distance; there each one for itself confers a magnetic condition on a piece of soft iron, and renders it active or repulsive of small permanent magnets; and these, acting in turn on a propellant, cause the index to pass at will from one letter to another on the dial face. The first electro-magnets, *i. e.*, those made by the circulation of an electric current round a piece of soft iron, were weak; they were quickly strengthened, and it was only when they were strong that their laws and actions could be successfully investigated. But now they were required small, yet potential. Then came the teaching of Ohm's law; and it was only by patient study under such teaching that Wheatstone was able so to refine the little electro-magnets at the indicator, as that they should be small enough to consist with the fine work there employed, able to do their appointed work when excited in contrary directions by the brief currents flowing from the original common magnet, and unobjectionable in respect of any resistance they might offer to the transit of these tell-tale currents.

These small transitory electro-magnets attract and repel certain permanent magnetic needles, and the to-and-fro motion of the latter is communicated by a propellent to the index, being there converted into a step-by-step motion. Here everything is of the finest workmanship, the propellent itself requires to be watched by a lens, if its action is to be observed; the parts never leave hold of each other; the vibratory or rotary ratchet wheel and the fixed pallets are always touching; and thus allow of no detachment or loose shake; the holes of the axes are jeweled; the moving parts are most carefully balanced, a consequence of which is that agitation of the whole does not disturb the parts, and the telegraph works just as well when it is twisted about in the hands, or placed on board a ship or in a railway carriage, as when fixed immovably. When it is possible, as in the vibratory needle, the moving parts are brought near to the centre of motion, that the inertia of the portion to be moved, or the momentum of that to be stopped, should be as small as possible, and thus great quickness of indication obtained. All this delicacy of arrangement and workmanship is introduced advisedly; for the inventor, whom I may call the student here, considers that refined and perfect workmanship is more exact in its action, more unchangeable by time and use, and more enduring in its existence, than that which, being heavier, must be coarser in its workmanship, less regular in its action, and less fitted for the application of force by fine electric currents.

Now there was no accident in the course of these developments;—if there were experiments, they were directed by the previously acquired knowledge;—every part of the investigations was made and guided by the instructed mind. The results being such (and like illustrations might be drawn from other men's telegraphs, or from other departments of electrical science), then, if the term education may be understood in so large a sense as to include all that belongs to the improvement of the mind, either by the acquisition of the knowledge of others or by increase of it through its own exertions, we learn by them what is the kind of education science offers to man. It teaches us to be *neglectful* of nothing;—not to despise the small beginnings, for they precede of necessity all great things in the knowledge of science, either pure or applied. It teaches a continual comparison of the *small and great*, and that under differences almost approaching the infinite: for the small as often contains the great in principle as the great does the small; and thus the mind becomes comprehensive. It teaches to deduce principles carefully, to hold them firmly, or to suspend the judgment:—to discover and obey *law*, and by it to be bold in applying to the greatest what we know of the smallest. It teaches us first by tutors and books to learn that which is already known to others, and then by the light and methods which belong to science to learn for ourselves and for others;—so making a fruitful return to man in the future for that which we have obtained from the men of the past. Bacon, in his instruction, tells us that the scientific student ought not to be as the ant, who gathers merely; nor as the spider, who spins from her own bowels; but rather as the bee, who both gathers and produces.

All this is true of the teaching afforded by any part of physical science. Electricity is often called wonderful, beautiful; but it is so only in common with the other forces of nature. The beauty of electricity, or of any other force, is not that the power is mysterious and unexpected, touching every sense at unawares in turn, but that it is under *law*, and that the taught intellect can even now govern it largely. The human mind is placed above, not beneath it; and it is in such a point of view that the mental education afforded by science is rendered supereminent in dignity, in practical application, and utility; for, by enabling the mind to apply the natural power through law, it conveys the gifts of God to man.

*Units of Work.**

The following are the results obtained in units of work or foot-pounds for one unit of heat by different authors.

	Centigrade thermometer. Foot-pounds.	Fahrenheit thermometer. Foot-pounds.
By Holtzman's formula,	1227	682
By Joule's experiments,	1386	770
By Rankine's formula,	1252	695
By Thompson's formula,	1390	772
For the best Cornish engine, by M. De Pambour,	148	82
For a perfect low-pressure condensing engine,	90.8	50.4
For an actual Boulton and Watt's engine,	46	25.5

Ransome's Process for Preserving Stone.† By R. HUNT.

The importance of the discovery of a process, which could be relied on, for the preservation of the stones employed in the erection of our public and other buildings, has long been felt; and many experiments have been made in the hope of attaining this object. In London, and in several of the large towns in the Provinces, we could point to buildings which have within a very few years exhibited the most unmistakable signs of decay. Lamina after lamina falls off, exposing a new surface to be freshly acted upon by the destroying agents; and thus, with comparative rapidity, the work of decay progresses; this has been referred to atmospheric causes, existing *now* as the result of our extensive manufactories and greatly increased population; but, to whatever cause the disintegration of the stone may be traced, certain it is, that scarcely any modern building, whether constructed of the coal measure sandstones, dolomites, oolites, or other well-known building stones, but exhibits, in a few years after its completion, lamentable evidences of decay.

Our attention has been directed to the Baptist Chapel built by Sir Morton Peto, in Bloomsbury. For some time past the Caen stone used in this structure has been crumbling, especially where it was exposed

* From the London Civ. Eng. and Arch. Jour., September, 1858.

† From the London Art Journal, October, 1858.