THURSDAY, APRIL 21, 1870.

ON ORIGINAL EXPERIMENTAL RESEARCH IN RELATION TO EMPLOYMENT FOR WORKMEN.

IT is an important national question, "By what means can employment for workmen in this country be increased?" My reply is, "By encouragement of experimental scientific research."

I have observed that increased employment of workmen constantly results from original experimental research in science in the following order: Experimental researches in science lead to scientific discoveries; scientific discoveries lead to practical inventions; and practical inventions lead to increase of employment. Usually, a scientific investigator first discovers some new fact or principle in science; next, an inventor applies this discovery, in the form of an invention, to some useful purpose; and then a manufacturer or man of business brings it into general use, and employs workmen or servants to assist him. In some cases, however, the discovery of a new truth in science, its application by invention, and its practical carrying out, are all effected by the same individual.

The following examples will illustrate the foregoing observation: — The discoveries of voltaic electricity, electro-magnetism, and magneto-electricity, by Volta, Oersted, and Faraday, led to the invention of electric telegraphy by Wheatstone and others, and to the great manufactures of telegraph cables and telegraph wire, and of the materials required for them. The value of the cargo of the *Great Eastern* alone in the present Bombay telegraph expedition is calculated at three millions of pounds sterling. It also led to the employment of thousands of operators to transmit the telegraphic messages, and to a great increase of our commerce in nearly all its branches by the more rapid means of communication. The discovery of voltaic electricity further led to the invention of electro-plating, and to the employment of a large number of persons in that business. The numerous experimental researches on specific heat, latent heat, the tension of vapours, the properties of water, the mechanical effect of heat, &c., resulted in the development of steam-engines and railways, and the almost endless employments depending upon their construction and use. About a quarter of a million of persons are employed on railways alone in Great Britain. The various original investigations on the chemical effects of light led to the invention of photography, and have given employment to thousands of persons who practise that process, or manufacture and prepare the various materials and articles required in it. The discovery of chlorine by Scheele led to the invention of the modern processes of bleaching, and to various improvements in the dyeing of textile fabrics, and has given employment to a very large number of our Lancashire operatives. The discovery of chlorine has also contributed to the employment of thousands of printers, by enabling Esparto grass to be bleached and formed into paper for the use of our daily press. The numerous experimental investigations in relation to coal-gas have largely been the means of extending the use of that substance and of increasing the employment of workmen and others connected with its manufacture. The discovery of the alkali metals by Davy, of cyanide of potassium, of nickel, phosphorus, the common acids, and a multitude of other substances, have led to the employment of a whole army of workmen in the conversion of those substances into articles of utility.

The foregoing examples might be greatly enlarged upon, and a great many others might be selected from the sciences of physics and chemistry, but those mentioned will suffice. There is not a force of nature, nor scarcely a material substance that we employ, which has not been the subject of several, and in some cases of numerous original experimental researches, many of which have resulted, in a greater or less degree, in increasing the employment for workmen and others.

The variety and extent of the employments which have resulted from scientific research are so great that they ramify in some form or other through nearly all our manufacturing, artistic, and commercial occupations, our social relations, and our every-day life; and those employments have become of such common occurrence that we are apt scarcely to think how much experimental research has had to do with their production, and we are thus led to undervalue original experimental investigation as a means of producing employment. Persons in general can easily understand that an acorn planted in the ground will, in the course of time, become an oak, because it is a palpable and visible effect; but they cannot so readily perceive that the abstract scientific fact discovered by experiment to-day will probably soon become an invention of practical daily use, not because it is less real, but simply because it is a phenomenon less evident to the senses, and requires a greater exercise of intellect to perceive it.

In many instances the application of original experimental science in new inventions has superseded, and in a limited sense diminished, manual labour, but it has in such cases either substituted more intellectual occupation for it, or has opened up new sources of employment to a far greater extent by increasing trade and manufacture. For example, the number of waggoners and horses now employed to collect and deliver all the goods for railways is much greater than the whole of those employed for conveying the goods of the country before railways were constructed.

The capability of developing increased employment by the means proposed is immense, and practically unlimited, because scientific discovery is quite in its infancy, and we are at present only on the very threshold of a knowledge of the forces of nature and of the constitution of material substances; in this sense, therefore, experimental scientific research may be viewed as *the* great fountain-head of employment for workmen.

The reason why original experimental science is the great fountain-head of industry in manufactures and trades trades is, that it is only by means of such research that we can become accurately acquainted with the forces and substances involved in manufactures, and be enabled to use them to the greatest advantage. The intimate connection between science and industry is shown by the fact that when new scientific discoveries are published there are numerous inventors who immediately endeavour to apply them to useful purposes, and men of business ready to carry out the inventions practically.

The great and important results already obtained by

the cultivation of original experimental research show that it is a national necessity, and naturally suggests the idea, can we not by a greater degree of encouragement of such research still further increase employment for working men, and still further elevate their intellectual condition?

At the present time there is in this country no recognised payment for the labours of scientific discovery, and no provision for the support of men who investigate science; any person is at liberty to take the published results of scientific men from the Transactions of the Royal Society, the Chemical Society, and other learned bodies, and employ them as the basis of inventions and patents, without the slightest payment, notwithstanding these results have been obtained at an immense cost of study, time, and labour, and a large amount of money. I do not mean by these remarks to conclude that scientific discoveries should not, on publication, become at once public property, but that some means of support should be provided for the men who make them, and thus the development of employment for workmen be increased.

Experimental scientific research, in the stricter sense of the words, is a comparatively modern thing, and though it has existed in a more limited degree during many centuries, it can only freely exist and thrive in civilised countries. Even at the present time, in consequence of the peculiar nature of the occupation, its hopelessness as a source of emolument to the investigator, the great skill and extreme self-denial required, and frequently danger incurred in its pursuit, and the consequent great difficulty of achieving success in it, *scarcely one person in one million of the population of England is exclusively devoted to it*, although a much greater proportion occupy a small amount of their time in its advancement.

The extension of physical and chemical knowledge by means of experiments and observations is *national* work: it benefits the nation, but does not pay the investigator. The various scientific men who discovered the chief facts and principles of science upon which steam-engines, electric telegraphs, and all the modern applications of science are based, received no remuneration for their researches. The results of purely scientific investigations are generally unsaleable, because, instead of benefiting a single manufacturer only, they benefit the whole nation; the nation, therefore, being the gainer, should pay and provide for those who make such researches. And when we consider that in this country upwards of 576 millions of pounds have been expended in the construction of railways alone, and immense sums upon electric telegraphs, which would never have been expended but for such labours, and nearly all of which have given employment to numberless workmen, it is evident that the magnitude and national character of the results would fully justify national encouragement of original experimental research.

The more abstract an experimental investigation is, the more important and widely diffused are its practical results. Who would have thought, when Oersted in his original abstract research in electro-magnetism first made a magnetized needle move by the influence of an electric current, that his labours would lead to the expenditure of many millions of pounds in the laying of telegraphs all over the earth, and the employment of many thousands of persons in their construction, maintenance, and use? And who can tell how many similar important discoveries have been lost to the nation, and how much of the present deficiency of employment for workmen has arisen, in consequence of experimental scientific investigators not having been paid for their labours?

At present, original experimental researches are generally made by teachers of science who expend a portion of their incomes in making experiments and observations; but the very limited means of such men is a serious loss to the nation by greatly retarding the progress of discovery, and consequently also of improvements in manufactures. Many of the experiments, also, necessary for the development of new discoveries are beyond the means of such persons at present, and cannot be made without the command of greater wealth.

If England is to keep pace with the progress of foreign intellect and of foreign manufacture, and keep her workmen fully employed, there must not only be a general diffusion of scientific knowledge throughout this country, but there must also be national encouragement of original scientific investigation.

Has it been wise in our Governments thus to overlook a great source of the nation's wealth, to disregard a most important means of national economy, to neglect the great fountain-head of industry? Shall we allow foreigners to supplant us in manufactures, and shall our fellow-men continue to be driven to emigration by want of employment? or shall we develope for them new sources of labour by means of original experimental research? It needs only to bring the subject fairly and effectually before the attention of our present enlightened and progressive Government, to ensure its careful and early consideration.

The neglect of original experimental science in this country by our Governments has long been noticed by scientific men and others, and a suggestion has been made to the British Association by Lieut.-Colonel Strange, to found "National Colleges of Original Research," in which science should be investigated, but not taught. This would be *one* way of supplying the want; the funds for supporting such colleges might with propriety be obtained from the fees paid for patents, because patents are in many cases based upon the published results of original experimental researches; other ways of supplying the want might also be indicated.

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OUR DOMESTIC FIRE-PLACES

Our Domestic Fire-places. By Frederick Edwards, jun. A new edition, &c. (London: Longmans, Green, and Co. 1870.)

THIS book, although bearing considerable traces of having for its object the advocacy of a particular manufactured article—nevertheless shows the author to have so much mastery over his subject as to justify its publication; and if the work be considered merely as the contribution of a highly qualified producer, the duty of the reviewer would be almost entirely to commend it; but if it is proposed as a complete and unbiassed treatise on the domestic fire-place he finds a good deal of reason to dissent.