be produced by evaporation, which, although too small to be observed, may yet be integrated over the surface of the earth into a large sum.

In looking back over the electrical year, we do not find any great discoveries. We notice, however, great activity in the process of refining old methods. The electrical exhibition at Vienna showed a host of applications of electricity to the arts. There was, however, no striking new invention like the telephone. In all civilized countries, the year has brought forth innumerable modifications of telephones and telephonic apparatus. When it had once been shown that even an imperfect sentence could be transmitted by electricity, the dullest inventor could discover, among the *débris* of his laboratory, magnets and electromagnets which needed but a slight twist here and there to be made into telephones. A touch of genius was necessary for the first twist; and then the whole electrical world had the seed of the invention. It is rumored that long-distance telephoning will soon be attempted with wires of low resistance.

Electric lighting continues to attract great attention; and more correct calculations are daily made, which will soon enable us to judge of the relative economy of incandescent lighting compared with gas. In an address to the Society of arts in London, the lamented Dr. Siemens — whose sudden death last December has been such a loss not only to electrical science, but to science in general — made an elaborate calculation of the cost of lighting large areas in cities, taking the parish of St. James in London as an example and also as a unit. He estimated that to light London to twenty-five per cent of its total lighting-requirements would require an expenditure of capital of fourteen million pounds, without including lamps and fittings; making an average capital expenditure of a hundred thousand pounds per district. Siemens estimated the cost of lighting by incandescence as twenty-one shillings and nine and a half pence per lamp per year; while to produce the same luminous effects in a good Argand burner costs twenty-nine shillings per year. This apparently shows that incandescent lighting is cheaper than lighting by gas, at the present price of gas.

Electric lighting seems to gain in the estimation of the public. Even the argument that if the electric-light companies were compelled to put their wires under ground the companies could not pay their expenses, and consequently that the public would lose the benefits of the electric light, has a strong influence upon many who prefer light to darkness in our city streets. The public, however, are only beginning to realize the dangers from the present method of running electric-light wires. A heavy storm at night might cause at any time disastrous conflagrations, from the electric-light wires coming in contact with other wires and with wood-work. The bulletins published by the Edison electric-light company show the great extension of his system. His plants are to be found in almost every civilized country; and the company are paying great attention to village plants.

The writer of this article is informed that the cost of lighting the great steamboat, The Pilgrim, is not far from that of gas, with a far better quality of light than gas could give. Lighting by incandescence is a great luxury; and, as soon as the public imagination has been sufficiently stimulated, it promises to become a necessity in many quarters. Other systems besides that of Edison are competing for the field opened for enterprise.

The practical applications of the storage of electricity, so called, have not been numerous during the year. It is maintained that it is more economical to use electrical accumulators than to light directly from dynamo-electric machines. There is still a wholesome fear of having several tons of lead left on one's hands in a disintegrated condition. Further experiments are necessary on an extended scale, with especial reference to a large factor of time, before electrical accumulators can be pronounced a practical success.

JOHN TROWBRIDGE.

BIOGRAPHIES OF NATURALISTS.

Heroes of science: botanists, zoölogists, and geologists. By Prof. P. MARTIN DUNCAN, F.R.S., F.L.S., etc. (London society for promoting Christian knowledge.) New York, *E. & J. B. Young & Co.* 348 p. 12°.

THE plan of the several volumes designated by the common title 'Heroes of science' is worthy of much commendation. It is a frequent and irritating experience of those who have become interested in scientific men's lives to find that they have a scant place in biographical encyclopaedias, and that even the greatest figures in that line of human activity are dismissed with epitaphal brevity of description. The proper way to meet this difficulty would be by preparing an encyclopaedia containing only the names of those who had contributed something to the store of science. 'Heroes of science' has a far simpler aim. Twenty-one names from the great muster-roll of men who may be termed naturalists are all that appear in this book. The first is that of Aristotle; the last, that of Lyell. The aim of the author is clearly to show how these men have played their parts, and something of the way in which they turned the course of science in their time. In this aim it seems to the present writer that Professor Duncan has attained a very substantial success. Within the slender space of two hundred and fifty small pages it is, of course, impossible to do any thing that can be called justice, to more than a score of very notable men, mostly of rich and varied lives; yet the reader will get a sense of their value to the world from the book, that he will not obtain elsewhere. Take, for instance, the life of Lamarck: though all too briefly told for true proportion, it is the best short account of

that true hero that can be accessible to the ordinary reader.

The greatest fault of the book is that the length of the text bears no sort of proportion to the importance of the men or their possible interest to the reader. Lamarck's life is one of the most picturesque of all scientific lives: it is more heroic in quality than that of any other given in the series. Lamarck gave as much or more to natural science than any other naturalist whose name appears here; yet to this man's eventful history but fifteen pages are given, while Sir Roderick Impey Murchison, from whom the world had little profit, who will find his place among naturalists of the second or third order, has twice the space allotted to him. Singularly enough, the one man who should have the first place among the modern men is not named at all. Darwin, who could have claimed a place in all the three divisions of the book as botanist, zoölogist, and geologist, is passed by. It may be that the book was prepared before the death of this great naturalist, and thus that the date does not represent the time of its printing. This is the only possible explanation of this startling omission.

The book is well printed. It has a sufficient table of contents, but no index.

GORDON'S ELECTRICITY AND MAGNETISM.

A physical treatise on electricity and magnetism. By J. E. H. GORDON. Second edition, revised, rearranged, and enlarged, in 2 vols. London, *Sampson Low*, 1883. 343 p., 27 pl., 151 illustr.; 332 p., 46 pl., 161 illustr. 8°.

THE demand for a new edition of a work of this magnitude, within about three years of its first publication, is a sufficient indication of its real usefulness, especially when we consider the fact that the first edition was also republished in this country.

The general scope of this treatise is to detail every thing of importance which is known experimentally respecting electricity and magnetism, referring to, and following as closely as may be, the original memoirs.

The mathematical theory of the subject is omitted so far as possible; nevertheless, the connection between the experimental facts and the results of modern theory are constantly pointed out by very numerous citations and references, especially to Maxwell. Indeed, these may, perhaps, be best regarded as companion volumes to those of Maxwell, from which the reader may learn how far theory and facts are now known to be in accordance.

We feel, however, that the author's reading has been too much confined to what has been published in England, and that he has not gleaned the field with equal diligence elsewhere. For example: we find no notice of the remarkable discovery by E. H. Hall of a new action of the magnet on electrical currents.[1]

The principal enlargements of this new edition are contained in the three chapters, 33, 35, and 36.

Chapter 33 contains an account of the beautiful experiments of Mr. Tribe in determining the variations of potential along the surface of a metallic conductor immersed in a fluid-cell by means of the electrolytic deposit upon the conductor.

Chapter 35 gives an account of the hydrodynamical experiments of Professor Bjerkens, on the apparent attractions and repulsions between bodies which are pulsating or vibrating in a fluid, which attractions are due to the mutual action of the currents set in motion by the pulsations. The importance of these experiments lies in the fact that they afford a possible clew to the nature of the mechanism which transmits electric and magnetic forces through space. In the course of these experiments, Bjerkens succeeded in imitating mechanically most of the ordinary magnetic phenomena, and showed that his field of force was similar to the magnetic field.

Chapter 36 details the subsequent researches of Mr. Stroh, respecting the same phenomena. Mr. Stroh used air instead of water as the medium in which the currents were set in motion. In this medium it was possible to explore the field of force much more completely than in water, and so to arrive at a much more exact knowledge of the facts and their explanation.

The author reserves what he has to say upon the subject of electric lighting for another work, which he has nearly completed, and which is to be specially devoted to that subject.

BASSLER'S WEATHER.

The weather: a practical guide to its changes, showing signal-service system, and how to foretell local weather. By S. S. BASSLER. Cincinnati, *Robert Clarke & Co.*, 1883. 54 p., illustr. 8°.

IN spite of our ten years' familiarity with the weather predictions of the signal-service as published in the newspapers, the general reader has as yet a very slight acquaintance with the principles and methods of weather study. The official circular on the 'Practical use of mete-

[1] *Amer. journ. math.*, ii. No. 3.