

science owes him a heavy debt. The magnetic circuit, and the mode of testing the performance of dynamo machines by means of characteristic curves, which themselves give valuable information regarding the magnetisation of the circuit, really did for the dynamo machine very much what practical thermodynamics and the indicator did for the steam-engine.

After an account of the General Properties of Magnetic Circuits, Dr. du Bois proceeds in his Chapter vii. to a discussion of the Analogy of the Magnetic Circuit with other Circuits. Here the author, as we think very properly, condemns the use of the term "Ohm's Law" to express the fact that magneto-motive force in the circuit divided by the magnetic reluctance is equal to the flux of induction in the circuit. This, it has always appeared to us, is using the term "Ohm's Law" to describe what is a mere result of definition. The equality of the magneto-motive force multiplied by the permeance (permeance =  $1/\text{reluctance}$ ) of the circuit to the flux of induction is a result of definitions of induction and field intensity, and to thus use it to introduce into magnetics the confusion which many have fallen into with regard to the law of Ohm in voltaic circuits. In the latter case, the law, properly speaking, expresses the proportionality of the current in a conductor to the difference of potential between two points in the conductor near its ends when the conductor is not the seat of any internal electromotive force. This result has no counterpart in magnetic circuits, and no "Ohm's Law" holds there.

In Chapter viii. the Magnetic Circuits of Dynamos or Electromotors is dealt with, the work of the brothers Hopkinson, the empirical formulæ for the magnetisation curves of such machines given by Frölich and others are all described, and the application of all this thoroughly practical theoretical discussion is focussed on the construction and arrangement of the field-magnets and armature of the machine.

We are immediately carried on in a natural sequence to magnetic cycles and hysteresis, and the immensely important researches on the magnetic properties of iron carried out by Ewing and others. The results in this field are, however, before all our readers specially interested in the subject, and the subject is so large and so full of detail, that we cannot with any advantage continue our sketch of the contents of the book.

The magnetic circuits of electromagnets, containing an account of the devices used by Ewing and the author to obtain very intense fields, and of methods of measuring such fields, is given in Chapters ix. and x. Up to about fifteen years ago determinations of field intensities had been confined to measurements of the earth's field-intensity or intensities of like magnitude, and a paper (*Philosophical Magazine*, 1882) by the present writer, describing methods which were in use in the Glasgow University Physical Laboratory, contained perhaps the first published statement of how the field between the poles of a powerful electromagnet could be quickly and accurately measured.

In this connection also we have one of the author's notable contributions to magnetics, in his account of the researches which he carried out at Berlin on the magneto-optical method of measuring intense fields.

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Here we must conclude our review of a most fascinating book. It cannot be praised too highly as a piece of work sound from every point of view, and tending to the advancement of knowledge. Dr. Atkinson and his colleagues have performed their work of rendering the book into English very carefully indeed, and on the whole the version reads like a book originally written, and well written, in English. Only in one or two places have we found, in a fairly extensive comparison of the German and English, that the sense has not been exactly caught. For example, at p. 340 a method of investigation there referred to is rather hardly treated by being described as "circuitous." The German "umständlich" ought here to be rendered by "circumstantial."

A. GRAY.

#### AUDUBON.

*Audubon and his Journals.* By Maria R. Audubon. With zoological and other notes by Elliott Coues. 8vo. Two vols. Vol. I., pp. xiv + 532; Vol. II., pp. viii + 554. Portraits, copies of diplomas, photographs, &c. (New York: Charles Scribner's Sons, 1897.)

NATURALISTS and many who are not naturalists will find this an entertaining book. It gives in great detail the incidents of certain years of Audubon's life, years in which he was carrying on his work in the field, or else meeting every day men who are still noteworthy. The book is founded upon unpublished journals and letters, of which parts are given at length. All has been corrected by recollections handed down in the family, and the zoological information has been revised by Dr. Elliott Coues. A summary of the naturalist's life is prefixed. We have now a full and lively account of what is most memorable in the life of Audubon.

Some readers who are not naturalists will turn with curiosity to the passages in which mention is made of places which are now populous American cities, but which, when Audubon dwelt there, or passed through, were backwoods settlements. Others will be glad to note small particulars concerning the naturalists, merchants, and men of letters whom Audubon saw during his visit to Europe in 1826-29—Cuvier, Bewick, Jameson, Selby, Jardine, Rathbone and Roscoe. Others again will study the character and methods of a man, who partly by real merit, and partly by the good-luck of becoming known to men who could write, has been widely accepted as a typical naturalist. Some of us can hardly remember the time when we had not heard of Audubon as the man who faced all dangers and fatigues, caring nothing for comfort or profit, if only he could learn more and more of the wild creatures which fly from the face of man. There is matter here for readers of very different kinds, and all should thank those who have rescued so many old papers, and arranged them so carefully.

Audubon was a real naturalist, if ever there was one. He had the passion for observing and drawing birds almost as a gift of nature. As a boy and young man he was fit for nothing else, but the responsibility which a family brings made him in middle life a sensible man of business. He was never a man of science. He never received from others, nor gave himself any kind of training in scientific method; he never studied the anatomy of

birds or systems of classification; above all, he never put questions of the slightest scientific interest. It was enough for him to draw his birds as they looked when alive, and now and then to note some curious detail in their mode of life. His less famous helper, MacGillivray, was far better furnished and far more productive. Audubon's "Birds of America" has great artistic merit, but less scientific value than a good series of photographs from life.

Audubon's career is now revealed to us more fully and more pleasantly than in any earlier account. He was born of French parents at Mandeville, on Lake Ponchartrain, somewhere about 1780. His first seventeen years were spent almost altogether in France, and he showed his turn of mind by making 200 drawings of the birds of France. Then he was sent out to Philadelphia, where his father had landed property. After another two years in France he came back to America, which henceforth he always claimed as his fatherland. At first young Audubon lived like a young gentleman of property, hunting, fishing, shooting, skating, but drawing birds too. He was a bit of a dandy in those days, and a favourite with young ladies. He went into business, married, and should according to all expectation have settled down as a money-making American. But he was intent upon birds and not upon money. He was easily diverted from a business-journey by a glimpse of a new bird, and was regularly cheated by his partners, agents, employers and customers. He complained that one of his partners cared only for money; the partner on his side complained that Audubon had no turn for commerce, and was continually in the forest. The advantages with which he started were soon lost, and in a few years we find him roving about in America, giving drawing-lessons, music-lessons, dancing-lessons, drawing portraits, but always adding to his portfolio of birds, and always studying how to make his delineations more life-like. The hope of publishing his great collection gradually became more definite. In 1826, being then near fifty years old, he came over to Europe to get subscriptions and engage draughtsmen. His diary shows him to us as sobered down by this time to a modest, careful man, minding his chances, and thoughtful for his wife and children. His success in publishing the "Birds of America," his later ventures, his expeditions to Labrador, Florida and the Missouri River, as well as his charming family life, are all described in the book before us. In 1847 his faculties began to give way, and he died in 1851.

The "Birds of America" has maintained its reputation, in spite of its enormous bulk, its costliness, and its want of scientific utility. It is now a luxury, only to be possessed by the wealthy, and very seldom enjoyed even by them, an unprofitable jewel in comparison with the homely tools which the working ornithologist requires. To have published a book which very few men can afford to buy, gives a certain kind of distinction. Audubon has better claims upon our attention than this, but the ever-rising price of his "Birds of America" has helped his fame.

One thing in the journals moves our indignation, but it will hardly excite remark among the naturalists of today; we mean the profuse and needless slaughter of wild animals, which fills almost every page of the journals. Audubon rises in the morning, snatches his gun, shoots

everything that shows itself, and then sits down to draw his victims. Some naturalists look upon all this bloodshed and torture as inevitable, or even enjoyable. That is the way to get together a museum of dried skins or a portfolio of drawings; it is not the way to solve scientific questions, nor to gain real insight into the works of nature.

L. C. M.

#### SEWER GAS AND HEALTH.

*Sewer Gas, and its Influence upon Health.* Treatise by H. A. Roechling, C.E. Pp. 224. (London: Biggs and Co., 1898.)

THERE is hardly a Corporation in the United Kingdom, we venture to say, to whose members sewer gas is not a hideous nightmare. It is the legacy of a bygone generation of hygienic enthusiasts, and is likely to prove the *bête noir* of many a succeeding generation of despairing sanitarians. Despite the brilliant achievements in the domain of hygiene of which the present century can justly be proud, the sewerage problem remains still a gordian knot the disentanglement of which seems as far off as ever.

Public opinion has swayed backwards and forwards, immense sums of money have been expended in what may be designated as vast hygienic experiments, sewers have been laid and relaid, ventilators introduced and abolished, and innumerable devices invented and applied in the hope of effectually getting rid of this mysterious and subtle influence in our midst.

Mr. Roechling in the above volume has added one more to the many indictments which have been published against sewer gas. These indictments are necessarily of a somewhat vague description, founded, as they must be, more on personal conviction than on strictly scientific facts; for our precise knowledge of the character and properties of this gas is at present so extremely limited, that we are frequently reduced to the manipulation of mortality statistics for a basis of attack. We must not, therefore, approach this book in the hope of finding a pyramid of new facts, for we may have to be satisfied with hardly a molehill, but we may recommend it as containing a useful summary of the circumstantial evidence which can be adduced against sewer gas.

The arrangement of the material, however, leaves much to be desired, and the writer is needlessly verbose. Considerably more than half the book is taken up with appendices, to which the preceding portion of the book has constant reference, and these appendices would be very much the better for judicious pruning. Page after page, for example, are devoted to detailed reports of cases of supposed poisoning through sewer gas; over twenty pages are occupied with reporting in full the legal proceedings connected with a case of blood-poisoning, &c. All this, no doubt, serves to swell the size, but it certainly does not increase the value of the volume.

As an example of the justifiably perplexed condition of some of our public authorities on the question of sewer gas, we may cite the case of Leicester as mentioned by the author. Up to the year 1881 the sewers of this city were in a very foul condition, and were not ventilated in any way, and the typhoid death-rate was as high as 32·2 per 100,000. In 1881, however, the Town Council decided to open up the sewers, thoroughly cleanse them