or three of its medical graduates on the Senate, founded an institute for the study of comparative pathology which, under Sanderson, Klein, Greenfield, Roy, and Horsley, has accomplished results of great benefit both to domestic animals and to man.

If, however, physiology and pathology are to some extent provided with means for research, others of the sciences allied to medicine and surgery are absolutely destitute. Physiological chemistry has scarcely existed in England since the days of Prout, and at the present day there is not a single laboratory where this difficult and important branch of knowledge is pursued. When Dr. Gamgee's excellent text-book is completed, the Index Auctorum will scarcely contain an English name.

Pharmacology—the experimental investigation into the action of drugs—is another foreign science. Fraser and Brunton have done much to redeem this country from absolute sterility, but in London there ought to be a laboratory like that of Prof. Schmiedeberg for this most obviously and practically useful of all medical sciences.

A laboratory for the study of Physiology would be the most closely connected with the memory of Hunter, with the Museum, and with the traditions of the College. A laboratory of physiological, pathological, or therapeutical chemistry would perhaps fill the most absolutely vacant space. A laboratory devoted to the direct study of the nature, origin, and propagation of Diseases, to their prevention, and to surgical methods of treatment would be the most directly useful and probably the most immediately fruitful.

So much is needful before England can begin to contribute her fair share to the common sum of knowledge, that it is scarcely possible to go far wrong in deciding what branch of medical science should first be taken up.

The Royal College of Surgeons has a great opportunity, and one that is not likely to return. If the great accession to its resources should be frittered away on a multitude of objects, the opportunity will be missed, and probably for ever. But we cannot doubt that the leading scientific surgeons in the kingdom will decide on using the Wilson bequest for the endowment of some new and urgently needed institution for research, which will be an honour to the College, a credit to the nation, and an instrument for increasing knowledge and diminishing suffering for centuries to come.

THE ELECTRIC MOTOR

The Electric Motor and its Applications. By T. C. Martin and Jos. Wetzler. (New York: Johnson, 1887.)

CONSIDERING the very rapid strides that have been made during the past six years in the industrial application of electric motors, the appearance of this handsome volume, giving the latest information on this topic, is thoroughly timely. It constitutes, though somewhat popular in style, a welcome addition to the library of the electrical engineer. Those who are accustomed only to the slow and steady development of industries in the Old World can hardly appreciate the revolution that is setting in in consequence of the employment, especially in small workshops and factories, of electric motors in place of steam-engines or gas-engines. They win their way because, though the actual cost of power is no cheaper, the expense of the electric motor is less than that of the steam-engine or gas-engine. It is less troublesome to keep in order, takes less room, runs at a more uniform speed, and is more cleanly. What wonder, then, that thousands—literally—of electric motors are already in use in New England, where an invention is welcomed, not sneered at, because it is new.

Much of the volume before us has already seen the light in another form in the pages of our American contemporary, the *Electrical World*, but the matter has been very carefully edited and arranged. It is by no means a scissors-and-paste affair; but a well-considered treatise, abundantly illustrated with drawings of motors and of their various applications. It treats the subject both historically and systematically.

The first chapter is devoted to an exposition of the elementary principles of electric motors. Almost at once we are plunged into the essence of the matter, the development in the armature of the motor of the counter-electromotive force, that *crux* of the untrained electrician. In this connection Jacobi's law, that the electric motor does its greatest possible work when it diminishes the original current to one-half, is given, and correctly given, not as a law of maximum efficiency, for which it has been so often mistaken, but as a law of maximum activity. But the authors have missed the point that Jacobi's law even in this sense is only true when the condition of supply of the electric energy is that of a given constant electromotive force. Jacobi's law would obviously not apply to motors placed in a circuit in which the given condition of supply was that of a constant current. The chapter concludes with some very apposite remarks on the general principles of construction of electric motors, quoted from a paper in the *Philosophical Magazine* by an English electrician, Mr. W. Mordey.

Chapter II. is devoted to early motors and experiments in Europe, from Barlow's wheel and the primitive engines of Jacobi and Froment down to the famous Pacinotti machine. The complement to this narrative is found in Chapter III., which deals with the early motors and experiments in America, beginning with Davenport in 1837. The most celebrated of these was that of Prof. C. G. Page, who succeeded in constructing a motor of 10 horse-power. The authors incidentally mention that, in the period of the Civil War, between 1860 and 1867 not a single patent on electric motors was issued in America.

Chapter IV. deals with the electric transmission of power, as developed successively by Pacinotti, Fontaine, and Marcel Deprez. In this connection the theory of the efficiency of electric transmission is explained by the use of graphic diagrams in which the areas are proportional to the energy transmitted or to the work performed. The experiments of Marcel Deprez are mildly criticised, and rules for calculating the cost are given.

The modern electric railway and tramway in Europe occupy Chapter V. Here several of Siemens's tramways are described, also those at the Giant's Causeway, at Brighton, and at Blackpool. Chapter VI. gives a similar account of the modern electric railway and street-car line in America. From this account it appears that Mr. Stephen D. Field is in America awarded the sole right to use "the combination of an electric motor operated by means of a current from a stationary source of electricity conducted through the rails," which "combination" he patented in 1880. Drawings of the electric

locomotives of Field, Edison, Daft, and others, are given. Several electric railroads of some magnitude are at work in the States. Chapter VII. resumes the subject of street railways in which storage batteries are employed for driving the electric motors. The work done in this country by Mr. Reckenzaun receives due recognition, and Mr. Elieson's tramway engine is also described. The industrial application of electric motors in Europe and in America occupies the next two chapters, the special form of motors devised by Profs. Ayrton and Perry being noticed in the one and those of Griscom and Daft in the other. Electrically-propelled boats and balloons are treated by themselves ; so also is the subject of telpherage. This subject—the transmission of freight along a wire road by electricity—originated with the late Prof. Fleeming Jenkin, and it has found imitators in America. The twelfth and last chapter is devoted to the latest American motors and motor systems, the motors of Brush, Sprague, Van de Poele, and others, being here described at length.

And here we must pause to point out the one blot on this otherwise excellent work : namely, that the entire theory of the self-regulating motor, which was discovered and worked out in 1882 by Profs. Ayrton and Perry, and which forms the basis of their epoch-making paper read in 1883 before the Society of Telegraph-Engineers, is appropriated *en bloc*, and accredited to Lieut. Sprague. From p. 160 it appears that Sprague's method of securing self-regulation is to use a differential compound winding ; but this is exactly Ayrton and Perry's method. Even the equation on p. 161, which is given as the Sprague law of winding, is identical with the equation given on p. 367 of the present writer's book (edition of 1884) on dynamo-electric machinery in the section on the theory of the differential compound winding. Another matter credited to Mr. Sprague by the authors is the discovery of a motor which, when supplied at constant potential, runs faster when the strength of the magnetic field is diminished. But this is no new principle : it is an inherent law of nature, common to all motors old and new, being the simple converse to the equally fundamental fact that a dynamo, if it is to generate a constant electromotive force, must be run faster in a weak field, and may be run slower if the field is strengthened. Lieut. Sprague has done good work in producing motors of excellent design and having points of original merit : this we may freely acknowledge without ascribing to him what was known before his work was begun. The authors will do well to correct these slips in the second edition, which will probably soon be demanded. The book is creditable alike to authors and publisher.

SILVANUS P. THOMPSON

THE FLORA OF LEICESTERSHIRE

The Flora of Leicestershire, including the Cryptogams. With Maps of the County. Issued by the Leicester Literary and Philosophical Society. 372 Pages and 2 Maps. (London and Edinburgh : Williams and Norgate, 1886.)

THE county of Leicestershire covers an area of 800 square miles of the centre of England, at the summit of drainage between three of the great streams, the Trent, the Severn, and the Midland Ouse. Almost the whole of the county is at least 100 feet above sea-level. A large portion of the surface is between 300 and 500 feet, and Charnwood Forest rises at its highest point to 900 feet, so that Leicestershire is very different from such low-lying level Midland counties as Cambridgeshire, Bedfordshire, and Huntingdonshire. Half the area of the county is in grass, about one-quarter is under arable cultivation, and there are 20 square miles of woodlands. In Charnwood Forest there are slate and granite, and the sedimentary rocks are represented in the county from the middle of the Palæozoic to the middle of the Mesozoic series—Carboniferous Limestone, Coal-measures (Permian missed out), Trias, Lias, and Lower Oolite—so that there is every variety of soil.

Competent botanists have resided in the county for the last three generations. The fathers of Leicestershire botany are Dr. R. Pulteney, F.R.S., who was a surgeon at Leicester, and the author of "A General View of the Writings of Linnæus" (1781), and the well-known "Historical Sketches of the Progress of Botany in England up to the date of the general adoption of the Linnæan System" (1790) ; and the poet Crabbe, who lived at Belvoir from 1782 to 1813, when he removed to Wiltshire. Between 1820 and 1850 Leicestershire was the home of three clergymen, all of whom were enthusiastic botanists. The Rev. Andrew Bloxam lived at Twycross for more than forty years. He is best known as one of the special investigators of the British brambles, and partly, perhaps, because he worked them so thoroughly there is a general idea that Leicestershire is the richest county in England in forms of this complicated genus. He was one of the last survivors who kept up the old tradition of botany as it was in the days of Smith, Hooker, Turner, Dillwyn, and Forster, when a collector swept through the whole vegetable kingdom, from the flowering plants down to the fungi. The Rev. W. H. Coleman was a most energetic and capable botanist. He was for many years one of the masters of the Ashby-de-la-Zouch Grammar School, and it was he who laid the basis of the present work, dividing the county into a dozen districts, and tracing out the distribution of the plants through them as fully as he had opportunity. He died in 1864, and in 1875 his manuscript was handed over by his friend Mr. Edwin Brown, of Burton-on-Trent, to the Leicester Literary and Philosophical Society, which appointed a Committee to amplify and revise it. Of this Committee Mr. Mott, of Leicester, has acted as Chairman, and Mr. Carter, Dr. Finch, and Messrs. E. and C. Cooper are the other members. The other clergyman who worked in conjunction with Messrs. Bloxam and Coleman was the Rev. Churchill Babington, for many years the Disney Professor of Archæology at Cambridge, and now Rector of Cockfield, in Suffolk. In 1850 Miss Mary Kirby (now Mrs. Gregg) published a small flora of the county, which contained a substantially complete list of the flowering plants and ferns of Leicestershire, but no attempt was made to trace out their distribution in detail.

In the present work the number of flowering plants and ferns, native and naturalised, in Britain is estimated at 1546, and of these, 825 are admitted for Leicestershire. This number of 1546 is reached only by counting the sub-species of such variable types as *Ranunculus aquatilis* and