months' standing, in a child two years of age, he obtained a rapid cicatrization by means of grafts from a fowl. He first tried grafts of frogs' skin, but as these proved to be repulsive to patients, and did not give very good results, he substituted others from the fowl; and the wound, which measured three inches by two and a half, had completely healed in two months. He had been equally successful in other and subsequent cases. He takes the skin from beneath the wing of a chicken, carefully securing the subjacent cellular tissue, but avoiding adipose tissue. The transplanted pieces varied from a sixth to a third of an inch in size, and they were maintained in position by means of a little cotton-wool and iodoform gauze. The skin of birds and fowls has the advantage of being supple, delicate, and vascular: it adapts itself readily to the surface of the wound, and adheres without undergoing absorption.

THE HUMAN BREATH. — Professor Brown-Séquard has recently been making experiments to determine whether the human breath was capable of producing any poisonous effects. From the condensed watery vapor of the expired air, he obtained a poisonous liquid, which, when injected under the skin of rabbits, produced almost immediate death. He ascertained that this poison was an alkaloid, and not a microbe. The rabbits thus injected died without convulsions, the heart and large blood-vessels being engorged with blood. Brown-Séquard considers it fully proved that the expired air, both of man and animals, contains a volatile poisonous principle which is much more deleterious than carbonic acid.

ELECTRICAL SCIENCE.

Electrical Traction.

IN the last two or three years a number of street-car lines have been equipped with electric motors, and most of them have been successful in spite of the inexperience of those who have done the work, — an inexperience due to the newness of the field. The number of electric railroads under way is increasing rapidly, and for certain classes of work the motor seems destined to take the place of the expensive and overworked car-horse.

As yet the greater part of the lines equipped have been for city tramways, generally in the suburbs, where there is comparatively little street traffic. This, however, is only a beginning, more useful in the experience it gives, and in the problems that are brought up and solved, than in the absolute results: for the question of the application of electricity to traction is a very broad one, and does not stop at street-railways. The elevated railroads may be run by electric motors; already motor cars are used in mines, where there is an extended field for their use; and it is possible that a few years will displace the steam locomotive, and substitute in its place powerful electrical locomotives.

There is no apparatus for the transformation of energy that compares in simplicity and efficiency with the dynamo-electric machine and electric motor. The steam-engine transforms perhaps fifteen per cent of the energy of coal into mechanical work; while the efficiency of a good dynamo may be ninety-two per cent, and a motor may have as high an efficiency. If, therefore, we transform mechanical work into electrical energy by a dynamo, and retransform it to mechanical work again by a motor, we have a total loss of perhaps fifteen per cent. It may be easily shown that in many cases it would be profitable, by taking advantage of the higher efficiency of large-power plants, and the comparatively small cost of attendance, repairs, etc., per horse-power, to generate all the mechanical energy needed in a district at some central station, and distribute it by dynamos and motors to the consumers, displacing the small steam or gas engine plants previously used.

For traction-work the problem is not to replace stationary steam-engines or gas-engines, but to replace horses, cables, and locomotives. This problem is being attacked, and will doubtless be at least partially solved.

Before taking up the relative merits and cost of different systems, let us consider the broad questions that are involved. The questions are, (1) How can we best produce the electrical energy needed? (2) How can we best get it to our motors? and (3) After we get it there, what is the best way to apply it to traction?

Under the first head there are a good many things to consider, and many of these can only be answered by knowing the exact conditions of our installation. We can say generally that for a given horse-power needed at our motor we should so choose our source of power and location of generating-station that the interest on first cost of plant and conductors (supposing we use them), the total depreciation, and the cost of the power *generated*, should be a minimum.

We will discuss these questions more fully when we come to the question of cost. To show the nature of the problem that might arise, suppose we have a railroad line from Philadelphia to New York to be run by electric motors. We would possibly find it best to have a number of generating-stations along the line, at distances apart of, say, twenty miles. Now, if there were no natural sources of power near the tracks, we would have to calculate the best distances apart for these stations, knowing the cost for a horse-power with plants of different sizes, the cost of copper for conductors, the cost of a ton of coal at different points on the line, etc. The problem would not be a difficult one. If, however, there was at some distance from the line a source of natural power, — a waterfall, for example, — we would have to redistribute our stations, and calculate whether it would cost less or more to utilize the waterfall, decreasing the cost of power, in that we do not have to pay for coal, but increasing the size of plant for a given electrical energy at the line (for we must supply the needed energy *plus* the loss on our lines), and increasing the outlay in conductors. Of course, this is all a very definite question, presenting little difficulty to the electrical economist. When we consider that some railroad lines have distributed near them water-power capable of running all of their trains, with help at long intervals from steam-generating stations (even windmills are not to be despised in some cases), and when we further consider that the conditions are much simpler than in city traffic (we can use high potentials and unsightly devices if we choose), it encourages one to predict a future for electric railroads.

If, as I have so far assumed, we are going to transmit the electrical energy to the motors by conductors, it is evident that the potential we can use comes in as a factor. In cities we are usually limited to a comparatively low potential, — a maximum, say, of five hundred volts. This has the effect of locating our generating-station as near the line as possible, — in the middle of the line if we can get it there, — for the cost of conductors would be great if the station were too far from the line. We will have more to say on this in any early number.

ELECTRICAL TREATMENT OF SEWAGE. — Mr. William Webster, F.C.S., has patented a process of purifying sewage by means of the electrical current. The pollution of rivers by the sewage of large cities is a constant source of danger to health; and, according to the London *Standard*, £1,000,000 is to be spent in attempting, by the employment of chemicals, to purify the London sewage. Mr. Webster's plan consists in sending a current of electricity from metallic electrodes through the sewage. The result, in experiments made on a very small scale, is to set the solid particles held in suspension in motion, "a kind of procession taking place from the top downwards, and from the bottom upwards. The sum-total of the movements consists in landing the suspended particles at the top of the liquid." "So prompt is the effect of the electric current that in twenty minutes a volume of opaque sewage becomes perfectly transparent, except at the top, where the organic matter collects in a semi-solid form." "From results already obtained it is calculated that the cost of the electrical treatment of the London sewage would be about £25,000 per annum. The annual outlay for chemicals is expected to be £18,000 for lime and iron, and £12,000 for permanganic acid, making a total of £30,000, a balance of £5,000 in favor of the electrical method. It would seem that Mr. Webster's experiments have, as yet, been on a small scale. If the practical results bear out what has been done in the laboratory, the process will be of the greatest importance.

TRANSFORMERS. — Two papers on this subject, read before the Society of Telegraph Engineers and Electricians, — one by Mr. Kapp, the other by Mr. Mackenzie, — have excited considerable discussion and interest on this subject of commercial induction-coils. Mr. Kapp's paper treats of the relative merits of different forms of transformers, and his methods are simple and easy of

comprehension. In all of this work on alternating-current apparatus the assumption that the electro-motive force and the currents follow simple sine curves is made; and, while the error in the assumption may or may not affect conclusions as to the types of action that occur, yet it must vitiate any attempt to deduce absolute values. Up to the present the subject of alternating currents has been singularly barren of experiments, while quite a number of problems have been solved by analytical and graphical methods. It is well known that a great many effects are not taken into account in the ordinary treatment, but the value of these outside effects has not been determined. The full discussion of these papers has not reached this side of the ocean: what has reached us is interesting and important, and will be given when the rest of it arrives.

BOOK-REVIEWS.

Chambers's Encyclopædia. New ed. Vol. I. A to Beaufort. Philadelphia, Lippincott. 8°. $3.

THE original issue of this work was completed twenty years ago, and few works of the kind have enjoyed an equal popularity, or rendered better service to the mass of readers. It is, of course, not to be compared in elaborateness with the *Britannica*, the articles in which are often in the form of lengthy treatises; but for non-professional readers, who do not wish to make a special study of the various branches of knowledge, but seek for general information on all subjects that arise in reading and conversation, this work has proved very valuable. The progress of events, however, and the increase of knowledge in almost every branch, have necessitated a new edition, the publication of which has now been begun. Many articles have been rewritten, and others partially so, while all have been subjected to a careful scrutiny by competent hands; and the result, so far as we have examined the work, seems to be excellent. Considerable attention has been given to American subjects, the more important of which have been treated by American writers; and their articles have been copyrighted in the United States by the J. B. Lippincott Company of Philadelphia, who publish the encyclopædia in this country. There is an article, however, on Americanisms in language, by an Englishman, Mr. Grant Allen, which contains some great mistakes. Thus, he says that "the speech and writing of the uncultivated classes diverge increasingly from the pure literary English standard;" the fact being that the language of the uncultivated Americans tends increasingly towards the literary standard, owing to the influence of the public schools and the growing taste for good reading. But most of the articles on American subjects are very good. One of the most difficult tasks in preparing an encyclopædia is to allot the right proportion of space to the various subjects treated, and in this respect the editors of this work have been quite successful. If the remaining volumes are up to the standard of the first, the encyclopædia will deserve and receive a renewal of the favor it has hitherto enjoyed.

Familiar Animals and their Wild Kindred. By JOHN MONTEITH. Cincinnati and New York, Van Antwerp, Bragg, & Co. 16°.

THE idea of presenting school-readers for youthful scholars, treating of familiar topics in natural science, is not a new one, but it is a thoroughly good one. The writer well remembers the permanent interest in every thing pertaining to natural history engendered in him by the use of the Wilson series of readers in years gone by. Such reading-exercises have been improved since that time, however, though there is still room for improvement. In no way, in the hands of a good teacher, can a child's powers and aptitude for self-observation be better stimulated than by well-prepared reading-exercises treating of the familiar forms of life. The knowledge imparted in such exercises should be accurate and comprehensible, but scarcely less important is the manner in which it is presented. A description that leaves nothing for the child himself to find out, no conclusions for him to draw, is of but secondary value. His faculties for thinking and observing, not his memory, need the most training.

The present school-reader, for that is what it is, meets fairly well these requirements, and, taking it all in all, merits commendation. It is intended for children of the third-reader grade, or say from eight to ten years of age, and is not only interesting, but instructive to them. The habits and anecdotes of the domestic and other familiar animals and their wild kindred are presented in pleasing shape. The material is largely adapted from known writers, or drawn from such authorities as Mivart, and is reliable. The engravings are good. Only mammals are treated of, and nowhere is the erroneous impression corrected that the word 'animals' is synonymous with four-footed mammals.

A Catalogue of Canadian Birds, with Notes on the Distribution of Species. By MONTAGUE CHAMBERLAIN. St. John, J. & A. McMillan. 12°.

THIS is an annotated list of the birds hitherto recorded or observed as residents or visitants of the vast and ill-explored region north of the United States. It is in reality the first attempt of the kind, and can only be looked upon as preliminary; but, though only a preliminary list, it has required labor, and will be very useful for future workers in Canadian ornithology, — a branch which, when we consider the excellent work done by the Canadian entomologists and botanists, has been much neglected in the Dominion. Notwithstanding the future revision which this list must be subject to, the author might have added to its value by tabulations after the manner of Merriam's work. By counting, it is ascertained that the whole number of species and sub-species recorded is nearly five hundred and fifty.

The Story of Creation, a Plain Account of Evolution. By EDWARD CLODD. London and New York, Longmans, Green, & Co. 12°. $1.75.

OF book-making on evolution there is yet no end. The present little work, however, presents a claim for recognition, not as an exponent of new views, theories, or facts, — for, as the author very naïvely admits, there is probably not a new idea in it, — but rather as an elementary exposition, a text-book, of the subject. As such, it will hardly find a place on the shelves of either the professed physicist or biologist, save as a fairly good epitome of the materials and methods of evolution in its widest sense. But to him or her who would not decry or accept Darwinism without some knowledge of the subject, and that fashion is happily subsiding, the work can be heartily commended. The author, while treating his subject in a scientific manner, has endeavored to make his book popularly readable; and he has succeeded fairly well, though the compression of so vast a subject into one small volume could hardly fail to produce a text-book-like concentration that will deter the mental dyspeptic. More than half the volume is made up of descriptive matter, both physical and biological, of the earth and the universe: the remainder is explanatory of their development or evolution, including man psychologically. In other words, as already stated, the author strives to give a brief exposition of the materials and methods of evolution in its widest sense. There are numerous good engravings, and the statements of fact, at least on the biological side, are in general fresh and reliable. The author might very properly modify the paleontological fiction of the thirty by one hundred foot Jurassic monster. It has never existed, for aught that is known. save in the describer's imagination: the figures need reduction one-half.

Practical Physics for Schools. Vol. I. Electricity and Magnetism. By B. STEWART and W. W. H. GEE. New York, Macmillan. 16°. 60 cents.

MOST physicists and many teachers of physics are already familiar with the two volumes on 'Elementary Practical Physics' by Messrs. Stewart and Gee, and nearly all will agree that they constitute an extremely valuable contribution to the facilities now available for the successful prosecution of instruction in physics by laboratory methods. The small volume now under consideration, since the word 'elementary' is omitted from its title, might be assumed to be more pretentious in its plan and execution than the others.

The contrary is the case, however, as it is intended for a lower grade of work. It is, as the titlepage has it, "for schools and the junior students of colleges."

To a considerable extent the book is an abstract, with simplifications, of the second volume of the other series. It is not entirely