The system is made still more effective by taking this air, not from the exhaust-pipe, but from the air-brake cylinders beneath the cars, and thus operating the continuous brakes on each car as well as the same work is done by the common Westinghouse system.

The experimental engine has drawn trains of three and four loaded cars from Harlem to the Battery, New-York City, a distance of nine miles, in two minutes and a half less than schedule time, — forty minutes, — making all stops, and on three-fourths of a single charge of air. The engine will handle well, alone, with a pressure of twenty-five pounds.

It is impracticable to cover long distances without refilling the reservoirs, and it is not proposed to attempt doing so. The reservoirs are to be filled at every ten-miles run, or every forty or fifty minutes; and filling-stations are to be provided at proper intervals along the line of the road. The reservoirs are so well made, that the engine stands all night, under a pressure of one hundred pounds, without appreciable loss of pressure.

The obvious and unquestionable advantages of this method of transportation are: safety from the dangers of explosion, which, aside from simple pressure, are unavoidable with steam and water; perfect cleanliness, not only on the engine, but along the line and on the train, in consequence of the avoidance of dust and smoke, and sparks from the engine; freedom from gas from the locomotive; less noise than with the steam-engine; freedom from the annoyances from dripping hot water, soiling the clothing, and half scalding the unfortunate pedestrian beneath; permanence of the reservoirs, which cannot be burned out, as can the steam-boiler, and which cannot be injured by the corrosion, due to leakage of water and steam, which is so serious a cause of injury to the steam-boiler. The engineer appreciates the latter points particularly, as well as the comfort of having no fire or fireman to look after and to distract his attention from his duties at the throttle, and ahead of the train. He is even saved the responsibility and taxation of 'looking out for the water' in the boiler, which is no small matter on the steam-locomotive.

Comparing the commercial sides for the two motors, the air-locomotive will undoubtedly be found to cost much less for repairs, to lose vastly less time in the shops, and to demand very much less of the time of the engineer and of the master mechanic, when off the road. Whether the cost of running will be so small as to permit the adoption of the system on our elevated railroads, and other railroads to which it may be as well adapted, cannot, as a matter of course, be certainly known until the experiment shall have been tried under all the best conditions for its operation. This is, in fact, the question to be determined. The experiment on the New-York lines is evidently very encouraging; and it is to be hoped that the very favorable estimates offered by its promoters may be confirmed by long trial, and the successful introduction of the motor. So far as we are aware, the compressed-air locomotive has hitherto been used only where, as in the longer lines of tunnels, there existed peculiar reasons for its introduction. The experiment is a perfectly legitimate one, and the new company are entitled to every favor that can be properly accorded those who attempt in any way the amelioration of the annoyances and the dangers of railway travel. R. H. THURSTON.

DANIELL'S PRINCIPLES OF PHYSICS.

A text-book of the principles of physics. By A. DANIELL. London, *Macmillan*, 1884. 20+ 653 p. 8°.

MANY of those who have been engaged in teaching physics to undergraduates during the last ten years have felt the want of a text-book more in accord with the present condition of the science than the majority of those accessible to the English-reading student. It is doubtless a fact, and a curious one, that those most generally in use in this country are, or perhaps it is better to say were, originally translations from the French; and this in spite of the generally admitted leadership of English-speaking people in this department of science.

Although, perhaps, the best attainable up to the present time, these English translations of French text-books have certainly fallen short of perfect adaptability to the work, and more and more so as the years passed by. It is true that an attempt has been made by the editors and publishers to keep pace with the rapid growth of the science, but this attempt has met with but doubtful success.

Any system or design or scheme which may have existed in some of these books in the beginning has been pretty effectually destroyed by the numerous additions which have been made from time to time, in the placing of many of which the convenience of the printer seems to have been oftener consulted than any thing else.

Although one may find a brief account of the very latest discovery or invention up to the time of going to press, he is likely to find it in a most unexpected place; and, although here and there will be found detailed fragments of modern theory, they are often so purely fragmentary as to be quite unintelligible to the student. In fact, the book comes to resemble a conglomerate in its structure; and the student, in attempting to 'go through it,' meets with sudden and remarkable changes in hardness and density. The fact is, the change which has been going on in the science of physics during the last fifteen or twenty years does not consist alone in the series of brilliant discoveries and inventions which have brought it glory and renown: along with these there

have been almost equally important revolutions in its methods and principles. It is less a collection of facts and experiments than it once was. Indeed, the accumulation of these within the past decade has been so rapid, and the collection is now so vast, as to preclude the idea of even an attempt to enumerate them in a text-book. Fortunately the accumulation of facts has been accompanied by classification and orderly arrangement. Theory and practice have been close companions, each occasionally taking the lead. Not many years ago it was possible, in a text-book of moderate dimensions, to state nearly all of the principal facts relating to certain departments of physics, which are to-day represented by special treatises, numbered by the hundred. The text-book for the undergraduate can no longer attempt to deal with these matters in detail. It must confine itself to a consideration of the established *principles* of the science, with such, and only such, experimental illustrations as are necessary to enable the student to comprehend these principles. Experiments must be typical rather than special in form, and of such a character that the phenomenon to be exhibited is the prominent feature, rather than the particular piece of apparatus with which it is shown.

In the preparation of this book, its author has taken a new departure, and largely in the direction indicated. In glancing through its pages, one is equally surprised, both by the presence of many things which he has not before seen in text-books of a similar grade, and by the absence of many other things to the sight of which he has long been accustomed. Of the latter, the most noticeable, at first, are the fine pictures, the absence of which is a conspicuous feature of the book: indeed, the character of the work is revealed more promptly through this feature than any other. Cuts and drawings are introduced whenever, in the opinion of the author, they are necessary to elucidate the text; but they are generally of the simplest character, and such as can readily be reproduced upon the blackboard, or added to, if thought desirable, by one possessing little skill. In describing an experiment, only the absolute essentials are shown; the details of construction, and special forms of apparatus, being left to the imagination of the student, or the descriptive powers of the teacher. Perhaps the economy exercised in this direction has been a little too rigorous; but the plan possesses great advantages, both direct and indirect. One is spared the elaborate descriptions of apparatus which occupy so many pages of other text-books. It must be admitted that this is, on the whole, a considerable gain. It is often difficult to understand a complicated instrument from a description and a cut; and often the more accurate the latter, the greater the difficulty, as much attention will be given to the really non-essential parts. Students have a perverse way of being interested in the architecture of an instrument, and often receive a more lasting impression from its 'elevation' than from its 'ground plan.' It is not an uncommon experience to find that a man will study an instrument from cut and description in the text-book, and fail to recognize the same thing under a somewhat different form, when it is placed on the table before him. It would be interesting to know how many undergraduate students who have studied electricity are able to distinguish the soul of a galvanometer from its body so completely as to be able to recognize it in all of the numerous forms in which it materializes.

Again: in many instances the instrument so carefully figured and described in the text-book has become obsolete, which can hardly be said of the principle involved.

The omission of this illustrative and descriptive part of the text-book is to be commended because it leaves room, — it leaves room for the introduction of much matter, which is certainly more than the equivalent of that which is omitted.

Considerable gain in space accrues from another noticeable feature of the book, in which it differs materially from those more generally in use.

It is not a book of reference. The reader will not fail to observe the entire absence of tables, and will look in vain for collections of physical constants, or of numerical data, or of the various and varying results of different experiments in quantitative investigations. The history and personal aspect of scientific discovery will be missed by many, and this omission was evidently reluctantly decided upon by the author.

Strip some of our well-known text-books of all these, and they will shrink very considerably in their dimensions. There may be difference of opinion concerning the desirableness of these omissions. Our author has unquestionably assumed, that, wherever his book is used, there will be a good collection of physical apparatus, which may be accessible to the student for examination when desirable; and an enthusiastic and competent instructor, who knows the history of his subject, and can arouse the interest and enthusiasm of his class by suitable references to eventful periods of discovery

and to the personal characters of discoverers. His text-book provides the pupil with the meat of the subject: the side-dishes, dessert, etc., must be furnished by the teacher.

The book is an octavo volume of about six hundred pages, — not larger than several well-known treatises in general use. Only an elementary mathematical training is assumed; so elementary, in fact, that the author has thought it desirable to define the well-known constant π, which he does in a note. Let no one be deceived by this, however: the student will discover, as he progresses, that he must know his elementary mathematics well, and that he must possess facility and readiness in the use of symbols.

In the introduction, some of the fundamental principles on which the science is based are discussed. One or two terms concerning which there has been more or less dispute are handled a little delicately in the beginning. An instance of this is the use of the word 'force.' The author is a little shy about defining it at first. His confidence grows, however, as the work progresses; and he once or twice hints at, but never quite reaches, the neat statement of Clerk Maxwell, that force is 'one of the aspects of a stress.'

A chapter is devoted to the processes of measuring space, time, and mass, in which the rather discouraging statement is made, that "good linear measurement, in whatever way effected, ought to present an error less than one-millionth of the whole." There is a well-written chapter on work and energy, including a brief discussion of the indicator diagram. This is followed by the subject of kinematics, covering more than a hundred pages.

The treatment of this subject is somewhat novel for a book of this class, including, as it does, a tolerably complete discussion of simple harmonic motions, their composition and resolution; a statement of Fourier's theorem; a discussion of waves and wave-motions; the propagation of waves, their reflection, refraction, interference, and diffraction; the vibrations of chords, membranes, etc. In the statement of Ptolemy's law for reflection, and Fermat's for refraction, often known as the principles of least distance and least time, the author has failed to note the very important exceptions to both, or to give the limitations to which they are subject.

There follows the subject of kinetics, in which some general propositions in reference to forces are derived from those already established in the study of motion. Moment of inertia, radius of gyration, and energy of a rotating body, are more thoroughly treated than is customary in such a treatise.

There is a very satisfactory chapter on attraction and potential. Potential of a point in space, equipotential surfaces, lines and tubes of force, etc., are discussed in a manner so clear and intelligible as to enable the student to be somewhat master of the situation when he comes to the practical application of these conceptions. The chapter on gravitation and the pendulum is satisfactory; but, in the last proposition, the author has made the not uncommon mistake of failing to correctly state the conditions of the reversible pendulum. It is a little curious that it is not oftener observed that a symmetrical bar will oscillate about *any* two points equally distant from the centre of gravity in the same time. Students are likely to be considerably puzzled when they attempt to determine in this way the length of a single pendulum, and discover, that, the shorter the pendulum, the longer the period of vibration.

In many text-books the study of matter and its properties forms the subject of the opening chapter; with some propriety, perhaps, as matter is assumed to be the solid foundation upon which the science of physics rests. In this volume, however, it is not discussed until nearly two hundred pages have been passed over. One of the peculiar features of the treatment of the subject by our author is the admission of the ether as a form of matter; and the reasons for so doing are ably presented. Its properties as matter are explained as far as known or surmised, and the vortex atom is not forgotten. The chapter includes a discussion of the molecular constitution of matter, a brief consideration of surface-tension and superficial viscosity, with their application to capillary phenomena, and a brief study of viscosity of solids, liquids, and gases.

The middle of the book is passed before the study of heat is begun. Heat is considered as including two totally distinct forms of energy; and the treatment of what is known as radiant heat is deferred until a later period. Under the head of heat proper will be found some discussion of the principles of thermodynamics, including a treatment of Carnot's cycle. It occupies forty pages, and might have been improved by a more complete presentation of the subject of conduction. Sound is considered through fifty pages, in which musical intervals and scales, the vibration of strings, and the propagation through solids, liquids, and gases, receive rather more attention than is usual.

Under the general head of 'ether-waves,' the unity of the so-called heat, light, and actinic rays is explained. The theory of exchanges, and Stokes's law, are considered. The treatment of color is extremely satisfactory. The origin and propagation of ether-waves, reflection, refraction, and polarization, together with the postulates of Fresnel, Neumann, and MacCullagh, occupy considerable space. All of this precedes what is generally known as geometrical optics, which is not elaborately discussed. In double refraction the Huyghenian construction is given, and the study of optical instruments is remarkable for its brevity.

Electricity and magnetism are provisionally defined as properties or conditions of matter, the matter referred to being that extraordinary form known as the ether. Just enough in the way of experiment is given to enable the student to understand the development of the principles of the subject, which are established under the assumption that he has mastered the chapter on attraction, potential, etc., already referred to. Some of the notable features of this part of the work are more than ordinarily intelligible discussions of thermo-electricity, Peltier's and Thomson's 'effects,' the presentation of Maxwell's theory, with his electromagnetic theory of light, and brief mention of Rowland's, Kerr's, and Hall's experiments. There is also a comparison of units in the electrostatic and electromagnetic systems, and a discussion of the meaning and value of the constant v. The arrangement of topics in electricity and magnetism may be criticised, in that it would seem desirable to have introduced the subject of magnetism and magnetic potential at an earlier stage, thus making possible an earlier exposition of the origin of the electromagnetic units of measure.

In connection with the matter of units, it is worth while to remark, that throughout the work the author has felt constrained, possibly out of respect for an unwholesome English prejudice, to make frequent use of the foot, inch, pound, ounce, grain, etc. It is, perhaps, hardly fair to expect an English author to adhere strictly to the use of the metric system; but in the present instance the confusion of the units is a blemish all the more noticeable by reason of the otherwise simple and elegant methods of treatment. Clumsiness of statement and solution is frequently the unavoidable result. No evidence of this is needed; but it may not be amiss to quote from so conservative a source as Thomson and Tait (Nat. phil., art. 408), who, although selecting the foot as being 'for British measurement generally the most convenient,' remark, that "the British measurements of area and volume are infinitely inconvenient, and wasteful of brain-energy and of plodding labor. Their contrast with the simple, uniform metrical system of France, Germany, and Italy, is but little creditable to English intelligence."

Not the least remarkable feature of the book is, that its author is a lecturer in a medical school, and it "was primarily designed as a contribution to medical education."

Altogether the book must be regarded as one greatly in advance of those of a similar grade generally in use. It is not intended as a substitute for a laboratory and laboratory practice, for no book can be this; but it is admirably adapted for a preparation to a laboratory course, in that it furnishes the student with such "a store of general principles, that, when he comes to enter a physical laboratory, he may then find around him, in the concrete form, a collection of pieces of apparatus the construction and the action of which he is able, by the application of principles already familiar to him, promptly and intelligently to comprehend."

The belief that such a text-book will be gladly welcomed by many teachers of physics in this country may justify the somewhat extended reference to its character and contents, given above.

PROPAGATION OF TUBERCULOSIS.

The influence of heredity and contagion on the propagation of tuberculosis, and the prevention of injurious effects from consumption of the flesh and milk of tuberculous animals. By A. LYDTIN, Carlsruhe, veterinary adviser to the Baden government; G. FLEMING, LL.D., F.R.C.V.S., principal veterinary surgeon to the British army; and VAN HERTSEN, veterinary surgeon, and chief inspector of the Brussels abattoir. New York, *Jenkins*, [1884]. 175 p. 8°.

THIS volume is a translation, by one of the committee upon its preparation, of a report prepared for discussion at the International veterinary congress, held at Brussels in September, 1883. The question of the etiology of tuberculosis is one of the most important of modern medicine, and occupies the attention of a large part of the profession to-day. Its importance is not confined to the human race, in so far as it attacks mankind; but, be-