

conversion of a "stream" into a "tone," and "adding" to the "resonance" of such a converted stream, is very slipshod-writing. On the whole matter of resonance (p. 46) the writer is unsatisfactory. He does not include the cavities between the vocal ligaments and the lid (epiglottis) among the resonating chambers, except in the objectionable passage just cited, and he does not enter into the question of the modification of quality of tone by means of these resonances. By some accident in engraving Plate XIII. the letter w is placed on the windpipe, as well as on the cartilages of Wrisberg, and the vocal ligaments are not distinct enough. All the figures, XIII. to XVI., seem to be copied from the English edition of Madame E. Seiler's "Voice in Singing." It is a pity to waste space in such a little book on controversy. It was hardly necessary to quote Madame E. Seiler at length (pp. 81-90), and then controvert many of her statements. This only tends to confuse the learner. The result should be given from the author's own observations, and then, if desired, the points of difference might be explained in a note. Similarly for the controversy about the action of the "wedges" (cuneiform cartilages) on p. 45, which has no interest or use for a beginner. The space devoted to controverting Mr. Lunn's "Philosophy of Voice" (pp. 52, 69, 70), and to Mr. Illingworth's "hazelnut" theory of the "pockets," and other bits of controversy with Miss Sabilla Novello (p. 30) and Dr. Garrett (p. 32) might also have been saved with advantage.

It takes much space to point out a few minor blemishes that scarcely detract from the general merits of the book, which is clearly the result of much real work and careful observation.

#### OUR BOOK SHELF

*Keith Johnston's Illustrations of Electricity and Magnetism.* By W. Lees, M.A. (W. and A. K. Johnston, Edinburgh and London.)

MESSRS. W. and A. K. JOHNSTON have begun an excellent work in issuing these four sheets of diagrams in illustration of the fundamental experiments of electricity and magnetism. The subjects are well chosen, and with hardly any exception well drawn and coloured. They will be welcomed by teachers of science classes in schools for their clearness and general excellence. Mr. Lees, who has prepared them, has also issued a specially-written "Handbook" to accompany each sheet. Of these handbooks—though perhaps useful for such pupil-teachers as may have the misfortune to be set to teach a subject in which they have themselves never made a single experiment—the less said the better. The writer of them is in bondage to the ideas of half a century ago. Take as a specimen the following statement concerning the Leyden jar:—"Suppose, then, the accumulation of electricity in the jar to proceed, the quantity of free electricity in the inner coating goes on also increasing, *until the density of that electricity becomes the same as the density of the electricity of the prime conductor.*" The italics are the author's own! This is no more absurd, as a scientific statement, than it would be to say that when a dock-sluice is opened the water rushes in from the higher level until the muddiness of the water inside is as great as the muddiness of the water outside; for the electric equilibrium of two conductors no more depends upon the *density* of their respective charges than does the flow of water upon its degree of turbidity. Yet the writer of this amazing sentence styles himself "Lecturer on Natural Philosophy, Edinburgh." For the sheets of diagrams themselves we have nothing but praise.

#### LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

#### A Fourth State of Matter

MR. CROOKES has given us optical evidence of the existence of matter in a state of tenuity known hitherto only indirectly, and considers himself warranted in affirming the discovery of a fourth or ultra-gaseous condition; yet it can scarcely be conceded that he has demonstrated the truth of his views, or that his recent exposition of them has strengthened his position or satisfied the doubts of the sceptical. It is simply a question of the use or misuse of certain specific terms, and it is difficult to follow the logic which justifies the creation of a "fourth state" by the attribution of properties not differing essentially from those of matter in its normal condition. Before his contention be granted it should be proved that the substance under experiment possesses properties exclusively and inalienably its own; as rigidly defined as those which distinguish the solid from the liquid, or the latter from the gaseous.

By the abstraction from his experimental chamber of a large portion of its contents he has enlarged the interstitial spaces of the residual gas, and thus amplified the mean free path of molecular vibration from some millionths of an inch to several inches; but beyond this extension of the path of oscillation there seems nothing to warrant the opinion that the residual gas is essentially other than it was before.

If this amplification of the molecular path be the feature relied on for justifying the term "fourth state"—and this seems the only inference—then further travel in this direction brings us to a point easily within our conception, where the contents of the experimental chamber shall not exceed one or two molecules; and it becomes interesting to know if Mr. Crookes would then add a *fifth* to the other states of matter. To do so would seem the inexorable outcome of his reasoning, and inevitably resolves the question into one of the numerical contents of the chamber; and it rests with him to define the precise point where the ordinary conditions cease, and the *ultra-gaseous* commences.

In gases, whether at the normal density, or rarefied to 3 mm., we have an unbroken continuity of condition; which, contrasted with the solid and liquid forms of matter, is noticeable for the absence of any point whence a new state can be said to originate: would Mr. Crookes assign a vacuum of 0.999 mm. or one of 0.0003 mm. as the critical point in the attainment of his "fourth state" or some intermediate density?

Again, has Mr. Crookes fully recognised the distinction between the properties of matter *per se* and those which are referable to electrical agency as revealed by the experiments of Messrs. De La Rue and Müller, where the projection of molecules against the walls of the containing vessel is attributed to electrification; or, further, the fact that a tenuity approaching that attained in his experimental chambers has been long familiar to us in the case of steam of very high pressure?

Whatever may be the solution of our speculations regarding the ultimate condition of matter, opinion seems unanimous that the concrete form in which it is known to us consists of an aggregation of particles having immutable properties and composition, gaseous bodies being definite molecular groupings of such particles; and if such be the case, and the chemical character of the contents of Mr. Crookes' experimental chambers remained unaltered, it is difficult, if not impossible, to conceive the existence of any further condition other than that produced by the breaking up of the molecule into its component atoms.

London, July 9

GEO. E. NEWTON

#### Permanent Record of Foucault's Pendulum Experiment

SOME four years since, while arranging a Foucault's pendulum for use in the class-room, it occurred to me to endeavour to obtain a permanent record of the experiment, and as the results were very good, and the method simple, they may be interesting to others.

The pendulum used was sixteen feet long, the height of my lecture-room at the Massachusetts Institute of Technology, and