tables; but the method now adopted is attended with the great disadvantage of adding enormously to the labour of examining the work critically.

In 1868 the most serious desideratum in Russian meteorology was the large number of undetermined heights among the stations. But shortly thereafter Wild commenced vigorously to make good this great defect, and his successor, Rykatchew, is successfully carrying out this good work. It is much to be desired that in a few years it will be completed. The more important desiderata still outstanding are large portions of northern and south-eastern Siberia.

The new hypsometrical and meteorological data put before us in this atlas are exceedingly valuable accessions to meteorology. For while the broad features of the geographical distribution of pressure and temperature, as previously disclosed, remain substantially the same, yet the fresh data now submitted result in many cases in more accurately defined positions of the isobars, isotherms and wind direction in their occurring changes from month to month.

It is truly a genuine pleasure to the climatologist to use these rectified monthly isobars and isotherms in explanation of the monthly changes in the geographical distribution of snow and rainfall, number of days of precipitation, humidity, cloudiness and other weather phenomena in their all-important bearings on the agricultural and other economic interests of the Russian Empire. Prof. Rykatchew and his singularly able staff are to be congratulated on the successful termination of this great work. ALEXANDER BUCHAN.

A FRENCH CRITIC OF MAXWELL.

Les Théories électriques de J. Clerk Maxwell. Étude historique et critique. Par M. P. Duhem. Pp. 228. (Paris: A. Hermann, 1902.) Price fr 8.

IN this work the earlier writings of Maxwell on electrical subjects, as well as his "Treatise on Electricity and Magnetism," are discussed. The general attitude is somewhat severe, as may be inferred from the following extract translated from the preface:—

"The different theories of the Scottish physicist are irreconcilable with the traditional theory; they are irreconcilable with each other. . . . At each instant it seems that the result even of his own reasoning and of his calculations is going to drive Maxwell to impossible and contradictory results; but . . . Maxwell makes an embarrassing term disappear, changes an inacceptable sign, transforms the meaning of a symbol; then, having passed the dangerous spot, the new electric theory, enriched by a paralogism, pursues its deductions."

Of the electrostatics in the paper "On Faraday's lines of force," which Prof. Duhem regards as the first of three different theories of statical electricity propounded by Maxwell, his concluding remark is that it is only the semblance of a theory. Maxwell states sufficiently clearly, we should have thought, that his object was not to establish any physical theory, but to point out certain analogies between lines of force and lines of flow.

Of the theory developed in the paper "On physical lines of force," Prof. Duhem writes that it does not even lead to the expression in equations of the problem of the polarisation of a given dielectric medium; this seems to be because Maxwell assumes without formal proof that the function whose spacial differential coefficients express on his theory the electromotive force is identical with the potential of the classic theory; it seems very easy to rectify the omission.

Altogether too much capital is made of Maxwell's unfortunate confusions of sign, and it seems puerile to complain of the use of the popular term "electric tension" where "electric pressure" is required by strict analogy.

Prof. Duhem's objection to Maxwell's interpretation of the various terms in the expression obtained for the magnetic force[1] appears well grounded.

In discussing the third electrostatic theory of Maxwell, as contained in the paper "On a dynamical theory of the electromagnetic field" and in the "Treatise," comments are made on the obscurity of Maxwell's idea of electric displacement and on the confusion caused in the form of the equation of continuity by thinking of a charge of electricity sometimes as a real thing and sometimes as a mere fiction representing the effect of nonuniform polarisation. All readers of Maxwell know these difficulties; most will be disposed to agree with Hertz that if we interpret the word "electricity" in a suitable way, nearly all the apparent contradictions can be made to disappear, rather than follow Prof. Duhem in his *reductio ad absurdum*.

Prof. Duhem contrasts Maxwell's theory of displacement through a dielectric considered as a continuous medium having an elastic constant different from that of pure æther with the theory which regards all the phenomena as due to action at a distance on the analogy of Poisson's theory of induced magnetism. His expression for the electrostatic energy on the latter theory contains a term which is furnished by the surface separating two different dielectrics and which corresponds to the fictitious charge of electricity due to change of polarisation on crossing that surface; consequently he infers that this theory clashes with that of Maxwell. Consideration of the work actually required to charge the conductors in such a case renders it difficult, however, to see how on either theory the expression for the total organised energy can differ from that given by Maxwell. Prof. Duhem then refers to Gouy[2] as having shown that the classic doctrine completely explains the actions observed between conductors and dielectrics by Pellat,[3] among others, and concludes that such actions could not be deduced from Maxwell's theory. In the absence of precise numerical calculation and comparison with experimental results, this inference appears somewhat rash, even if the premisses were correct. Gouy, however, in the paper referred to does not consider the case of two different dielectrics at all. Pellat, moreover, considers the results of his experiments to be in perfect accordance with Maxwell's theory; he points out, however, that as his calculations of the effective forces on the surfaces of conductors and dielectrics are deduced from the variation of the electrostatic energy, his experimental results, as well as those of Quincke, may be explained without accepting Maxwell's

1 "Scientific Papers," vol. i. p. 463.
2 *Journal de Physique*, 3e série, t. v. p. 154, 1896.
3 *Annales de Chimie et de Physique*, 7e série, t. v. 1895.

theory and thus do not serve to establish it. (The simplicity and directness of Pellat's theoretical investigation seem noteworthy when compared with the discussions of Gouy and of Larmor;[1] in each of the latter some of the apparent forces have to be explained away, and they appear to contradict each other. It may be that in such discussions too much importance is at present assigned to Maxwell's stress-system in the absence of more definite knowledge concerning the transmission of force between æther and matter, if the use of such a phrase is permissible.)

Prof. Duhem points out that Maxwell, in obtaining his first estimate of the velocity with which electromagnetic waves are propagated,[2] confounds Lamé's coefficient of rigidity with one of his own, which is really double the former, and that on correcting this mistake a velocity is obtained which exceeds that of light in the ratio of $\sqrt{2}$ to 1. This work of Maxwell's is, however, generally regarded as containing only the germ of a theory of light and as indicating that the two velocities concerned are of the same order of magnitude.

The author concludes by lauding the electrodynamic theory of Helmholtz, which he regards as satisfactorily reconciling the electromagnetic theory of light with the ancient theories of electricity and magnetism.

It is surprising to find no reference whatever to Larmor or to H. A. Lorentz in the historical sketch of this branch of the subject.

Although some of the mistakes pointed out by Prof. Duhem are real and important, the view taken throughout, as will be gathered from the above, appears a very narrow one. W. McF. ORR.

OUR BOOK SHELF.

Clinical Pathology and Practical Morbid Histology. By J. Strangeways Pigg, M.A. Second edition. Pp. 107; 5 plates and 6 figures. (London: Strangeways and Sons, 1901.) Price 5*s*.

THIS is a small interleaved handbook for use in the laboratory, dealing with the different methods employed in examining blood and other normal and pathological fluids and morbid tissues.

The descriptions of the various methods referred to are brief and concise, and the steps of each operation are tabulated in exact sequence, with perhaps the exception of 24, D, where steps 6 and 5 should obviously be transposed. Objection may be raised to such an arrangement as being too dogmatic and allowing no scope for individual ingenuity, but, on the other hand, those who have to deal with large classes of students, to whom the book is chiefly directed, will agree that some such method is absolutely necessary if one would instil the principles underlying good technique.

The general "get-up" of the book is good; there are very few printers' errors save an occasional missing letter at the end of a line, or the interpolation of a letter from another fount of type. "The illustrations," we are told, "are diagrams only," a description obviously applying to those of apparatus and urinary sediments—which latter, by the way, would have been more useful had they been bound up in somewhat closer proximity to the letterpress relating to them—but hardly fair to the two coloured plates of blood-cells. These are, in spite of their accuracy, beautiful and artistic, and reflect nothing but credit on artist and lithographer.

[1] *Phil. Trans.* 1897, A. p. 248.
[2] "Scientific Papers," vol. i. p. 500.

The methods set out in the text are, for the most part, well chosen and well described; those dealing with morbid histology are, however, by far the most successful. In blood work, we notice, the author recommends Cabot's "two-cover-slip" method of spreading films—a method which in the hands of experts yields, perhaps, 10 per cent. of stainable specimens—and quite ignores the simpler method introduced by Manson, in which gutta-percha tissue or a piece of cigarette paper is employed.

We notice, too, in the preparation of cover-glass films from pus or sputum, that extremely dirty and slovenly method of pressing out a small portion of the material between two cover-glasses and then sliding them apart, is given as the usual method. We hope that this is not the universal practice in Cambridge laboratories.

The sections dealing with bacteriological methods and urinalysis are certainly disappointing—in the latter the methods are few in number and, in our opinion, not always happily chosen, whilst fuller indications of the fallacies which attend some of the tests would have enhanced their value. In that portion dealing with bacteriological investigations, many of the methods might find favour in the clinical laboratory, but would certainly be *taboo* in the well-regulated bacteriological laboratory. We notice, too, that the author invariably uses *Carbol*-gentian-violet in staining by the method he terms Gram's; it is true the actual stain is easier to prepare, but its results are decidedly inferior to those yielded by the Anilin-gentian-violet originally described by Gram.

As we have before mentioned, the book is intended for the medical student, and as such is of distinct value, a fact sufficiently evidenced by the success with which the first edition has met

The Balancing of Engines. By W. E. Dalby, M.A., B Sc. Pp. xi + 283. (London: Edward Arnold, 1902.) Price 10*s*. 6*d*. net.

THIS work is of a character which can be studied with interest. It deals with a subject of great importance to mechanical engineers, and one which is coming more and more to the front in the design of high-speed engines and machinery.

Prof. Dalby is the author of several papers dealing with this important subject, read before the Institutions of Naval Architects and Mechanical Engineers; these papers are largely drawn upon in the present volume.

"The main object of the book is to develop a semi-graphical method which may be consistently used to attack problems connected with the balancing of the inertia forces arising from the relative motion of the parts of an engine or machine." This we learn from the preface, and, what is more, it requires nothing but the knowledge of the four rules of arithmetic and good draughtsmanship to apply satisfactorily the methods so well described.

The balancing of the working part of locomotives has always been treated from different points of view, and the practice of a particular drawing office largely governed the result; in fact, not many years ago an eminent locomotive engineer looked upon the balancing of his locomotives as an unnecessary addition to their weight.

Chapter iv. deals with this very important subject in a clear, concise and practical manner, and even only for this one chapter all interested in locomotive design should possess this volume. The author advises that those interested in locomotive work should begin chapter iv., after working the examples of arts. 48 and 49, progress being tested by working the exercises at the end of the book.

The treatment is simple, several types of Lancashire and Yorkshire Railway Company's locomotives being taken as examples, and little thought will be necessary to carefully follow the threads of the argument. The experimental apparatus described to illustrate the