of the prism, gave the data for plotting the dispersion curve of rock-salt. The results, exceeding in accuracy any heretofore obtained, and which will be of the greatest value to other investigators using rock-salt dispersion for infra-red work—are given in several convenient forms, most conveniently, perhaps, in the shape of a very large scale curve, extending between the limits $\lambda = 0.5\ \mu$ and $\lambda = 6.5\ \mu$, from which indices of refraction can be read off to 0.000002, and for which the probable error lies usually between 0.000009 and .000018. The dispersion curve of fluorite is given on the same scale between the limits $\lambda = .75\ \mu$ and $\lambda = 3.5\ \mu$. From the data for rock-salt have been calculated the five constants of the Ketteler dispersion formula, which differ quite noticeably from those calculated by Rubens and Trowbridge for a longer wave-length interval; but the differences between the observed and computed values of index of refraction are hardly greater than the probable errors of deviation, except for the longest wave-lengths. Accurate comparisons have also been made of the dispersion of three rock salt prisms which confirm the view that rock-salt as found in nature is in one respect of great optical uniformity, so that accurate determinations of indices of refraction for one prism can be safely applied to another for the purpose of determining wave-lengths; an extremely fortunate circumstance.

It is impossible to do more than mention some of the lesser pieces of work here recorded —such as the determination of the energy curves of various incandescent mantles; tests of the accuracy or constancy of the bolometer, which unfortunately do not touch the most difficult point, *i. e.*, constancy as regards sensibility for long time intervals; and a study of the minute structure of the infra red absorption band 'ω_1.' A considerable space is, appropriately, devoted to the discussion of errors, and to methods for overcoming difficulties inherent in bolometric work; of which the most troublesome are undoubtedly 'drift,' or the continuous change in the zero position of the galvanometer spot of light, and the more or less rapid periodic changes of zero, or 'wiggle.' The various precautions taken, which have finally almost eliminated the drift and greatly reduced the 'wiggle,' are dealt with in full; few of them altogether new perhaps, but certainly applied here with greater completeness and care than has been done elsewhere. The detailed consideration of manipulation and construction will be of great value to others engaged in similar work. In particular should be mentioned the study of the behavior of rock-salt prisms under conditions of rising temperature; the question of the construction of linear bolometers, in which such skill has been attained, and of the design of balancing bridges; and the full discussion of the adjustments of the fixed-arm spectroscope. In the chapter on the galvanometer will be found a useful table of the computed axial magnetic force produced by galvanometer coils of various resistances, wound either with a single size of wire or with different combinations of three sizes, which not only shows clearly the advantage of sectional winding, but will be a valuable aid in the design of galvanometers. The use of the Ayrton-Mather scale for expressing galvanometer sensibilities, now so generally adopted, would have rendered easier the comparison of the observatory instrument with others.

The valuable and interesting material, which it has been here attempted briefly to summarize, is the result of about nine years of work, involving the labors, successively, of Dr. Hallock, Mr. Wadsworth, Mr. Child and, for a longer time, of Mr. Abbot and Mr. Fowle, all under the direction of Professor Langley. From time to time statements of the progress of the work have been made by Professor Langley, and some special points considered in papers of Mr. Wadsworth, Mr. Abbot and Mr. Fowle, but the results now made public are so interesting and so important to all engaged in similar work that it is to be hoped that in the future conditions affecting publication by the government may allow more frequent and less delayed reports from this observatory, which is unique in its possibilities for the highest class of work with radiant energy.

C. E. Mendenhall.

Dynamo Electric Machinery. Its construction, design, and operation. Direct current machines. By Samuel Sheldon, A.M., Ph.D.

Assisted by HOBART MASON, B.S. 12 mo. Pp. 281. Price, $2.50, net.

The appearance of a promising new text-book on a subject relating to electrical engineering in any of its phases is a matter of much interest in the engineering schools; but Dr. Sheldon's book on 'Dynamo Electric Machinery' may justly receive special attention on account of the author's experience as a teacher and writer, his reputation for vigor, and the evident care with which he has constructed the book. Covering a field in which there are many books, the new comer finds an ample demand which is unfulfilled; for none of the older books are completely satisfactory as text-books and few are more successful as reference books. The demand for a really successful college text-book on applied electromagnetism and the construction of dynamos is therefore large and crying, and the new comer was assured of a certain effusiveness of welcome from technical college circles.

It then becomes a matter of interest to scrutinize the book and learn whether it fulfills those important requirements that are yet unfulfilled by existing literature; and it is a satisfaction to say that in many respects it bears the scrutiny well. In order of treatment and clearness of exposition the book is admirable, as it also is in typography and in much of the illustrative matter. The book has characteristics which are excellent in one designed for classes of trained mechanics, and perhaps the shorter and in some respects more superficial 'information courses' of instruction, which are given in our engineering schools to classes of men who are not following the professional course in electrical engineering and for whom the allotment of time to the subject of dynamos is insufficient for the most approved scientific instruction.

Dr. Sheldon's book was thus used during the past year in the University of Wisconsin as the text-book for a short course of study in dynamos required of mechanical engineering students. In this place the book proved successful, though several predecessors that presumably occupy a similar field had failed to give satisfaction. It is also expected that Dr. Sheldon's book will give good results in the better classes of the Summer School for Apprentices and Artisans which has just completed its first session at the University of Wisconsin.

For the longer course in applied electromagnetism and the construction of dynamos that should be presented to the men pursuing a college course in electrical engineering, this book does not appear to be so well adapted. Such a course should deal in principles, principles, principles; and it should be remembered that good results involve much labor on the part of the student, however much interested he may be. In the small compass of Dr. Sheldon's book, so much space is occupied by descriptions and illustrations of the commercial apparatus of the day that the principles of electromagnetism and the modes of their application cannot be adequately treated.

We have no text-book on this subject which satisfactorily meets the requirements of a thorough treatise for the 'electrical engineering students' of our colleges, and we may justly say that it is better to use as a syllabus for these classes some book which deals sensibly and with reasonable adequacy in the theory of electromagnetism, than to use a book like Dr. Sheldon's which is of the so-called 'more practical' character. This choice of the preferable plan casts much labor on the teacher; but where the best teaching is the object, labor cannot be shirked.

To meet the requirements of the college classes to which I refer, a book is required of much greater scope than Sheldon's and much greater volume. One may doubt whether Sheldon's book was seriously planned for such classes, as the author's intention is stated in his preface to be to write a book 'to be used primarily in connection with instruction on courses of electrical engineering in institutions for technical education'; and also to meet the wants of '*the general reader, who is seriously looking for information concerning dynamo electric machinery* of the types discussed, * * *.' The object which I have set forth in italics has been well attained. It is obviously impossible to attain this object, and also to meet the requirements of extended scientific instruction, in the subject of this book, all within the covers of a duodecimo volume of 281 pages.

One object well attained is success, and it is to be hoped that the book will reach sufficient sales through the reasonable accomplishment of this object, so that the author may be encouraged to write another and more extended volume which may meet the needs of the electrical engineering students.

The author is to be congratulated upon the remarkable freedom of his first edition from typographical errors. In other respects he is perhaps not always so fortunate, as in some of his definitions, which are not always adapted to give a proper physical conception to the student. Also, in certain parts of the book, the descriptive matter is inexact or inadequate —especially is this true in the chapter on armature windings, where no attempt is made to present the rational laws of windings, and the short descriptions are inadequate and the diagrams too small to be thoroughly serviceable. Such faults, however, may be readily corrected in another edition, the compliment of an early demand for which we cordially wish for the author.

All in all, we heartily welcome the book to a useful sphere and compliment the author on his success. But we must regret that he did not make a book which might occupy the more important place of a scientific college text-book on applied electromagnetism and the construction of dynamos.

DUGALD C. JACKSON.

DISCUSSION AND CORRESPONDENCE.

A NEW FIELD FOR KITES IN METEOROLOGY.

TO THE EDITOR OF SCIENCE: Although kites carrying recording instruments to a height exceeding three miles have rendered great services to meteorology at Blue Hill and elsewhere, they have been subject to the limitation of requiring a wind that blows at least twelve miles an hour. In certain types of weather—notably anti-cyclones—the winds are light and consequently observations with kites can rarely be obtained at these times. It also happens frequently that, while the wind at the ground is sufficient to raise the kites, it fails completely above the cumulus clouds so that the kites are unable to penetrate this calm zone.

By installing the kites and apparatus on a steamship, not only can kites be flown in calm weather, but observations may be made above the oceans where little is known about the conditions of the upper air. It is evident that a vessel steaming twelve knots an hour through a calm atmosphere will raise the kites to the height they would attain in a favorable natural wind, while the force of strong winds can be moderated by steaming with the wind. In this way, kites can be flown on board a steamer, under almost all conditions and probably more easily than on land, since the steadier winds at sea facilitate launching them. Wherever these observations in the upper air may be made, there is always a station at sea-level and not far distant horizontally with which to compare them.

To test the practicability of this method of flying kites, experiments were undertaken on August 22, 1901, with the aid of my assistants, Messrs. Fergusson and Sweetland, upon a tow-boat chartered for this purpose to cruise in Massachusetts Bay. Anti-cyclonic weather conditions prevailed, and a southeast wind blew from 6 to 10 miles an hour, but at no time with sufficient velocity to elevate the kites, either from sea-level or from the summit of Blue Hill. With the boat moving 10 miles an hour toward the wind, and within an angle of forty-five degrees on either side of its mean direction, the resultant wind easily lifted the kites and meteorograph with 3,600 feet of wire to the height of half a mile.

While it is desirable to have a vessel that can be started, stopped and turned at the will of the meteorologist, as was the case in the experiments described, it is nevertheless probable that soundings of the atmosphere can often be made from a steamship pursuing its regular course, and such are about to be attempted by me on a steamer eastward bound across the North Atlantic. Although observations above all the oceans are valuable, the exploration of the equatorial region is the most important, since, with the exception of a few observations on the Andes and on mountains in central Africa, we know nothing of the conditions existing a mile or two above the equator. The need of such data to complete our theories of the thermo-