

ally attractive to chemists concerned with the application and manufacture of dyes.

Praise is due also for the general index, and, excepting a few lapses into laboratory slang and the "of course" habit, the literary form is commendable. In the second edition, however, it is to be hoped that the author will establish uniformity of construction in the compound words; to find "octa-chlor anthracene" in one line, and "tetrachloranthraquinone" in the next, is exasperating to a methodical reader, and a bad example to students. This fault is persisted in throughout, and is the only blemish in an otherwise admirable treatise. M. O. FORSTER.

The Future of Geometrical Optics.

(1) *Geometrical Investigation of the Formation of Images in Optical Instruments, embodying the Results of Scientific Researches conducted in German Optical Workshops.* Edited by M. von Rohr. (Forming vol. 1 of "The Theory of Optical Instruments.") Translated by R. Kanthack. Pp. xxiii+612. Printed and published for the Department of Scientific and Industrial Research by H.M. Stationery Office, 1920. (From any bookseller or through H.M.S.O. at Imperial House, Kingsway, W.C.2, and 28 Abingdon Street, S.W.1; 37 Peter Street, Manchester; 1 St. Andrew's Crescent, Cardiff; 23 Forth Street, Edinburgh; or from E. Ponsonby, Ltd., 116 Grafton Street, Dublin.) 2l. 5s. net.

(2) *Die Binokularen Instrumente: Nach Quellen und bis zum Ausgang von 1910 Bearbeitet.* By Prof. Moritz von Rohr. Zweite, Vermehrte, und Verbesserte Auflage. (Naturwissenschaftliche Monographien und Lehrbücher. Zweiter Band.) Pp. xvii+303. (Berlin: Julius Springer, 1920.) 40 marks.

AT a meeting of the Optical Society held in Cambridge on May 21 last, the future of geometrical optics formed the subject of an interesting discussion, in which the points of view of mathematicians and practical designers respectively were expressed. The subject has regained actuality in recent years in view of the undoubted superiority in optical design possessed by the German manufacturers in 1914, a superiority which proved a serious handicap to us in the manufacture of optical instruments such as range-finders, etc., required for military and naval purposes. The importance of this branch of knowledge was then realised; unfortunately, before the war the subject had been gradually dropping out of university curricula, the labori-

ous algebra involved and the stereotyped methods of treatment combining to render it distasteful to mathematical teachers and students. Relegated to a corner of the mathematical syllabus, geometrical optics was too often reduced to a few formulæ crammed in a hurry, and it lacked the vitalising influence of really interesting and practical illustrations. The manufacturing optical designer, on the other hand, tired of waiting for mathematical developments adequate to his needs, became increasingly empirical in his methods, and even now depends almost exclusively upon trigonometrical tracing of a few rays, which is, in fact, nothing else but trial and error. Probably this almost complete divorce between theory and practice accounts largely for the unprogressive character of pre-war British optical design as compared with the German.

(1) It is a natural inference that in some way the British type of text-book on this branch of science fails to stimulate the reader, and, bearing in mind the pioneer work of Abbe, Seidel, Steinheil, Koenig, and von Rohr in Germany, it is obviously desirable that the work of these masters of the subject should be made readily accessible to English-speaking students. The Department of Scientific and Industrial Research is therefore to be congratulated upon bringing out a translation of the classical treatise on "The Theory of Optical Instruments," edited by Moritz von Rohr. The translation has been carried out by Mr. R. Kanthack, and the work has evidently been done with great conscientiousness and accuracy. The translator acknowledges the valuable help of Messrs. J. W. French and E. B. Knobel and of Prof. J. W. Nicholson. In various respects the translation is an improvement on the original, the numbering of the paragraphs and equations greatly facilitating reference. Additions and modifications have also been made to the bibliography, and the figures have been improved and various errors corrected. The book is well got up, and altogether a very creditable production, which meets an undoubted need.

When all this has been said, however, it may be doubted whether, after all, von Rohr's treatise is really likely to stimulate the student, at any rate in this country. For one thing, it is not the work of a single mind. Chap. 1, on the fundamental principles, is by H. Siedentopf; chap. 3, on Abbe's theory of optical images, by E. Wandersleb; chap. 4, which treats of optical images from a different point of view, by P. Culmann; chap. 8, on prisms, by F. Loewe; Dr. Koenig has written chaps. 6 (on chromatic aberrations) and 7 (on the computation of optical

systems in accordance with the theory of aberrations), the latter probably the most important of the whole book, from the point of view of the designer; von Rohr himself, although responsible for the editing of the entire collection, has actually written only chaps. 9 (on the theory of stops) and 10 (on the photometry of optical instruments); while he and Koenig are jointly responsible for chaps. 2 (on the computation of rays through an optical system) and 5 (on the theory of spherical aberration).

In the circumstances it is inevitable that there should be a certain lack of cohesion, which gives one the impression of a number of separate treatises bound together rather than of an ordered and progressive exposition.

To remedy this an attempt has been made to set up a rigorously uniform nomenclature throughout. A list of symbols is given at the end, but this list occupies six large pages of print, and the very sight of it seems likely to paralyse the reader. If symbols are to be standardised, then they should be as few and as fundamental as possible, so that they can be readily learnt and retained in the memory. This has the additional advantage of releasing a mass of symbols for use in special problems, where they may be usefully employed in simplifying the algebra.

Even with all these precautions the notation is not always clear; thus in formula (7), at the foot of p. 350, x' apparently refers (although this is not stated) to the intercept on the axis made by a principal image ray of a particular colour; but on the very next page x' is used to denote the intercept on the axis made by the image plane, and these two are not the same.

The suffix notation is based on refracting surfaces, quantities after refraction being accented. In many respects a notation which assigns odd suffixes to refracting surfaces (or to given combinations of them) and even suffixes to media is more convenient; it saves the use of accents, which are always confusing, making them available for other uses.

The main trouble, however, is, that throughout the book the learner is not led up progressively from the easy to the difficult. Fundamental principles and results which must be grasped and remembered are not sufficiently extricated from a mass of detail which is best put on one side for reference if and when it is needed. Each chapter takes the reader to the limits of its particular domain, and leaves him there, somewhat bewildered at the multiplicity of results. What is really required in a mathematical subject of considerable algebraic complexity such as geometrical

optics (or, say, theory of elasticity, or lunar theory) is a guiding thread, knotted at intervals into fundamental theorems. For such a guiding thread one looks in vain in von Rohr's treatise.

One notices, too, that characteristic tendency of most German works towards needless elaboration. Thus Fig. 15 and almost the whole of pp. 45 and 46 could be dispensed with by simply applying to the triangles BB_uO_u and BB_uO_u' in Fig. 14 the rule that the sides of a triangle are proportional to the sines of the opposite angles, which leads immediately to formula (6) of p. 46. Instead, we are given two pages of algebra, with several new symbols, including an auxiliary angle. This is only one of many examples.

On the other hand, the work is not free from the converse defect of introducing statements made on unconvincing grounds. Thus on p. 351 we are told that $V\beta=0$ when $s_k'=\infty$, because

$$\frac{Vs_k'}{s_k' - x_k'} = \frac{V\beta}{\beta}.$$

But in this case we have usually $\beta=\infty$ and $Vs_k'=\infty$, so a proof that $V\beta=0$ would involve a discussion of awkward indeterminate forms, of which nothing is said.

Such failures, however, are few. On the whole, the subject is treated with complete thoroughness, and the discussion is exhaustive, if laborious. von Rohr's theory of optical instruments is, and must remain, a classic and an admirable book of reference. But one must regretfully admit that the ideal book which is to fire the enthusiasm of the young British optical designer has still to be found.

(2) Far more attractive to the reader, and conceived in quite a different spirit, is another book by von Rohr, which appeared last year in Berlin, to wit, the second edition of his "Binocular Instruments." This is an eminently readable and interesting monograph dealing with the development of stereoscopic instruments, a branch of optical design in which German manufacturers had made very great progress before the war. The chapter dealing with the early investigations before the time of Wheatstone has been enlarged and rewritten.

The book opens with a chapter on the theory of stereoscopic vision, but the bulk of it is historical and descriptive, and the reader gradually builds up his knowledge of the subject by following the evolution of successive instruments. We would strongly recommend the study of this work to the British optical manufacturer. Its language is non-mathematical, and the geometrical arguments are easy to follow. The diagrams are not

elaborate (probably on account of post-war conditions), but they are sufficient. The whole subject is one of great interest. Stereoscopic instruments have now got well beyond the curious toy stage, and have many applications of precision, not the least of which is to range-finders, of which the Germans appear to have made considerable use.

The value of such a historical monograph, especially with the excellent index of names and references at the end, is very great. To anyone desirous of acquiring rapidly knowledge of a subject for research purposes, it means an incredible saving of time and labour. It is also an aid to research in another way, by unearthing a number of results long forgotten, from which many a valuable hint can be gleaned. For the lack of work of this kind far too much of the time of men of science nowadays is spent on re-discovery.

L. N. G. F.

Kite Balloons.

The Design and Stability of Streamline Kite Balloons, with Useful Tables, Aeronautical and Mechanical Formulae. By Capt. P. H. Sumner. Pp. viii + 146. (London: Crosby Lockwood and Son, 1920.) 10s. 6d. net.

WHILE a vast literature has grown around aeroplanes since the outbreak of the war gave an unprecedented stimulus to aeronautical theory and practice, and a certain amount has been written about airships, very little indeed has seen the light of publication in connection with balloons. Popular interest was attracted to the more spectacular phases of flight; the Zeppelin raids dominated the minds of millions of non-combatants in the early part of the war, and the aeroplane raids captured their minds later on. To the active service man who was inclined to join the Air Force the aeroplane gave promise of excitement and distinction; to the scientific investigators at home the aeroplane and airship presented many problems of baffling difficulty and interest. The kite balloon, on the other hand, never reached such heights of popularity. Its work was more useful than spectacular; ever shrouded in secrecy, it scarcely ever attracted the attention of any who were not immediately engaged in its construction or its use.

A certain amount concerning the kite balloon is to be found in such a book as Bairstow's "Applied Aerodynamics," but it seems that Capt. Sumner's is the first separate book on the subject, at least in English. The author takes as model a balloon of capacity 670 cubic metres, which can rise to a height of 2500 ft. with one observer,

and a suitable amount of ballast. By means of proportional rules other sizes can be readily calculated.

First the functions of the various parts of the kite balloon are explained, and then the aerodynamics are dealt with, leading up to the equilibrium problem. Longitudinal stability comes next, but the stability considered is statical, not dynamical; this ensures great simplification, of course, but something might have been said about the justification for using it. Chapters follow on the effect of the wind, tension in the material of the balloon, the valve, the envelope and rigging. There is, finally, a short account of meteorological balloons.

Much useful information is contained in the appendix, which is, however, rather miscellaneous in character. One wonders whether a man capable of following the reasoning in such a book needs an appendix containing the formula for the area of a circle or the definitions of the trigonometrical ratios.

S. BRODETSKY.

Our Bookshelf.

Airman's International Dictionary: Including the Most Important Technical Terms of Aircraft Construction, English, French, Italian, German. By Mario Mele Dander. Pp. vii + 227. (London: Charles Griffin and Co., Ltd., n.d.) 6s.

AVIATION for commercial purposes has failed to develop in the manner that was anticipated, yet several regular air services have come into existence, and if the evolution of civil aeronautics is slow, we can have no reason to doubt the ultimate emergence of the aeroplane and airship as standard means of locomotion. There is therefore complete justification for the assertion in the publishers' note that "... there is urgent need for a handy dictionary which will enable a flying man to make his needs and desires known in whatever country he may land." The dictionary was printed in Italy, and Messrs. Griffin have secured copies for issue in this country. It forms an eminently useful handbook, not only for the pilot, but also for the student and researcher, who often have to consult literature in foreign languages and deal with terms which are too recent for the standard dictionaries.

The dictionary gives the important technical terms in connection with aeroplanes and airships, as well as with aeroplane and airship construction. There is a "one alphabet" index for all four languages, thus saving much time in the search for the meaning of any term.

In a book of this kind mistakes and misprints are to be expected, and it is to be hoped that in a future edition experts in the various languages will be called in to revise the terms. Thus any