

## A COURSE IN EXTERIOR BALLISTICS

*A Course in Exterior Ballistics.* Ordnance Textbook. Washington, Government Printing Office, 1921. 127 pp.

This is one of the books prepared by the Ordnance Department, and is issued "for the information and guidance of all concerned." It is based upon a course in ballistic methods given in the Ordnance School of Application at the Aberdeen Proving Ground by Captain R. S. Hoar during the winter of 1919-20. Captain Hoar was at that time in charge of the Ballistic Section of the Proof Department at the Proving Ground. He is the real author of the book.

As this is the first attempt to give, in anything like complete form, an exposition of the new ballistic methods developed during the World War in this country, it will be of unusual interest. The criticisms that appear in this review are all intended to be constructive, and are the result of observations made while using the book as one of several texts in a course given at Aberdeen during the next term of the school referred to above.

In Chapters I-IV the author gives what he considers "the irreducible minimum of higher mathematics" necessary for an understanding of the later chapters. As prerequisites the student is supposed to be grounded thoroughly "in algebra, in trigonometry, and to know enough of calculus to appreciate the meaning of a derivative, a differential, and a definite integral." The irreducible minimum consists of partial differentiation, successive approximations, the effect of differential variations, and finite differences. Following Chapter IV the book takes up in succession the following topics: An introduction to modern ballistic methods; the computation of trajectories; the computation of differential corrections; the construction of range tables. Alternate methods and a brief mention of the more involved mathematical processes are given in supplements at the end of the book. These topics will be reviewed in this order.

Of the first four chapters those on successive approximations and finite differences are written clearly and explain these subjects in sufficient detail for a thorough understanding of these methods in subsequent chapters. But in interpolating to find range, time of flight, etc., Lagrange's interpolation formula would serve the purpose quite as well as the one given, is at least as easy to use, and is more easily understood by the average student. The chapter on partial differentiation could have been omitted as it contains nothing which cannot be found in standard texts on calculus with which the student is supposed to have some familiarity. The chapter on differential variations and the subject of differential corrections as later developed are, it seems to me, decidedly inadequate. In my opinion the author should have shown in detail how Major F. R. Moulton first derived the differential equations that must be satisfied by the differences between the coordinates of a point on the standard and those of a point on the disturbed trajectory, how these were subsequently simplified, and how