SMOKELESS POWDER, NITRO-CELLULOSE, AND THEORY OF THE CELLULOSE MOLECULE

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PREFACE

FOR purposes of comparative study, the writer has brought together in the present volume a series of papers, by various investigators, upon the composition of cellulose and the properties of explosives prepared therefrom. He has supplemented these with an account of experiments made by himself; and from the whole has drawn certain conclusions as to the possible ultimate chemical composition of cellulose and the nitro-celluloses.

While the general development of war-material from the mechanical and metallurgical standpoints—the production of ordnance and armor—is so largely identified with progress in the useful arts in the United States, yet, until very recently, but little has been accomplished in our country in the way of improvement in explosives. Within the last few years, however, a particular form of smokeless powder has largely supplanted the old black and brown powders for military uses; and the last decade of the past century has witnessed the virtual abandonment of a propellant that has held its place in war, with

comparatively little modification, for four hundred years.

This new smokeless powder, which is adapted for use in arms of all calibres, is prepared from a particular type of colloid nitro-cellulose. Such an extension of the employment of this latter body from its original use for detonating purposes, to its new use as a progressive explosive, has attracted general attention, and led to a more careful and extended study of the nitrocelluloses in general. It is with the view of further extending such study and of possibly preparing the way for the introduction of future improvements in progressive explosives that this book has been prepared.

Before presenting it, the author wishes to express his thanks to certain eminent scientists for the privilege that they have courteously afforded him of making his own translations of certain portions of their works upon explosives: to Professor D. Mendeléef, of Russia, for his paper entitled "Pyrocollodion Smokeless Powders"; to M. Vieille, of the French Service des Poudres et Salpêtres, for his article upon the nitration of cotton; and to M. Bruley, of the same service, for a similar paper. Thanks are due also to Messrs. Longmans, Green & Co. for the privilege kindly extended of making certain extracts from Messrs. Cross and Bevan's valuable work, "Cellulose," published by them.

Finally, the author wishes to express his indebtedness to Dr. Alfred I. Cohn, of New York, for the care he has bestowed upon the reading of the proof of

this book at a time when the writer's absence from the United States on active service afloat prevented his giving the matter the personal care and attention it otherwise would have had; and for his preparation of a comprehensive index.

U. S. S. "Dixie," April 24, 1901.

AUTHOR'S NOTE, 1908

SEVEN years have elapsed since the publication of the first edition of the present work. With the exception of minor modifications of processes previously established, the interval has witnessed no radical changes in the methods of manufacture of or the composition of smokeless powder. The substitution of centrifugals for pots in the nitrating process to promote rapidity of nitration —a step of doubtful expediency—and the introduction into the solvent of a small amount of an ether less volatile than the ethylic ether, to prevent the too rapid "drying out" of the powder, represent the most important changes made.

Several years ago Mr. George W. Patterson, the able chemist in charge of the laboratories at the U. S. Government powder works at Indian Head, Maryland, remarked to me that he did not believe that "gun-cotton" was soluble in ethylic ether, even at as low a temperature as that produced by liquid air; and he proposed that we conduct a second series of experiments, employing as the solvent absolute ether dehydrated over sodium. Results showed that the "gun-cotton" was *not* soluble in the modified solvent and at the low temperature stated; whereas, it *was* soluble in the Squibb's ether that I had

previously employed and which was marked "Squibb's Ether, C. P., for Anæsthesia." This Squibb's ether was subsequently found to contain traces of ethyl alcohol.

I had but one morning at my disposal in which to make these experiments, and so could make no effort to determine whether or not ethylic ether treated with sodium contained traces of some other impurity that acted to render it incapable of dissolving the gun-cotton. The presence in the ethlyic ether of exceedingly small quantities of ethyl alcohol on the one hand, or of sodium on the other, may have developed katalytic tendencies of diametrically opposite character, the one tending to promote, the other to prevent, the solution of the "gun-cotton" under the conditions stated.

But the fact has been brought out clearly that, starting from the 2–1 ethylic-ether ethyl-alcohol compound solvent, the greater the diminution of the amount of alcohol present the lower the temperature required to effect the solution of the "gun-cotton." As this is in accordance with experimental results already cited in Chapter IV, upon which the development of the theory of the nitro-cellulose molecule is based, no change will be made in that part of the present work. Attention is called, however, to the fact that the use of ethylic ether alone as a solvent, in connection with insoluble nitro-cellulose of highest nitration, probably represents a limit at which solution can only be obtained through the employment of some temperature not far from absolute zero.

Rome, Italy, April 28, 1907.