

# **INTERNAL BALLISTICS**

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Internal Ballistics by James Atkinson Longbridge

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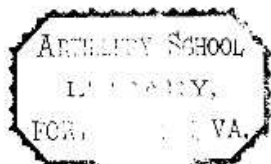
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**JAMES ATKINSON LONGBRIDGE**

**INTERNAL  
BALLISTICS**



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BY

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E. & F. N. SPON, 125, STRAND, LONDON.

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1889.

To

MONS. ÉMILE SARRAU,

INGÉNIEUR-EN-CHEF DES POUDBES ET SALPÊTRES,

This Treatise

IS RESPECTFULLY INSCRIBED

BY

THE AUTHOR.

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## P R E F A C E.

IN my treatise 'On the Application of Wire to the Construction of Ordnance,' published in 1884, I touched lightly on one or two questions relating to Internal Ballistics, such as chambering, slow-burning powder, and heat imparted to the gun.

Shortly afterwards I presented a paper to the Institution of Civil Engineers on "Guns considered as Thermodynamic Machines," which was published in the 'Minutes of Proceedings,' vol. lxxx., 1884-85; and in 1887, I printed a small pamphlet on Internal Ballistics, which, however, was only circulated among a few friends.

The subject of Internal Ballistics appears to have met with comparatively little attention in this country, and although the researches of Dr. Hutton are very valuable, they, owing to the change of conditions, are inapplicable to a great extent to the present time.

The researches of French artillerymen of late years have shed a flood of light on the subject of the action of gunpowder, and especially those of M. Émile Sarrau, but these are scattered over a number of serial publications in France, many of which are not accessible to the general body of artillerymen. M. Sarrau, with that spirit of liberality which characterises the true man of science, has most kindly given me permission to make use of his investigations, and it is to

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this that the most valuable part of the following treatise is due.

In *Chapter I.* I have briefly treated of Explosives in general.

*Chapter II.* treats more particularly of Fired Gunpowder, the nature of the Products of Combustion, of Ignition and Combustion, the influence of the Form of Grain, the Temperature of Combustion, the Strength of Powder, the Loss of Temperature by the cooling action of the metal of the gun, and the Pressure and Movement of the Products of Combustion.

*Chapter III.* is devoted to M. Sarrau's investigations of the Formulæ for Muzzle Velocity and Maximum Pressure.

*Chapter IV.* contains a few remarks on the Designing of Guns, and on Pressure Curves.

*Chapter V.* treats of Guns as Thermodynamic Machines.

I am fully sensible of the many imperfections of the present treatise, and of my own incompetency to treat this important subject in an exhaustive manner, but I am not without hope that it may be found useful and suggestive to those who are interested in artillery questions. My object has been, to the best of my ability, to combine theoretical investigations with practical utility.

In the Report of the Royal Commission on Warlike Stores (1887), presided over by Sir James Stephen, a distinction is made between what is there called the "science of gunnery," and the "science of gun construction," and I am represented as claiming the latter as my special science. I never did anything of the kind. I certainly claimed to have a special knowledge of the subject of the application of wire to gun construction, but I did not, and could not, represent gunnery as one science and gun construction as another. What I tried to show to the Commission, but apparently failed in, was that gun construction should be conducted on,



and guided by, scientific knowledge, and that such knowledge greatly depended on these theoretical considerations.

The Commissioners appeared to doubt whether it is possible to state precisely the relation in which theory and practice ought to stand to each other, and in this they were supported by Sir Frederick Bramwell, who gave it as his opinion, that it would be dangerous to give theorists control over such a matter as the manufacture of a gun.

It is a grave error to suppose that theory and sound practice are, or can be, divergent. Hypothesis and practice may, and very often do, disagree, but theory never, unless it be a false theory. De Quincey says, "Theory is, in fact, no more than a system of laws, abstracted from experience; consequently, if any apparent contradiction should exist between them, this could only argue that the theory had been falsely or imperfectly abstracted; in which case the sensible inference would be, not a summons to forego theories, but a call for better or more enlarged theories." And Kant, in his essay "On the common saying, that such and such a thing may be true in theory, but does not hold good in practice," says, "It is far more tolerable that an unlearned person should represent theory as superfluous for the purpose of his imaginary practice, than that a shallow refiner, whilst conceding the value of theory for speculative and scholastic uses, should couple with this concession the doctrine, that in practice the case is otherwise; and that upon coming out of the schools into the world, a man will be made sensible of having pursued mere philosophic dreams. In short, that what sounds well in theory is not merely superfluous, but absolutely false for practice. Now the practical engineer who should express himself in such terms upon the science of mechanics, or the artillery officer who should say of the doctrine of projectiles, that the theory of it was conceived indeed with great sub-

tilty, but was of little practical value, because in the actual experience of the art it was found that the experimental results did not conform to the theory, would expose themselves to derision. For, supposing that in the first case should be superadded to the Theory of Mechanics that of Friction, and that in the second, to the Theory of Projectiles were superadded that of the resistance of the air—which in effect amounts to this, that if, instead of rejecting theory, still more theory were added—in that case the results of the abstract doctrine and of the experimental practice would coincide in every respect.”

My object has been to assist in removing the incubus of empiricism from artillery science, and whilst fully conscious of the imperfection of my efforts, and of the opportunity I have given to adverse criticism, I will only say to my critics, “*Si quid rectius novisti, candide imperti.*”

J. A. LONGBRIDGE.

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