

**AN ESSAY ON THE BOILERS OF  
STEAM ENGINES: THEIR  
CALCULATION, CONSTRUCTION,  
AND MANAGEMENT, WITH A  
VIEW TO THE SAVING OF FUEL**

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An Essay on the Boilers of Steam Engines: Their Calculation, Construction, and Management, with a View to the Saving of Fuel by R. Armstrong

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ON

THE BOILERS

OF

STEAM ENGINES:

THEIR

CALCULATION, CONSTRUCTION, AND MANAGEMENT,

WITH A VIEW TO THE

SAVING OF FUEL.

INCLUDING

OBSERVATIONS ON RAILWAY AND OTHER LOCOMOTIVE ENGINES, STEAM  
NAVIGATION, SMOKE BURNING, INCRUSTATIONS, EXPLOSIONS,  
ETC., ETC.

BY R. <sup>obert</sup>ARMSTRONG,  
CIVIL ENGINEER.

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TO  
JOHN DALTON,  
D.C.L., LL.D., F.R.S. L AND E., ETC., ETC., ETC.  
THIS FIRST ATTEMPT  
TO COLLECT THE PRACTICAL RESULTS OF A NEW AND  
IMPORTANT BRANCH  
OF  
CHEMICO-MECHANICAL ENQUIRY,  
IS,  
WITH EVERY SENTIMENT OF RESPECT AND GRATITUDE,  
INSCRIBED  
BY HIS OBLIGED FRIEND,  
THE AUTHOR.

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## P R E F A C E.

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THIS Essay having already experienced a very favourable reception at the hands of those practically engaged in steam engineering, and therefore best qualified to judge of its merits, I have been induced to make considerable additions and improvements in this edition, with a view to make it more worthy the patronage of the public generally.

I am fully aware that the unexpectedly rapid sale which this book has met with, cannot in justice be ascribed to any peculiar quality in the performance itself, but rather to the well-known fact, that complete works from the hands of practical men, on this and some collateral subjects, were very much wanted.

This consideration has determined my intention to follow up the general subject in a series of theoretical and practical essays on the production and application of steam as connected with engineering and mechanical purposes, each work to be about the same size and price as the present.

The next of the series is intended to be on the *Chimneys* of steam engines, and will include rules for the proper construction and arrangement of the flues and furnaces of steam boilers generally, so as to insure a good draught. This proposed work is not so much intended to be a complete guide in *all* the details of construction, as it will be a practical assistant to the employer, the capitalist, or the man of science ;



and still less is it meant to encroach on the province of the architect in anything regarding beauty of design or embellishment, any more than the present can be considered as interfering with the business of the professed boiler-maker or experienced engineer.

My principal object in this, as it will be in future essays, is to collect and arrange data from the practice of the best engineers and builders as found in their works, free and unprejudiced by any previously formed theoretical views whatever, and at the same time perfectly unconnected with any particular *shop* or individual tradesman, so that a fair comparison may be made; and in order that rules may be obtained for the guidance of the master manufacturer, as well as to simplify the various processes of calculation required by the working mechanic.

In attempting the accomplishment of the above objects, it has been deemed expedient to confine the scope of the present volume as much as possible to the general practice that is found within a range of thirty to forty miles round Manchester; but, with a few alterations in the rules and formulæ, easily made, and which are pointed out where necessary, the latter will be found equally applicable in any other part of the kingdom.

Although *locomotive* and *marine* boilers are only incidentally treated of, they being thought of sufficient importance to require an essay exclusively to themselves, yet the principles evolved in the present work will be found to be a necessary groundwork towards forming plans for their future improvement, they being comparatively recent inventions as compared to the ordinary land boilers, which have been the subject of experiment and observation for more than a century; hence the necessity that the elements (at least) towards a settled theory of the latter should precede any satisfactory investigation of the former.

For similar reasons to the above, some of the details which

do not essentially affect the construction or calculated power of a boiler, are omitted, or only slightly touched on. The various kinds of feeding apparatus for coal and for water; steam gauges and water gauges; cleansing apparatus for the boiler and for the furnace, the fire-grate and the flues; safety valves and safety pipes, and other accessories, afford abundant matter for two or three such volumes as the present.

To the cotton manufacturers, and other proprietors of steam-engines generally, in Lancashire, my grateful acknowledgments are particularly due, for the many opportunities for improvement which they have afforded me during several years in obtaining constant access to, and personal inspection and examination of, every thing concerning their engines and boilers.

Of the value and variety of information so obtained, it needs only to be stated, that Manchester alone is supposed to contain at the present time at least double the amount of steam power of any other town in the world. Within the boroughs of Manchester and Salford there are 400 steam engines of about 10,000 horse power, but working at 12 or 14,000, and within six or eight miles round, there are at least about 10,000 horse power more, working up to 15 or 16,000. The total consumption of coal for this purpose, within a semicircle of seven miles radius from Manchester Exchange, is about 20,000 tons per week.

In a district where such facilities exist for obtaining correct data in so important a branch of physical science, and at a period when the almost illimitable powers of the steam engine are being developed for railway and marine purposes to an extent so perfectly unprecedented, that minds the least imbued with enthusiasm are forcibly impressed with the belief that the age of invention and improvement is yet but in its infancy, it is but natural to expect that the establishing of a system of steam engineering upon facts, rather than upon theoretical principles, should be considered an object

highly worthy of attainment. If, in furnishing materials towards such ulterior object, this attempt be considered only as that of a useful practical pioneer, my present purpose will be fully accomplished.

The additions to this edition are principally as follow :

1. In Chapter III. (Art. 119 to 143,) I have introduced a new theory on the comparative durability of iron and copper boilers, as used for locomotive and marine engines, grounded on recent experiments made with her Majesty's steam ships in the Mediterranean, by Mr. Dinnen, Assistant Engineer, Royal Dock-yard, Woolwich. To this gentleman I am under considerable obligations, not only for his excellent paper on Marine Boilers, in Weale's edition of Tredgold, which first induced me to remodel this Essay, but also for recent valuable private communications of facts and observations, (accompanied with a series of specimens of boiler scale from various parts of the world,) which have been the means of considerably modifying some opinions which I previously held on this and other subjects, and which I have endeavoured to make in part available in this work. I therefore, with much pleasure, take this opportunity of recording my sense of his valuable assistance.

2. In the same Chapter, (Art. 152 to 159,) will be found a new theory of some variations in the temperature of the boiling point, containing an explanation of the previously unaccounted for experiments on that subject by Dr. Bostock and M. Gay Lussac, and which was briefly alluded to in the last edition.

3. The *fourth* chapter is almost entirely a new one. In addition to some theoretical views that were given in the fifth chapter of the last edition, it contains various tables of dimensions, calculated for the practical use of the engineer and boiler-maker in the designing of new boilers, together with the mathematical investigations on which they are based.