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William Fairbairn  
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# Treatise on Mills and Millwork

WILLIAM FAIRBAIRN



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UNIVERSITY PRESS

University Printing House, Cambridge, CB2 8BS, United Kingdom

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Information on this title: [www.cambridge.org/9781108070010](http://www.cambridge.org/9781108070010)

© in this compilation Cambridge University Press 2014

This edition first published 1861–3

This digitally printed version 2014

ISBN 978-1-108-07001-0 Paperback

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# MILLS AND MILLWORK

PART I.

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978-1-108-07001-0 - Treatise on Mills and Millwork

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LONDON

PRINTED BY SPOTTISWOODE AND CO.

NEW-STREET SQUARE

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TREATISE  
ON  
MILLS AND MILLWORK

PART I.

ON THE PRINCIPLES OF MECHANISM

AND ON

PRIME MOVERS

COMPRISING THE ACCUMULATION AND ESTIMATION OF WATER POWER,  
THE CONSTRUCTION OF WATER-WHEELS AND TURBINES, THE PROPERTIES OF STEAM,  
THE VARIETIES OF STEAM-ENGINES AND BOILERS, AND WINDMILLS

BY

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LONDON

LONGMAN, GREEN, LONGMAN, AND ROBERTS

1861

Cambridge University Press

978-1-108-07001-0 - Treatise on Mills and Millwork

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## P R E F A C E.

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THERE is probably no department of practical science so generally useful, or so little studied of late years, as the machinery of transmission. The term "*millwork*," as applied to this class of machinery, is of modern origin, but "*millwright*" has long been a household word, and at no distant period conveyed the idea of a man marked by everything that was ingenious and skilful.

The millwright of former days was to a great extent the sole representative of mechanical art, and was looked upon as the authority in all the applications of wind and water, under whatever conditions they were to be used, as a motive power for the purposes of manufacture. He was the engineer of the district in which he lived, a kind of jack-of-all-trades, who could with equal facility work at the lathe, the anvil, or the carpenter's bench. In country districts, far removed from towns, he had to exercise all these professions, and he thus gained the character of an ingenious, roving, rollicking blade, able to turn his hand to anything, and, like other wandering tribes in days of old, went about the country from mill to mill, with the old song of "*kettles to mend*" reapplied to the more important fractures of machinery.

Thus the millwright of the last century was an itinerant engineer and mechanic of high reputation. He could handle the axe, the hammer, and the plane with equal skill and precision; he could turn, bore, or forge with the ease and despatch of one brought up to these trades, and he could set out and cut in the furrows of a millstone with an accuracy equal or superior to that of the miller himself. These various duties he was

called upon to exercise, and seldom in vain, as in the practice of his profession he had mainly to depend upon his own resources. Generally, he was a fair arithmetician, knew something of geometry, levelling, and mensuration, and in some cases possessed a very competent knowledge of practical mathematics. He could calculate the velocities, strength, and power of machines: could draw in plan and section, and could construct buildings, conduits, or watercourses, in all the forms and under all the conditions required in his professional practice; he could build bridges, cut canals, and perform a variety of work now done by civil engineers. Such was the character and condition of the men who designed and carried out most of the mechanical work of this country, up to the middle and end of the last century. Living in a more primitive state of society than ourselves, there probably never existed a more useful and independent class of men than the country millwrights. The whole mechanical knowledge of the country was centred amongst them, and, wherever sobriety was maintained and self-improvement aimed at, they were generally looked upon as men of superior attainments and of considerable intellectual power. It, however, too frequently happened that early training, constant change of scene, and the temptation of jovial companions, led the young millwright into excesses which almost paralysed his good qualifications. His attainments as a mechanic, and his standing in the useful arts, were apt to make him vain; and with a rude independence he would repudiate the idea of working with an inferior craftsman, or even with another as skilful as himself, unless he was born and bred a millwright.\* I remember an old millwright who, in palliation of an offence with which his employer charged him, urged that he ought not to forget, that he had condescended *to work even with carpenters to please him*.

The introduction of the steam engine, and the rapidity with

\* This had reference to the young practitioner being the oldest son of a millwright, which circumstance in itself was, until of late years, considered a sufficient guarantee for skill and industry, whether he possessed them or not.

which it created new trades, proved a heavy blow to the distinctive position of the millwright, by bringing into the field a new class of competitors in the shape of turners, fitters, machine-makers, and mechanical engineers: and, notwithstanding the immense extension of the demand for millwork and the great stimulus which it afforded to the manufactures of the country, it nevertheless lowered the profession of the millwright, and levelled it in a great degree with that of the ordinary mechanic. He, however, retains his distinctive appellation, and I hope he will long continue the representative of a higher class of mechanical artisans, to whom the public are deeply indebted for many of our first and greatest improvements in practical science.

Serious, and perhaps not altogether unfounded, charges have been brought against millwrights as a class, but on examination I do not think that they are borne out to the extent some persons would wish us to believe. On the contrary, I am persuaded there is no class of mechanics so intelligent or who work harder than the millwright, or who exercise a sounder judgment in the performance of their varied duties in the perfect execution of their work. It is true that, in former times, they too frequently gave way to habits of dissipation, and neglected their work; but in this respect they were not alone, as the changes which have lowered their standing have proved of use in reforming their habits, and produced in the millwrights of the present day a highly moral and intellectual class of workmen. Taking them as a body, I believe there is not a more trustworthy or a more respectable class of men in existence. I make this statement from experience, and have great pleasure in doing so.

It used to be a custom, before the days of Mechanics' Institutes, for the millwrights to form one for themselves in every shop. Their meetings were generally held at a public house on Saturday evening; and many were the times when long discussions on practical science and the principles of construction were carried on between rival disputants with a fiery eagerness

which not unfrequently ended in a quarrel, or effected a settlement by the less rational but more convincing argument of blows. It was a rough way of imparting knowledge but it was not worse than that practised in the schools and seminaries of the day, where the application of the rod was the general remedy for dull apprehensions and indocile minds. This was beginning at the wrong end, endeavouring to impart knowledge through the sensitive parts of the body, instead of appealing to the higher organs of the intellect. The principal difference between the Millwrights' Institute and such schools was, probably, that the former was the more ferocious of the two, as the rival disputants hit harder under the influence of potations than would now, fortunately, be tolerated. On more peaceful occasions, however, it was curious to trace the influence of these discussions on the young aspirants around, and the interest excited by the illustrations and chalk diagrams by which each side supported their arguments, covering the tables and floors of the room in which they were assembled. The great objection to these gatherings was, however, the angry feeling too frequently aroused, and the injurious influence of the place of meeting, which gave rise to prolonged debates under the encouragement of the landlord, who on most occasions was appealed to as referee in all matters in dispute.

The above is no overdrawn statement of the condition of the millwrights some fifty years ago. Their education and habits were those of the times in which they lived. There were then no schools for the working classes but those of the parish, nor any libraries or mechanics' institutes; and after the usual course of reading, writing, and accounts, the millwright was thrown upon his own resources in the attainment of the knowledge which might aid him in his profession. Hence his value and worth were most exhibited when away from home, and isolated from all assistance, where he was left to the construction and erection of work. In such a position his energies were frequently called into action, and on many occasions he displayed powers calculated to advance the interests of his employers, and

to complete his task with accuracy and skill. Thus the genuine millwright became, to a fault, tenacious of his own views and position, and jealous of any interference or assistance from others. He would reconnoitre and survey the premises on which he was to work, rule and line in hand, and would stand for hours (much to the annoyance of his employers) before he could make up his mind as to what was best to be done. These preliminaries being settled, his decision was final, and he would fix his levels, stretch his lines, and in the course of a day or two commence work with an energy which generally led to the best and most satisfactory results.

Another feature of this class, which should not be lost sight of, was the kindly feeling and generous sympathy which generally belonged to them, and that exhibited especially towards those in declining years or in distress. It is in acts of charity and good will to those in want that the millwright of all times has shown his native goodness. He may frequently be reckless and dissipated, but he seldom fails in generosity, and I know of no other trade where a more hearty feeling of liberality and kindness exists.

Yet the millwrights, with all these good qualities, have been and are still subject to faults injurious to themselves and annoying to the public. Such are their frequent contests with their employers, either for an advance of wages or for some fancied privilege which they seek to maintain or establish. They are united in benefit societies for the relief of the old and indigent, and those who from sickness or other causes may be unable to work. Unfortunately these are connected with trade societies established for the purpose of maintaining what they consider their rights,—rights often of a very imaginary character, and ill calculated to advance their position or promote their individual interests. It is not my wish to enter here into the questions which these contests suggest. I am willing to forget bygone days and to look forward with sanguine hope to better times, when truer principles of freedom and social economy shall be acted upon, without destroying the independence and

originality which have always been characteristic of an intelligent body of men for whom I entertain individually and collectively the highest veneration and respect.

I have deemed it necessary to give this brief account of the habits and character of a body of men whose skill and spirit of perseverance has done so much for the advancement of applied science, and whose labours have still a large influence on the industrial progress of the country. I am, perhaps, better qualified for this task than most others, from having been associated with them from early life, so that an experience of some fifty years must be my excuse for having imposed this narrative upon the reader.

For many years I have had it in contemplation to give an account of my own practical experience in millwright construction, but a multiplicity of engagements has combined with other causes to delay the work, and to modify considerably the original plan. This first volume, I hope, may contain reliable data and true principles for the successful guidance of the millwright in his professional duties.

The present portion of the work treats of the first principles of mechanism generally, and proceeds to the discussion of the various constructions of prime movers. I hope shortly to complete the work by a treatise on the new system of transmissive machinery, and on the arrangements necessary for imparting motion to the various descriptions of mills.

The accumulation, storage, and measurement of water has received attention; as well as the construction of prime movers depending upon this motive power, including the best forms of water-wheels, according to my own practice, and the more recently introduced varieties of turbines. In discussing the principles of the steam engine I have inserted a short treatise on the properties of steam, derived in part from researches carried on under my own superintendence, bearing on the density of saturated steam and the law of expansion of superheated steam. To this has been added a chapter on engines and boilers, their strength, powers, and principles of construction.

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## PREFACE.

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It is evident that, in the present improved state of mill machinery, steam and water are the chief agents on which we depend for motive power. In former times the wind was also looked to as a source of power, but it is now very little employed, except in Holland and the fenny districts of this country, where it is still used for pumping and other operations where constant uniformity of action is not required. Notwithstanding the changes effected by steam, as windmills are not yet obsolete, I have given a short chapter on their mode of construction.

In the prosecution of this work I have been ably assisted by my friend Mr. Thomas Tate, to whom I owe the chapter on the elementary principles of mechanism; as also to my assistant and secretary, Mr. William C. Unwin, to whose assiduous attention and love of science I am greatly indebted.

Cambridge University Press

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## ERRATA.

Page 171, line 13, *for* "44 cubic feet" *read* "90 cubic feet."  
 ,, 169, ,, 9, *for* "52 inches" *read* "46 inches."  
 ,, 240, ,, 12, *for* "Fig. 161" *read* "Plate VIII."