

Edward Baines on the Development of the Steam Engine by Watt and Boulton, 1835

(Although experiments with steam engines had taken place earlier in the 17th century, it was not until the turn of the 18th century that Thomas Savery (c. 1650-1715) and Thomas Newcomen (1663-1729) successfully constructed steam beam engines to drain Cornish mines. It was not until the late 18th century that the Glasgow mechanic James Watt (1736-1819) and his Birmingham partner Matthew Boulton (1728-1809) made the major improvements in steam engines that would lead to their widespread use in factories in the 19th century. Edward Baines, the sympathetic and Liberal historian of early industrialization explains these later developments. Edward Baines. *History of the Cotton Manufacture in Great Britain*, 1835, 220-1, 222-5, 226-7, 228; in J. T. Ward, ed., *The Factory System, Vol. I, Birth and Growth* (New York: Barnes & Noble, 1970), pp. 101-05.)

Amazing as is the progress which had taken place in the cotton manufacture prior to 1700, it would soon have found a check upon its further extension, if a power more efficient than water had not been discovered to move the machinery. The building of mills in Lancashire must have ceased, when all the available fall of the streams had been appropriated. The manufacture might indeed have spread to other counties, as it has done to some extent; but it would not have flourished in any district where coal as well as water was not to be found; and the diffusion of the mills over a wide space would have been unfavourable to the division of labour, the perfection of machine-making, and the cheapness of conveyance.

At this period a power was happily discovered, of almost universal application and unlimited extent, adapted to every locality where fuel was cheap, and available both to make machines and to work them, both to produce goods, and to convey them by land and water. This power was the *steam engine*, which, though not an invention of that age, was first made of great and extensive utility by the genius of James Watt....

James Watt, a native of Greenock, was brought up as a maker of philosophical instruments in Glasgow and London, and settled in Glasgow in 1757. He was appointed instrument maker to the university, and thus became acquainted with Dr. Black, professor of medicine and lecturer on chemistry in that institution, who, about this time, published his important and beautiful discovery of latent heat. The knowledge of this doctrine led Watt to reflect on the prodigious waste of heat in the steam-engine, where steam was used merely for the purpose of creating a vacuum in the cylinder under the piston, and for that end was condensed in the cylinder itself, -the piston being then forced down solely by atmospheric pressure. The cylinder was therefore alternately warmed by the steam, and cooled by the admission of cold water to condense the steam; and when the steam was readmitted after the cooling process, much of it was instantly condensed by the cold cylinder, and a great waste of the steam took place: of course, there was an equal waste of the fuel which produced the steam, and this rendered the use of the machine very costly.

It happened that Watt was employed, in the year 1763, to repair a small working model of Newcomen's steam-engine for Professor Anderson. He saw its defects, and studied how to remedy them. He perceived the vast capabilities of an engine, moved by so powerful an agent as steam, if that agent could be properly applied. His scientific knowledge, as well as his mechanical ingenuity, was called forth; all the resources of his sagacious and philosophical mind were devoted to the task; and after years of patient labour and costly experiments, which nearly exhausted his means, he succeeded in removing every difficulty, and making the steam-engine the most valuable instrument for the application of power, which the world has ever known.

It is not a little remarkable that his patent, "for lessening the consumption of steam and fuel in fire engines", should have been taken out in the same year as Arkwright's patent for spinning with rollers, namely, 1769—one of the most brilliant eras in the annals of British genius;—when Black and Priestley were making their great discoveries in science; when Hargreaves, Arkwright, and Watt revolutionized the processes of manufacturers, when Smeaton and Brindley executed prodigies of engineering art; when the senate was illuminated by Burke and Fox, Chatham and Mansfield; when Johnson and Goldsmith, Reid and Beattie, Hume, Gibbon, and Adam Smith, adorned the walks of philosophy and letters.

The patent of 1769 did not include all Watt's improvements. He connected himself in 1775 with Mr. Boulton, of Soho, Birmingham, a gentleman of wealth, enterprise, and mechanical talent; and, having made still further improvements in the steam-engine, an Act of parliament was passed in the same year, vesting in him "the sole use and property of certain steam engines (or fire-engines) of his invention, throughout his majesty's dominions", for the extraordinary term of twenty-five years. * So comprehensive was the Act, that it prevented others from making steam-engines which contained improvements of their own, if their engines condensed the steam in a separate vessel: this was the foundation of Watt's improvements, and it was so great an improvement, that no person could without immense disadvantage dispense with it. Watt, therefore, took up his position in a narrow pass, which he was able to defend against a host; and he kept the whole business of making steam engines to himself, deterring all invaders of his privilege by instantly commencing prosecutions. He enjoyed his patent for more than thirty years, from 1769 to 1800: and, though it was probably unproductive for the first ten years, it afterwards produced him a large fortune, so that he retired from business a wealthy man, on the expiration of the exclusive privilege. The monopoly was much more extended than any legislature ought to have granted; but it must be allowed that no man could have better deserved or better used it.

Watt laboured incessantly to perfect this important and complicated engine, and took out three other patents in 1781, 1782, and 1784, for great and essential improvements. . . .

Up to the time of Watt, and indeed up to the year 1782, the steam-engine had been almost exclusively used to pump water out of mines. He perfected its mechanism, so as to adapt it to the production of rotative motion and the working of machinery; and the first engine of that kind was erected by Boulton and Watt at Bradley iron-works, in that year. The first engine which they made for a cotton mill was in the works of Messrs. Robinsons, of Papplewick, in

Nottinghamshire, in the year 1785. An atmospheric engine had been put up by Messrs. Arkwright and Simpson for their cotton mill on Shude-hill, Manchester, in 1783: but it was not till 1789 that a steam engine was erected by Boulton and Watt in that town for cotton spinning, when they made one for Mr. Drinkwater: nor did Sir Richard Arkwright adopt the new invention till 1790, when he had one of Boulton and Watt's engines put up in a cotton mill at Nottingham. In Glasgow, the first steam engine for cotton spinning was set up for Messrs. Scott and Stevenson, in 1792. So truly had it been predicted in the Act of 1775, that "several years, and repeated proofs, would be required before the public would be fully convinced of their interest to adopt the invention". But when the unrivalled advantages of the steam-engine, as a moving force for all kinds of machinery, came to be generally known, it was rapidly adopted throughout the kingdom, and for every purpose requiring great and steady power. The number of engines in use in Manchester, before the year 1800, was probably 32, and their power 430 horse; and at Leeds there were 20 engines, of 270 horse-power.**

By some writers, who have not remarked the wonderful spring which had been given to the cotton manufacture before the steam-engine was applied to spinning machinery, too great stress has been laid upon this engine, as if it had almost created the manufacture. This was not the case. The *spinning machinery* created the cotton manufacture. But this branch of industry has unquestionably been extended by means of the steam engine far beyond the limit which it could otherwise have reached. ..

The spirit of improvement, which had carried the spinning machinery to so high a degree of perfection, was next directed to the *weaving* department, and did not rest till that operation, as well as spinning, was performed by machinery.

*The reasons for this great favour shown to Mr. Watt are thus stated in the Act: "James Watt has expended great part of his fortune in making experiments to improve steam-engines; but on account of the difficulties in execution, could not complete his invention before the end of 1774, when he finished some large engines, which have succeeded. In order to make those engines with accuracy, at moderate prices, a large sum must be previously expended in mills and apparatus; and as several years and repeated proofs will be required before the public can be fully convinced of their interest to adopt the invention, the term of the patent may elapse before he is recompensed. By furnishing mechanical power at less expense, and in more convenient forms than hitherto, his engines may be of great utility in many great works and manufactures, yet he cannot carry his invention into that complete execution that will render it of the highest utility of which it is capable, unless the term be prolonged, and his property in the invention secured in Scotland, as well as in England and the colonies".

**Farey on the Steam Engine, p. 654