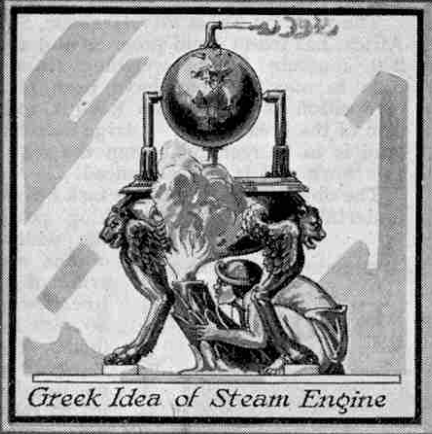

Greek Idea of Steam Engine

# LIVES OF FAMOUS INVENTORS

## I. WATT AND THE STEAM ENGINE

**This month we commence a series of articles on the Lives of Famous Inventors, on somewhat similar lines to our existing series dealing with Famous Engineers. Almost all great engineers have been inventors to some extent while many inventors have been also engineers, and in many cases it is difficult to decide in which category to place certain men. In the present series, commencing with James Watt, the Father of the Steam Engine, we shall include men whose inventions rather than their engineering work have contributed towards the world's progress.**

JAMES WATT was born on 19th January, 1736, in the Scottish port of Greenock, where his father carried on a large business as a carpenter and shipwright. The products of the busy workshop varied from furniture for ships to capstans for quays. In addition, the work of a builder and contractor was dealt with, and it was Watt's father who erected the first crane on a Greenock dockside, this being put up for the use of the tobacco-trading vessels that came over from Virginia. The Town Hall and Council Chambers built at Greenock in the 18th century were also his design and work. Watt's father was also part owner of several ships trading with foreign countries. In this matter he suffered serious misfortunes in later years, sustaining a heavy financial loss when one of these vessels was wrecked. Still worse was the loss of one of his sons while on a voyage to America in another of these ships.

Of the five children in the family, only James, the future inventor, lived to a good age, and for many years the possibility of his enjoying a long life appeared to be remote. During the early years of boyhood he was extremely delicate, and was practically an invalid, and it was not until he was fourteen years of age that he was considered strong enough to attend school. His early education was received in the home, his mother teaching him to read and his father imparting to him some arithmetic, in addition to the ability to write.


Watt's house in Delftfield Lane, Glasgow

### Early Constructive Ability

When not busy with these studies Watt devoted many quiet hours to dissecting his toys and either rebuilding them or evolving new creations from the miscellany of loose parts. A further source of delight to him was provided by a set of carpenter's tools brought by his father from the workshop, and in the use of these the boy became very skilful. Later, in the intervals of schooling, he would resort to his father's workshop and continue his hobby. His ingenuity in making small articles was very marked and often evoked from the workmen the remark that "little Jamie had gotten a fortune at his finger ends." A bench was fitted up for him and also a small forge. He was thus able to extend his activities to metal work and his bench soon became arrayed with model cranes, pumps, capstans and the like, to the great delight and interest of his father's employees.

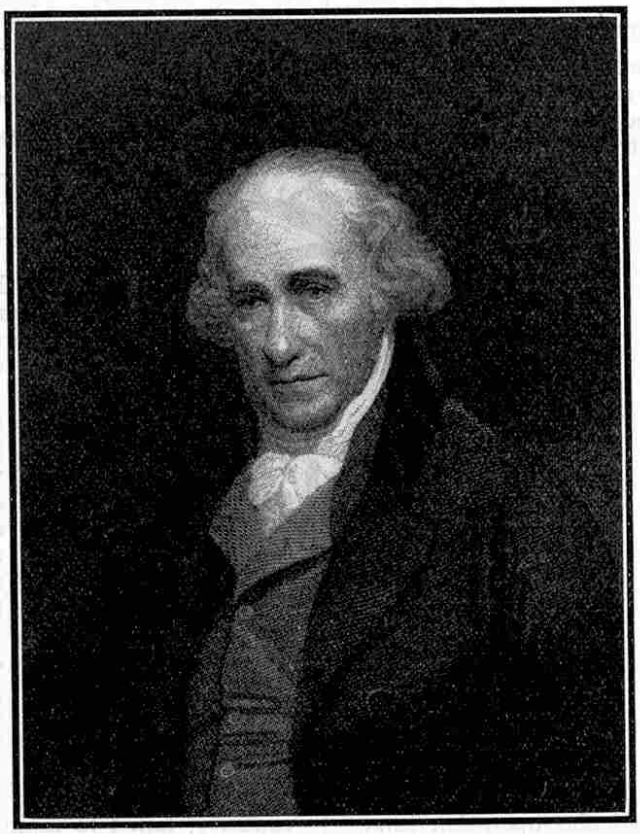
The delicate operations of adjusting and repairing nautical instruments fascinated him most of all, and when eventually he was permitted to experiment he quickly became remarkably skilful and accurate. His proficiency in this respect, his love of tools and the good grasp of mathematics he acquired at school paved the way for his training as a mathematical instrument maker, to which trade his father decided to apprentice him.

In 1754, therefore, we find Watt, then eighteen years of age, arriving in Glasgow with but little luggage apart from his beloved tools. The city proved to be without a skilled mathematical instrument maker and Watt was placed under the tuition of a mechanic who, although trading as an optician, was a veritable "Jack-of-all-trades," his business including the repairing of fiddles and the

making and mending of fishing rods and tackle!

### Apprenticeship in London

At Glasgow Watt became acquainted with Professor Dick of the University, who urged him to go to London and obtain more expert tuition. To Watt's joy his father readily agreed, and arrangements were made for Watt to accompany a relative named Marr, a sea-captain, who was about to journey south to rejoin his ship lying in the Thames. Accordingly on 7th June, 1755, the two set out for London on horseback, no stage coach as yet being run between Glasgow and the Metropolis. Travelling by way of Newcastle and the Great North Road, they reached London twelve days later.



James Watt

In London a year's apprenticeship was entered into with John Morgan, a reputable maker of mathematical instruments in Cornhill, for a premium of twenty guineas and the unpaid services of his apprentice. Watt quickly showed his determination to succeed. In spite of the long hours—five nights a week he worked until nine o'clock—he sought to make pocket money by executing small jobs on his own account. These were done after hours at his lodgings and sometimes necessitated his working far into the night. When he had time for outdoor leisure he seldom ventured out lest he should be kidnapped by one of the gangs of ruffians at that time in London making life a terror to the male population. Many of these gangs were employed by shipping companies to capture able-bodied men, who were hustled on board ship and later sold to owners of plantations in the colonies of North America!

The strain of the long working hours and the enforced confinement told heavily upon Watt and during the following year he decided to return to Scotland. With money sent by his father he bought many of the tools he would need to commence in business for himself, and materials wherewith to make the rest, and thus stocked he returned north.

### Instrument Maker to Glasgow University

In Glasgow Watt found himself debarred by the Guild of Hammermen from commencing a business of his own or even erecting a small workshop, on account of his not having served within the borough the customary seven years of apprenticeship. The Guild had no power within the precincts of the University, however, and it was there that Watt found his opportunity. He had already repaired several scientific instruments for the University in a manner that greatly pleased the professors, and when the latter heard of the Guild's opposition they offered Watt two rooms within the college buildings, the one for a workroom and the other for use as a shop. The offer was gladly accepted and Watt was officially appointed resident "mathematical instrument maker to the University."

In a short time Watt became very popular among professors and students alike and his workroom was frequently the scene of earnest discussions on scientific matters. The discoverer of the principle of latent heat, Dr. Joseph Black, was then lecturer on chemistry at the University and he and Watt became great friends. John Robison, who is remembered as the designer and first editor of the "Encyclopædia Brittanica" was another close friend. It was in Watt's workroom that Black and Robison—who was at that time a student at the University—first met, and a life-long friendship began between them.

The three friends often met together in the young mechanic's room to discuss scientific matters. One day, in 1759, the conversation turned upon the subject of the steam engine and the possibilities of improving upon Newcomen's engine, at that time largely in use for pumping water out of mines.

### Newcomen's Engine

The Newcomen engine was invented in 1705 by Thomas Newcomen, a blacksmith and ironmonger, of Dartmouth, and was based partly upon an earlier invention by Thomas Savery, which was brought out in 1698. Savery's pumping engine, as it was called, was very imperfect, but it provided a starting point for various inventors interested in the possibilities of the steam engine. Of these, Newcomen appears to have been the most progressive. It is related that, having by some means become acquainted with Savery's engine, he built a model of it in his garden and in studying its operation quickly perceived its many faults. After long experiment and many failures Newcomen finally evolved his atmospheric pumping engine.

In this engine a pipe fitted with a stopcock led up from the top of the boiler to a vertical cylinder containing a close-fitting piston. The piston rod was connected by a chain to one end of a beam overhead, which functioned see-saw fashion upon a central axis. From the other end of the beam hung a long weight, the bottom of which was attached to a pump rod. Steam was generated in the boiler and passed upwards into the cylinder at a pressure slightly greater than that of the atmosphere, thereby raising the piston. As the piston end of the beam was thus lifted, the other end was correspondingly lowered and the pump rod depressed. This motion was aided and steadied by the balance weight.

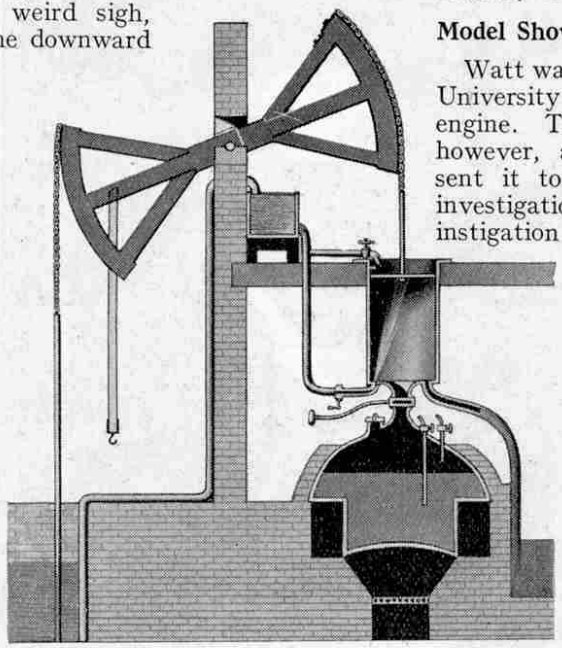
The stopcock was then turned to shut off steam. Cold water was passed down a narrow pipe from a cistern above the cylinder, entering the latter at the bottom in the form of a jet, and this, condensing the

steam, created a vacuum. The cylinder was open at the top and atmospheric pressure upon the piston immediately forced the latter down, thereby re-canting the beam to its original position and raising the pump-rod. The descending piston forced out the injected water and condensed steam through an escape valve into a pipe leading down to an adjoining well. Steam was then re-admitted to the cylinder and the cycle of operations repeated.

### Noisy and Inefficient in Operation

The engine was extremely noisy in operation. As the pump rod descended, the sound of the plunge was accompanied by a weird sigh, and a loud bump denoted that the downward stroke was completed. With a squeak and a further bump the upward stroke was then commenced, the pump rod's chronic wheeze being rendered less audible by the sound of the rushing water as it was sucked up and ejected.

At first a man and a boy were required to work a Newcomen engine, the former attending to the fire and maintenance of steam while the latter looked after the stopcock for admitting steam into the cylinder and the injection cock for admitting cold water to effect the condensation. These two cocks had to be turned on and off alternately, a task which quickly grew very monotonous.



Newcomen's Atmospheric Engine

### Invention due to Boredom !

The manner in which this particular operation came to be rendered automatic is very interesting. A boy named Humphrey Potter, employed as just described, was particularly struck by the dullness of his task. He noticed how the beam ascended and descended in slow succession and he sought for some way of keeping it moving while he had a rest. At length he contrived a catch that worked by strings tied to the beam, and found to his delight that his rough device was successful. Indeed, it had the effect of not only making the engine self-acting but of increasing the number of strokes from about six to fifteen per minute !

At a later date his innovation was improved upon by a man named Beighton, who affixed to the beam a rod, the lower or "free" end of which opened and shut the tappets of the two cocks as required.

Newcomen's invention failed to improve upon Savery's in regard to lessening the consumption of fuel. The drawback was not felt where the steam engine was installed at a coal mine, but where fuel was scarce, as at the tin mines in Cornwall the huge appetite of Newcomen's engines absorbed practically all the profits ! This excessive consumption of fuel was due to the wastage of steam caused by the alternate heating and cooling of the cylinder.

### Watt's Interest Aroused

To Watt, who had never seen even a model of a steam engine, the discussion in his room on the subject opened up entirely new ground. Robison appears to have promoted this particular discourse. He suggested that the power of steam might be used for driving carriages by adapting Newcomen's principle, and that in order to avoid having a working beam the cylinder could perhaps be satisfactorily placed with its open end downward.

The subject greatly interested Watt and in leisure moments he gave it much thought. He experimented upon Robison's idea and made a rough model comprising two tinplate cylinders from which he purposed that the respective pistons and connecting rods should operate alternately on two pinions fitted to the axles of the vehicle. The model failed to work to his satisfaction, however.

### Model Shows Defects in Newcomen's Engine

Watt was surprised to learn one day that the University owned a model of Newcomen's engine. The model had not worked properly, however, and the perplexed professors had sent it to a London instrument maker for investigation and adjustment. At Watt's instigation the model was sent for to be turned over to him to deal with. While he waited for its return from London he studied diligently the little that had been written of the experiments of others regarding steam. It is easy to picture his delight when at length the model arrived, and the eagerness with which he tried it out.

In due course Watt got the engine to work and was awarded £5 by the professors for his success. The limitations of the invention were apparent, however. The boiler, for instance, though seemingly of sufficient capacity, failed to maintain a steady supply of steam, with the result that after about a dozen motions of the piston the engine stopped for want of breath ! Such imperfections served only to increase Watt's resolve to invent an engine in which they would be successfully overcome.

Meanwhile his instrument-making business was not neglected. By 1760 it had developed so successfully that he decided to enlist more capital, and the same year he took into partnership John Craig, in co-operation with whom he transferred the business to larger and more suitable premises in the city. In 1764 Watt married a cousin named Margaret Miller and removed from his rooms at the college to a house in Deltfield Lane, a narrow thoroughfare since absorbed in modern street improvements. His business had prospered so considerably by then that he was able to provide regular employment for sixteen workpeople.

### First Attempt Fails

During these years the subject of the steam engine remained uppermost in his mind, and every opportunity that offered itself was used to carry out investigations bearing upon the problem. Early in his experiments Watt devised a boiler that registered the amount of steam taken at every stroke of the engine, and the quantity of water evaporated during any set period. He discovered that the cold water injected into the cylinder to condense the steam already there was appreciably warmed by the latter, and that the steam was