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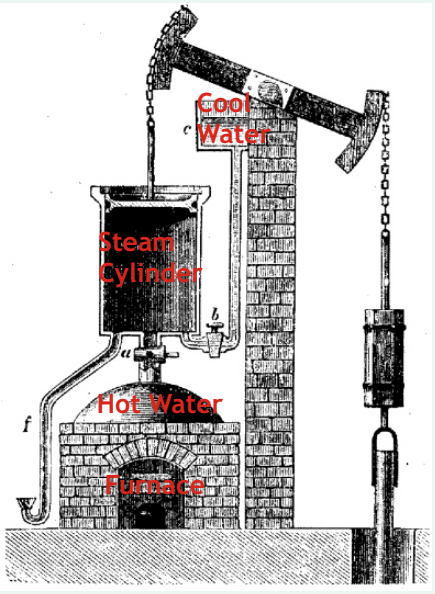
'GRASSHOPPER' BEAM ENGINE H170

The 'Grasshopper' beam engine was invented in 1803 by William Freemantle. It gets its name from the nodding action of the overhead beam which is supposed to resemble the action of the rear legs of the grasshopper. It is sometimes called a half beam engine.

The first full beam engine powered by steam was built In 1712 by Thomas Newcomen (1663-1729). Newcomen was a Baptist lay preacher by calling. However, he worked as an ironmonger by trade in his home town of Dartmouth, as the Baptist community there could not afford to pay him as a full time minister.



Newcomen's engine (right) had a large horizontal beam balanced in the middle like a seesaw. A piston which fitted into a cylinder hung from one end of the beam. When steam was let into the steam cylinder, it forced the piston up, lowering the other end of the beam. Cold water was then sprayed into the cylinder, the steam condensed, and the vacuum sucked the piston down again. This raised the other end of the beam, which was attached to the piston of a pump in a mine.



Newcomen's design was both powerful and useful. The first example was able to replace a team of 500 horses that had powered a wheel to pump out a mine! However it had a major problem in that the steam cylinder had to be repeatedly heated up and then cooled down. This used a huge amount of fuel and made the engine work very slowly.

Left: The Elscar Engine shed. The Elscar Engine, a Newcomen atmospheric engine built in 1795 to drain Earl Fitzwilliam's New Colliery, is the oldest engine in the world still at its original site. Elscar is close to Barnsley, Yorkshire.

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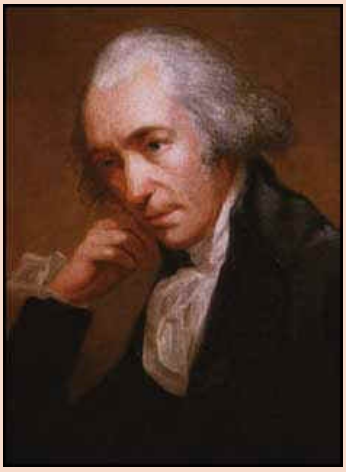
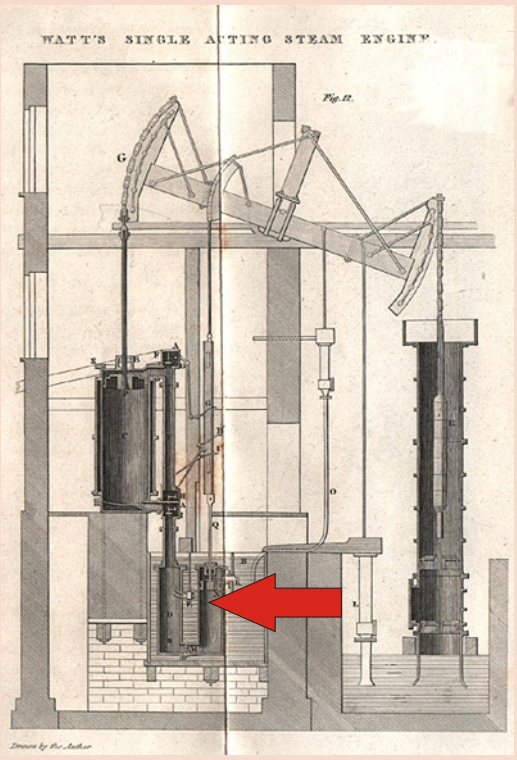


It was James Watt (1736-1819, right), from Scotland, who found a simple but very effective solution to the problem of fuel consumption by Newcomen's engine. In 1763 he realised that if the steam could be sucked out of the steam cylinder and cooled in a separate chamber this would mean that the steam cylinder would not need to be repeatedly heated and cooled. This separate chamber is called a condenser. By doing this the steam chamber could be kept at a constant temperature and the amount of fuel needed would be greatly reduced. It also meant that the engine could run much more quickly. A plan of a Watt engine can be seen on the lower left - his condensing chamber is marked with a red arrow.

Many Newcomen engines were adapted to take Watt's design. Watt teamed up with Matthew Boulton, a forceful and energetic Birmingham-based tycoon, and Boulton & Watt became the most important engineering firm in the country, meeting considerable demand. Initially this came from Cornish mine-owners, but the engines were soon being used for purposes other than pumping water and could be found in paper, flour, cotton and iron mills, as well as distilleries, canals and waterworks. By 1790 Watt was a wealthy man, having received £76 000 in royalties on his patents in eleven years. In 1785 he and Boulton were elected fellows of the Royal Society.



Despite Watt's improvements, Common Engines (as Newcomen engines came to be known) remained in use for a considerable time. More Newcomen than Watt engines were built up to 1800, as they were cheaper and less complicated. Of over 2,200 engines built in the eighteenth century, only about 450 were Watt engines.

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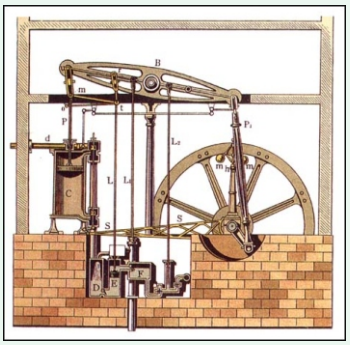
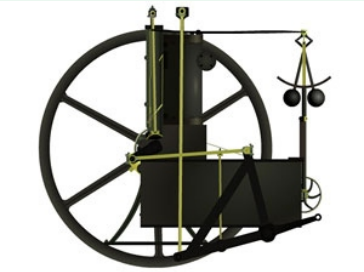
For a long time steam engines were thought of exclusively as a means of pumping water, but Watt realised that if he could design an engine in which the up-and-down action could be translated into rotary action then it could be used for many new purposes powering saws and mills, hauling heavy weights and so on.



In 1782 Watt produced his first rotary-motion steam engine and it was quickly used to drive machinery in textile mills and other factories. The diagram on the right shows his design, which involved a complex arrangement of linkages to allow both the up-and-down action of the piston and the rotary motion of the fly-wheel. The large fly-wheel helped to maintain momentum. A smaller drive wheel could be attached to the fly-wheel from which a belt would power machinery. A photograph of another preserved rotary engine made by Watt can be seen in the photograph below - the smaller drive wheel is also clearly visible.





All of Watt's engines were true beam engines - they feature a large beam which is pivoted at the centre. Often the engine house itself was used to support the rocking beam. Towards the end of the eighteenth century smaller, self-contained and low-power engines began to be designed. In 1799 William Murdoch, an associate of Watt, built his first bellcrank engine (left). This was the first independent engine (that is self-supporting - lacking a central pivot), of just 2-3 horsepower, to become commercially available.

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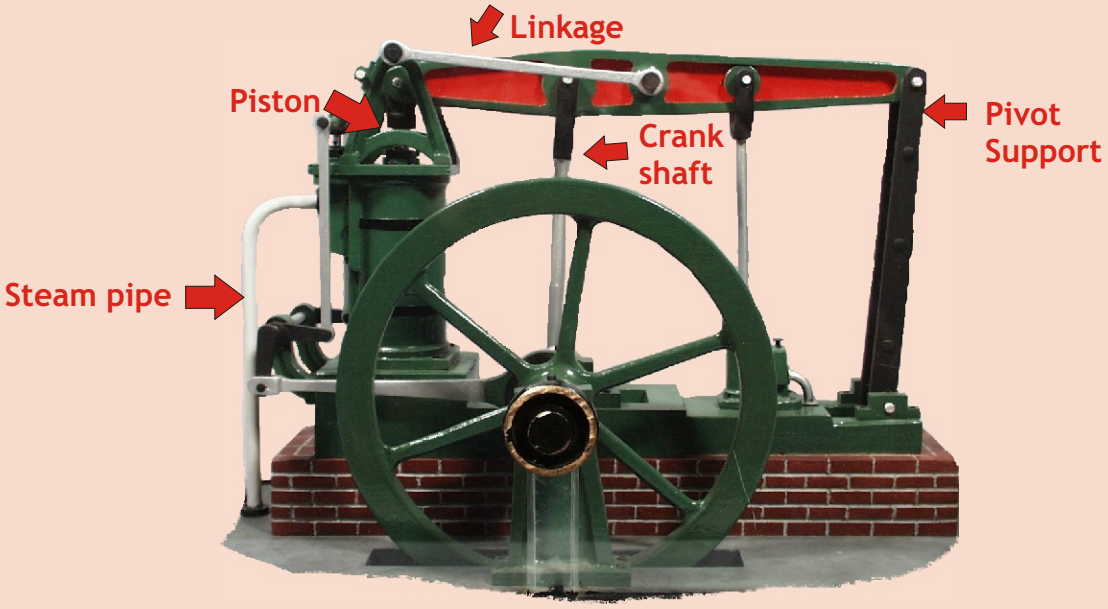

The grasshopper engine was invented a few years after Murdoch's bellcrank engine, in 1803. It was used throughout the nineteenth century to provide power for many small workshops and mills. This particular model is based on an Easton and Amos 7½ horse power grasshopper engine which was used to drive water supply pumps until 1928. The piston, which operated the small water pump, is located between the crank shaft and the pivot support. The original is now in a museum in Scotland.

The grasshopper engine was more compact than the normal rocking beam engine as the piston and the crank shaft were positioned on the same side of the pivot support, which was allowed to 'wiggle' slightly. A linkage arm travelled from the centre of the beam to a sturdy bracket immediately above the steam cylinder. This arrangement allowed the beam to move with a 'loping' motion, rather than the circular rocking motion that you would get with a conventional beam engine.

James Easton (1796-1871), the partner of Charles Amos, was the owner of the English patent for Mongolfier's hydraulic ram - a water-powered cyclic pump which harnesses the forces of a water hammer to pump a portion of the water being used to power the pump to a point higher than where the water originally started. Easton's firm grew during the nineteenth century and owned a large works at Erith, Kent. They specialised in water supply and sewerage systems world-wide, but as hydraulic rams need running water to operate they also made steam powered pumps such as this one.