Steam Engine Development

These pages are still being developed !!

Introduction

Throughout history certain events have taken place, which have drastically changed and influenced the advancement of mankind. The Industrial Revolution was one such event and the invention and development of the steam engine played a major part in its rapid progress
Around 1712 the first atmosheric beam engines were built primarily to pump water out of many mines in and around Cornwall. This allowed deeper mines to be worked thus increasing their working life
With the invention of the crank, rotary motion was introduced. This meant that steam would take over from water as the main provider of power. Industries could now be located practically anywhere, not just in the areas where water was in constant supply to drive water wheels etc
As towns and cities expanded the need for clean water, in large quanties became a priorty, as did the removal of sewage Massive beam engines, driving massive pumps provided the answer
Steam engines also replaced wind power, such as windmills, to drive land drainage pumps which kept reclaimed land from flooding
Wherever any industrial activity was required the steam engine provided the power These activities included mine machinery, textile mills, railways, steel works, road building, civil engineering, just to name a few
A truly remarkable story!!

The Early Days

Whenever the question 'Who invented the steam engine?' is asked, the answer will most likely be James Watt. The truth is that Watt did not invent the steam engine but did make many crucial improvements to increase its efficiency.
Thomas Savery, born around 1650 in Shilston, Devon, was the first person to build commercial apparatus to pump water, by condensing steam to create a vacuum

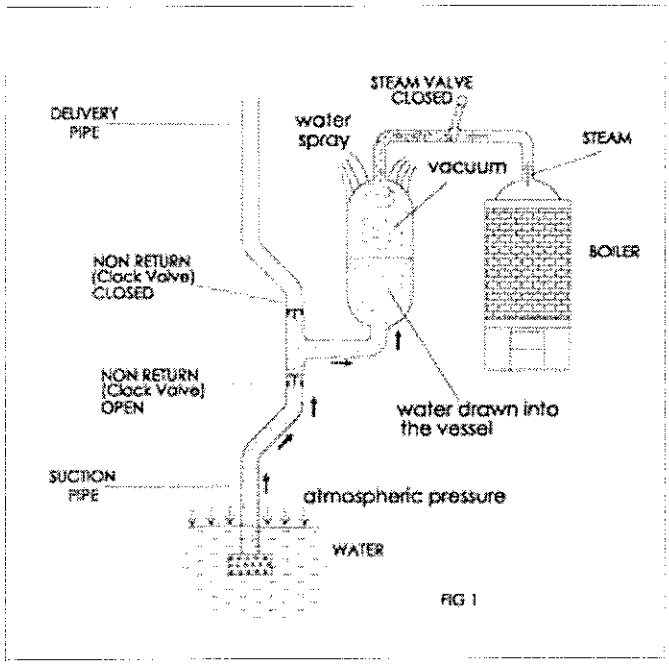
The principle that the earth's atmosphere could exert a force when a vacuum is formed, has been known for hundreds of years In 1643 an Italian by the name of Evangelista Torricelli did experiments to show that water could be drawn up a tube by the use of a piston creating a vacuum on top of the water. This column of water could in theory be 34ft high with a perfect vacuum. Torricelli managed 28ft in his laboratory
Once this phenomena was know the next challenge was to find a means of creating the vacuum.
Around 1690 a Frenchman named Denis Papin first of all tried explosions to remove all the air, which proved impractical. He then experimented by condensing steam, which was much more successful. He managed to condense steam under a piston, which was forced down by the atmosheric pressure. This in turn raised some weights by using ropes and pulleys
Papin did not continue any further with this but had clearly demonstrated an important theory.

The Miners Friend

Thomas Savery, born around 1650, would have known about the work already done on vacuum and atmospheric pressure He was also aware of the problems regarding the pumping of water out of the

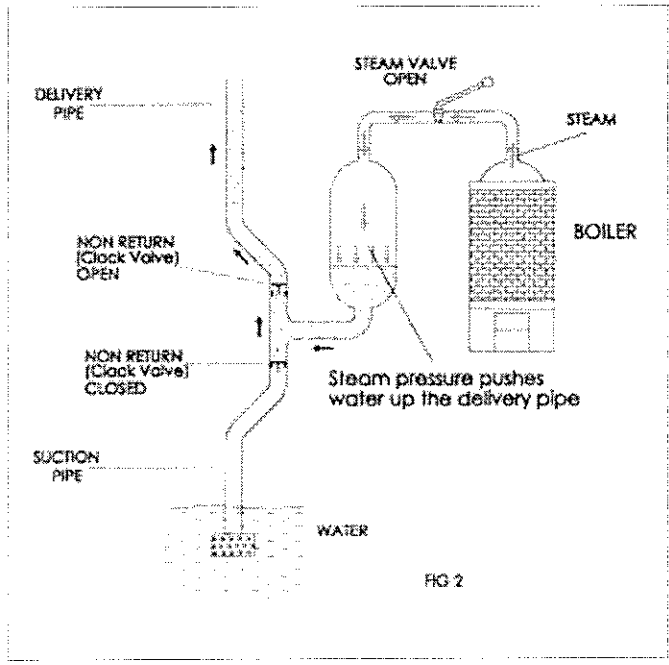
local copper and tin mines.
He set about building an 'engine' which would draw water into a container, by condensing steam within the container. Then, using steam pressure, push the water up a pipe to the required height

The following diagrams outline the principle of Thomas Savery's pump:



In FIG 1 the non return valve in the delivery pipe would be held closed by the weight of water above it The steam valve was opened to fill the vessel with steam and then closed again. Water would be poured or sprayed on the outer surface of the vessel, which condensed the steam and caused a vacuum within Atmospheric pressure would then push the water up the suction pipe to fill the vessel

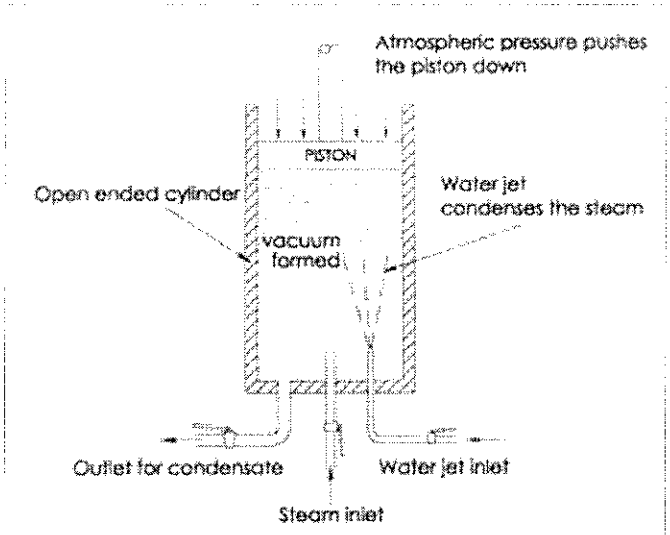
The next stage, in FIG 2 the steam valve would be opened to allow steam pressure to build up in the vessel This would tend to close the non return valve in the suction pipe and force the water out of the vessel and up the delivery pipe.
The cycle would then be repeated



In practice, Savery's latest pumps had two vessels side by side, with common delivery and suction pipes. In this way he could have one pumping water out, whilst the other was filling with water ready to be pumped.
In 1698 Thomas Savery took out a patent for his pump, which was described as **'Raising water by the impellent force of fire'**. He later published some literature promoting his invention, which he called The Miner's Friend, from then on his engines were refered to as **'the miner's friend'**

The Atmosheric Engine

Although Savery's pump was used in several Cornish mines it had serious limitations The height at which water could be pumped (100 to 150 feet) was dependant upon the steam pressure generated in the boiler. This was relatively low, because the art of boiler making and the materials available were very primative compared with modern times The maximum suction height was around 25 to 30 feet so that the pump had to be constructed within the mine shaft itself. The actual pumping cycle was slow and the manual opening and closing of the valves would be a laborious job requiring the full concentration of the operator.

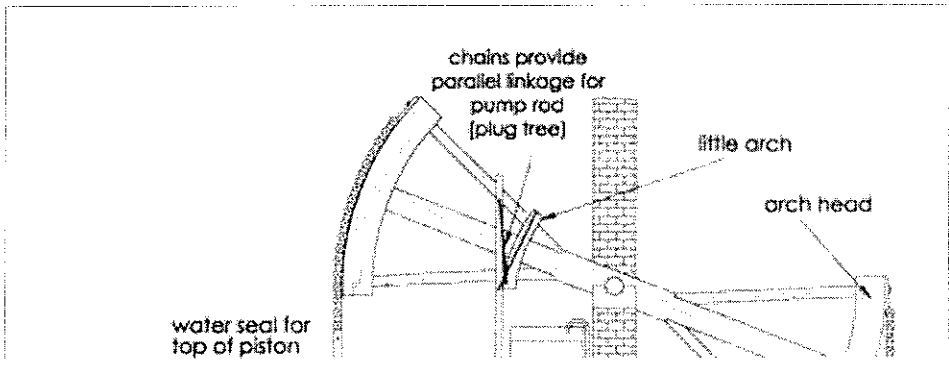


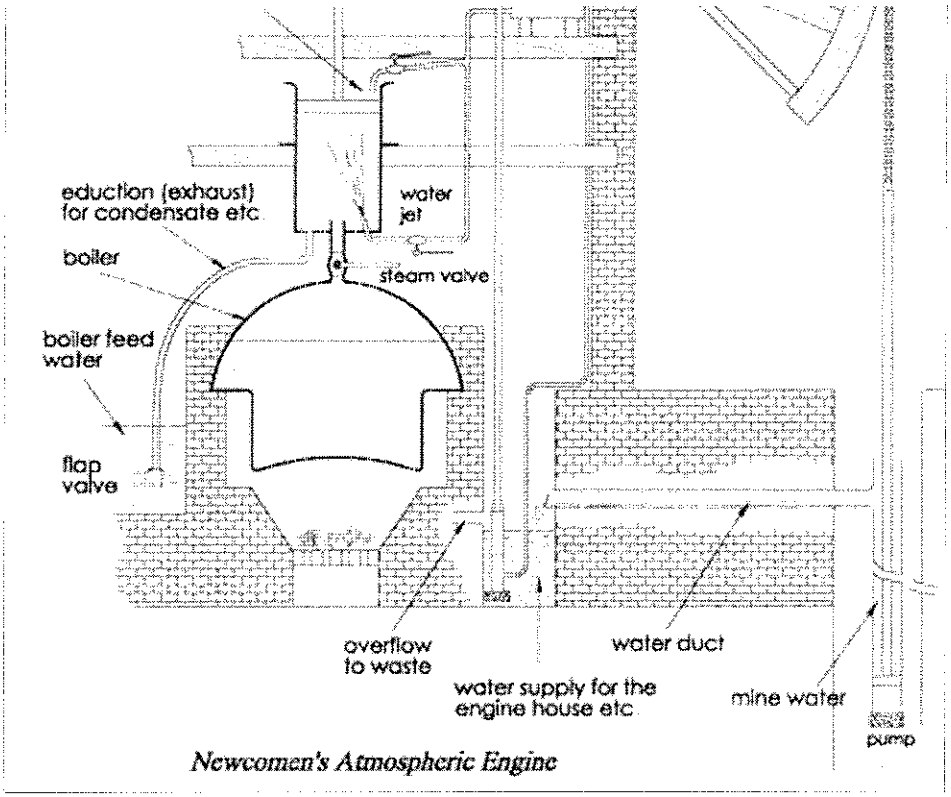
Principle of Newcomen's Atmospheric Engine

Whilst Thomas Savery was developing his engine, Thomas Newcomen was experimenting with engines which had a piston inside a cylinder He took his inspiration from the work of Papin, who had successfully used atmospheric pressure to act on a piston within a cylinder. The principle, by which Newcomen's engine worked, was the same as Savery's, in that condensing steam, in a closed space, creates a vacuum But instead of atmospheric pressure sucking water up into the engine (as in Savery's engine) it pushes a piston down a cylinder

To make use of this power, Newcomen created a large wooden beam pivoted in the middle A length of chain connected one end of the beam to the piston rod and similarly the other end of the beam was connected to the mine water pump and rods.

Newcomen, along with his assistant John Calley, tried many designs to improve the reliabilty of the engine A particular problem was how to condense the steam quickly. In his earlier attempts he made a lead jacket to surround the cylinder and filled it with cold water. This improved matters but it was still inefficient since some of the incoming steam would continue to condense on the cool cylinder walls.
The solution came out of the blue. It is reputed that a defect in the cylinder wall allowed the surrounding water to leak, in sufficient quantity, to condense the steam rapidly and cause the piston to descend with considerable force Newcomen promptly introduced a water jet directly into the cylinder to condense the steam as soon as the piston was at the top of its stroke
This discovery was the key to the success of the Newcomen engine.



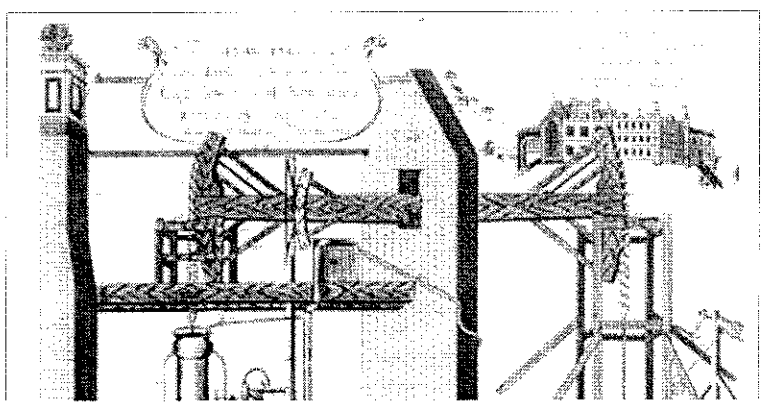


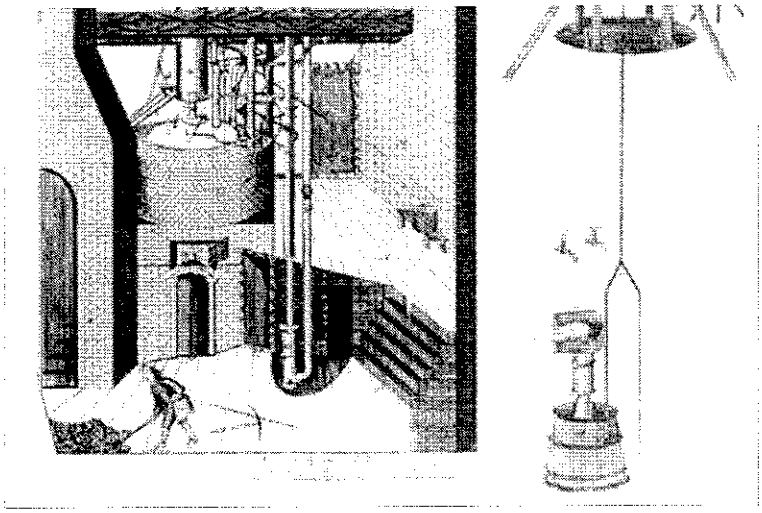
Newcomen's Atmospheric Engine

This diagram shows the layout of a typical early atmospheric engine. As the piston moves upwards, steam from the boiler would be admitted into the cylinder. At the top of the stroke the steam valve would be shut and the valve to the water jet opened. The jet of water would rapidly condense the steam, causing a vacuum to form under the piston. Atmospheric pressure, acting on top of the piston, would force the piston down, pulling the beam down with it. At the other end of the beam the pump rod and water would be lifted up the shaft. The injection valve is then closed, and the weight of the pump rods would cause the beam to rock in the other direction to lift the steam piston up the cylinder and start another working cycle. Condensed steam and injection water is exhausted, through an automatic flap valve, into a hot well to supply boiler feed water etc
In the early development of the engine it would be operated by manually opening and closing the appropriate valves. Later on this operation was performed automatically

Below is shown a print of an engraving, by Thomas Barney.

"The STEAM ENGINE
near Dudley Castle. Invented by
Capt: Savery, & Mr Newcomen.
Erected by ye later 1712
delin: & sculp: by T: Barney 1719."





This engraving, together with various prints, is the only surviving record of the atmosheric engine erected by Newcomen, some 24 years before James Watt was born The engraving also contains references (not shown here), which describe in detail, some of the working parts of the engine In particular the engine was clearly working automatically with the valves controlled from the pump rod (plug tree) attached to the little arch by chains These chains pulled and pushed the pump rod in a straight line An 'in house' water pump was attached to the end of this rod
The plug tree was simply a wooden rod moved up and down by the little arch. Pins or plugs were fastened to the rod in such a manner that they would open and close the valves through a series if linkages

Some details of the engine from the Reference Table on the engraving:-
The Boiler 5 Feet 6 Inches Diameter, 6 Feet 1 Inch high. The Cylindrical part 4 Feet 4 Inches, Content near 13 Hogsheads.
A Brass Cylinder 7 Feet 10 Inches high, 21 Inches Diameter, to Rarify and Condense the Steam.
The Great Balanced Beam vibrates 12 times in a minute and each stroke lifts up 10 gallons of water 51 yards perpendicular

More to come in the near future !!

Top of Page