THE TREVITHICK SOCIETY

KOWETHAS TREVITHICK

NEWSLETTER 192 SUMMER 2021

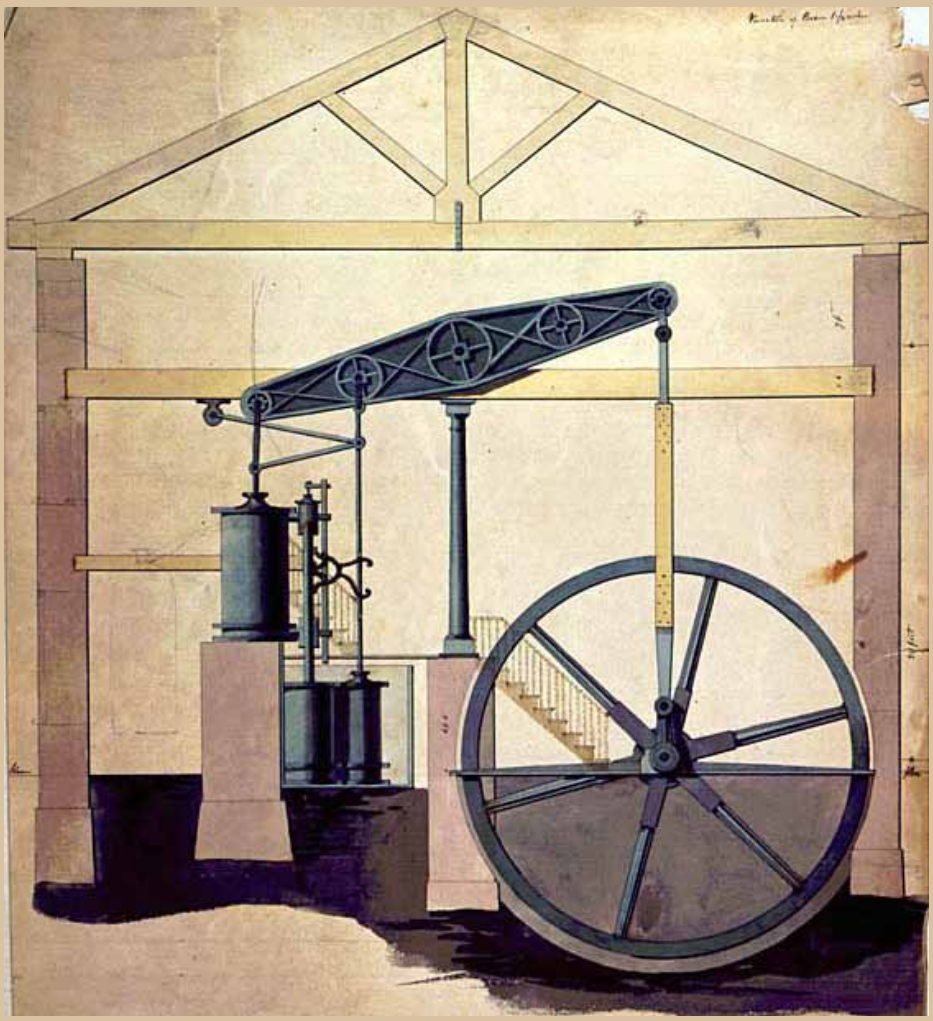

Figure 8: Frederick Graff's drawing of the 44-inch Boulton and Watt-type beam engine (South Engine) erected at the Fairmount Waterworks in Philadelphia in 1815 (Philadelphia Water Department Historical Collection, www.phillyh2o.org).

Reg. Charity No. 1,159,639

EDITORIAL

The Society has received some very good publicity recently through the auspices of Channel 4 television. The first episode of the new Devon and Cornwall series included footage of the ten year boiler test of the Puffing Devil, which took place at Sam Henwood's engineering works near Summercourt. When the film company researchers were looking for something suitable to film they asked Sam if he had anything interesting coming into his workshops. "Oh yes", he said, "the Puffing Devil". If you missed it you can view online at:

https://www.channel4.com/programmes/devon-and-cornwall-box-set/on-demand/71717-001

Series 4 Episode 1 - first shown on 21 June 2021

Due to the coronavirus pandemic the usual Trevithick Day was cancelled. Instead the Trevithick Day committee organised a virtual event including a 250th anniversary video:

https://www.youtube.com/watch?v=lq4faMOw05A

and commissioned a *Story of Trevithick* cartoon:

https://www.youtube.com/watch?v=snb6YeNJB9Y

The shops in Camborne celebrated also the Trevithick Day with suitable window dressings including the model of Trevithick's proposed monument to celebrate the Great Reform Act made on a 3D printer!! This photograph was taken by Trevor Dalley.

The Society has now held several Zoom meetings and various members at home and overseas have expressed their delight at being able to join the last couple of talks.

CNF

Copy date for next newsletter:

September 15th 2021

TM

Established 1935

NEW MEMBERS

The Society gives a very warm welcome to the following new members and looks forward to meeting them at any Society events:

John Kanefsky	Morchard Bishop, Devon
John Harris	Barnet
David Williams	Mabe

LETTERS TO THE EDITOR

Dear Editor,

In March I managed to find the portal of the Great County Adit, one of our great mining engineering feats. Now overgrown, the portal is only visible from an equally overgrown footpath above; if one can find the correct path (see photograph on right).

With over 40 miles of tunnels that at one time served some 100 mines and discharged 14 million gallons of water a day, we need to celebrate this achievement. A decent path needs to be made from the Coast to Coast Mineral Trail and an observation point established with an information board. A job for the Trevithick Society or Cornwall Council?

Robin Knight
robincknight60@yahoo.com
Penzance

Dear Editor,

I have had an email from the Peruvian Embassy asking if I know of any direct descendants of Trevithick. They particularly want to know about any that live in the U.K. It seems that they would like to plan some sort of reception. Can the Trevithick Society help?

Trevor Dalley
Trevithick Day Committee
vanoweth@gmail.com

Dear Editor,

Watching the Channel 4 programme "Devon and Cornwall" prompted me to write.

My aunt lived opposite Trevithick's son, and when young I remember her saying he was always busy in his workshop - lights on late!

When he died his coats (a duffel and army-style great coat) were passed to my aunt for her sons (it was wartime). These were subsequently passed to my husband's mother, nearby, for her son, whom I married many years later.

As an engineer he was in his workshop every evening and in winter time always wore Trevithick's coat.

When he died (unexpectedly - he was a young 67) I passed the coat to his cousin; also an engineer.

Mrs Ewer
Lymington
Hampshire

MORE ON REV. RICHARD FRANCIS TREVITHICK

I am able to add more to Kenneth F Trevithick's account of his father in the Spring 2021 Newsletter.

Known as "R. Francis" he achieved a remarkable official Obituary in the 1949 Minutes of Conference p135.

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RICHARD FRANCIS TREVITHICK: born at Pool, Illogan, Cornwall, in 1896. In his early years he became conscious of a call to the Christian Ministry. He was, however, handicapped by a pronounced impediment of speech. Confiding in his schoolmaster (a Local Preacher of considerable ability), he was advised to set aside the idea of becoming a minister, for with such a defect of speech he could not have been a preacher. Another disadvantage was the lack of a good education. Imbued with a sure knowledge that God wanted him to be a minister, he conquered the impediment and quickly became a fluent speaker. After a course of training at Cliff College, for which he was ever grateful, he developed into a remarkably able preacher. Accepted as a candidate in 1921, he later trained at Didsbury College. Throughout his ministry he was regarded as one possessing outstanding pulpit gifts. He not only preached to people, but also loved them intensely, and this was evidenced in a great pastoral ministry. Taken ill during a service on Sunday, 23rd January 1949, he died a few days later at the early age of fifty-two years, in the twenty-fifth year of his ministry. At the time of his death he was minister of the Mint Church, Exeter. During the seventeen months he was there, he did a great work for God, as indeed he did whether travelling in Hull, London, Clacton-on-Sea, Ipswich, Penarth, or Redruth. Francis Trevithick was a great gift of God to Methodism. Hundreds of people were converted by his persuasive preaching and loving ministry. A number of young men were inspired by him to enter the Ministry. He was a great lover of Jesus. He will remain an inspiration to many who were privileged to know him.

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Cliff College is Methodism's lay training college in Derbyshire for the training of evangelists. Didsbury College was one of several ministerial training colleges for Wesleyan ministers, located on the south side of Manchester. After ministerial training was moved to Bristol the college went through many expressions of further education, but now only the Listed original building and chapel remain.

References to "a great gift of God," "Hundreds … converted" and "an inspiration" were remarkable in an official Obituary.

There would probably also have been a larger obituary in *The Methodist Recorder* newspaper, but copies of it are not available to me.

Francis' travelling (i.e. the sequence of appointments to which he was sent) is …

1921	Liverpool Mission	1
1922	Didsbury College	
1924	Formally entered the ministry	
1925	Hull, Waltham St.	3
1928	London, Ilford	3
1931	Clacton-on-Sea	3
1934	Ipswich, Museum St.	4
1938	London, Brixton Hill	3
1941	Cardiff, Penarth	3
1944	Redruth	3
1947	Exeter	

The places are Circuits, groups of Chapels working together, with an extra line to the title when an area had more than one Circuit. Several of these Circuits would

have had rural as well as town Chapels. Methodist ministers are appointed to all the Chapels in a Circuit, but usually have specific pastoral responsibility for a group of several.

The dates are from September for a year. 1921 would be described as a Pre-Collegiate Year. Whether Francis had some special role 1924-5, or continued with his studies I cannot now ascertain, but not to be sent to a Circuit in 1924 would have been unusual.

The numbers are length of stay. It will be noticed that Francis stayed in Ipswich for four years.

He was never a Superintendent minister.

The copy of the preaching appointment book is interesting. The first appointment is at a "U.M.C." – a United Methodist Church, the 1907 union of the Bible Christians, the United Methodist Free Churches and the Methodist New Connexion. Francis was a Wesleyan, the Methodist branch who did not accept union until 1932; most of the Chapels are Wesleyan. But Paynter's Lane End was ex-United Methodist Free Churches while Radnor was ex-Bible Christian. Each, for instance, used a different hymn book from the other, and the Wesleyans' was different again. There was little real sense of rivalry between the different Methodist branches for as long as they stayed different organisations, especially with a large population still in Cornwall. The rivalry developed when full union occurred and chapels had to close now that the same organisation was running meetings cheek-by-jowl.

The list also shows a feature not uncommon then, or indeed when I started preaching in the late 1960s: only 5 different services (sermons) were preached over 19 services and 17 months. You wrote a sermon and preached it for as long as you had a congregation who hadn't heard it – number 1 of September 5, 1915 was still going strong on February 18, 1917 (although Treswithian had number 3 in 1916!).

And finally a correction to Kenneth: Flower Pot in Fore Street Redruth has indeed gone, but The Mint is still open 7 days a week in Exeter! (subject to Coronavirus regulations of course).

Colin C Short
(wearing his hat as Chairman of the Cornish Methodist Historical Association).

FROM THE ARCHIVE

Recently when delving into the Society's archives I found the following correspondence between W. Tregonning Hooper, Secretary of the Cornish Engines Preservation Society and Daniell & Thomas Solicitors, concerning the insurance policies with London Assurance in April 1958. These covered the Public liability to the tune of £10,000 for:

1. Engine House at Taylor's Shaft, East Pool and Agar Mine, Carn Brea, containing a Cornish pumping engine operated solely by South Crofty Mines Ltd.
2. Engine House at Levant Mine, near St Just, containing a disused rotative beam winging engine.
3. Engine House at East Pool Mine, near Redruth, containing a disused rotative beam winding engine.
4. Engine House at East Pool Mine, near Redruth, containing disused caudle-down engine valve gear and disused lower Goonvean engine valve gear.

Annual premium - £8. 5. -d.

Also lodged in Barclays Bank was a Deed of Grant Cottage Garden & Outhouse at Higher Penponds, Camborne - Olivey to Holman dated 6th March 1945. Trevithick Cottage was insured separately for £500.

KJTR

THE FUTURE OF THE SOCIETY RETAIL BUSINESS

Having worked in the retail environment for forty years during my working life I was only too pleased to take on the Society's retail arm which, for the last twenty two years, I have managed. Over that period we have had to keep up to date with modern trends, have improved our image and expanded our inventory to increase turnover as much as possible. This is a job I have thoroughly enjoyed and I thank the many volunteers who have given their time as members of the Canary Crew. In recent years I have had excellent regular support from two others who, like me, were trained in retail business and there have been numerous other members who have volunteered for odd days when they were able. Unfortunately time moves on and health issues have very much reduced the time and effort we can inject into the business which has prompted thoughts on the future after covid.

At eighty three years of age I am not sure how long I shall manage to lift heavy boxes or even still be driving and hauling the Society show trailer and erecting the show tent. If there is anyone out there who would relish a challenge then I would be delighted to hear from them. The rewards to the right person are endless.

To save a rush of telephone calls and e-mails I will broadly go into the system here and now. Typical of retail business obtaining stock, banking takings, organising the volunteer rota, dealing with event organisers and cleaning and maintaining our tent and display kit are the main priorities. Erecting the tent is a skill that needs to be learnt and requires four people as is packing it and the rest of the gear into the trailer at the cessation of trading. We attend five or so one day events each year and are often asked to appear at more but asking volunteers to turn out too much at weekends can cause problems at home like "Where is my dinner dear?" "It's been in the dog for two hours!".

Occasionally we have attended special events beyond Cornwall such as in Norfolk, Staffordshire, Shropshire, York, London, Wales and other places, publicising Cornwall, the Trevithick Society and the importance of industrial heritage.

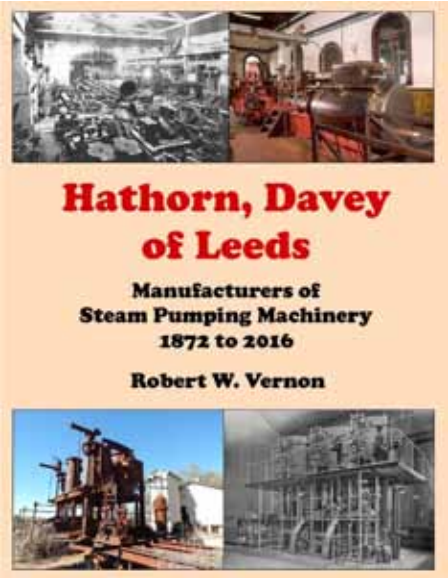
The hours can be long but meeting the public and answering their questions is very rewarding and sometimes educating for us as customers are often quite knowledgeable and at other times hilarious. I will recall just three examples - two concerning the Puffing Devil. One gentleman enquired as to what were the black stones we had in the large baskets on the man stand so he was obviously very unfamiliar with coal even if he was at a steam rally! The second was a gentleman on a different occasion who had studied the Puffing Devil for some time then said "I know this is a replica but what was it before?" I think I know what he meant! The third concerns a well known television personality with whom I was working on a television programme in Camborne. He said to me "It is odd that I have never heard of this town Trevithick before" to which I replied, "You haven't heard of it because the town is Camborne". I presume he had never passed his geography exam!

One of the greatest skills our volunteers can have is learning how to carry four cups of tea from the snack booth to the tent in a force eight without spilling any!

The retail section is an important part of the Society producing much needed income and publicity. Unfortunately the recent lockdown restrictions and bad weather in 2019 have affected outdoor events and reduced our turnover markedly so the future is an interesting challenge.

As stated above if you are interested in running this section of the Society then do contact the chatline 01209 716811 or contact k.rickard@talktalk.net to talk over any thoughts, problems or ideas. Full support will be given. I need to reduce my work load but will still be available to help staff the tent if and when required.

KJTR



Hathorn, Davey was established in 1872 at Hunslet, Leeds as a means for a retired Scottish Army Captain, John Fletcher Hathorn, to give his half-brother a worthwhile career. A year later, a young engineer Henry Davey, joined the Partnership. Davey was to become probably one of the most innovative engineers in pumping technology of the period, and it was his patent of a new type of steam engine governor, the differential gear, together with its application to the two-cylinder Compound Engine, that gave the Company worldwide fame. The differential gear was also fitted to many Cornish type beam-pumping engines as it eliminated potential piston damage if the load on the engine was suddenly removed by pump rod breakage, for example.

The Company was dominant during the period when the use of steam power was starting to wane. Nevertheless, the Compound Engine was sold to many colliery companies throughout the United Kingdom.

The purchase of two engines by the South Staffordshire Mines Drainage Commission for example meant many less efficient pumping engines could be scrapped. Hathorn, Davey hydraulic engines from this period survive underground in the Sir Francis Level, Swaledale, North Yorkshire, while a steam pumping engine from the Marine Colliery, is on display on the surface at Ebbw Vale, South Wales.

John Taylor and Sons the London based mining consultants held Hathorn, Davey pumping engines in high regard, for their efficiency and reliability and they erected Hathorn, Davey engines on their mines sites in Spain, India and Australia. The Vertical Compound engine at the Waihi Gold Mine, New Zealand with a 110 inches diameter low-pressure cylinder was the largest sold by the Company.

By 1900, the Company had come under the Directorship of the Lupton family, Leeds. At that time the triple expansion engine was popular mainly for waterworks, but some were also sold to a few mining companies. The last Compound Engine made by the Company was erected at the Mill Meece Pumping Station Staffordshire, and still works the original pair of pumping quadrants.

Rob's book describes the establishment of the Sun Foundry, Leeds where the Company was based, and the many partnerships in its formative years until the Company was finally wound up in 2016. The book is amply illustrated (170 drawings and photographs) together with examples of the many engines and pumps produced by the Company for mine sites and waterworks worldwide. There are also contemporary descriptions of the engines taken from a variety of patents, and technical journals, and the book will more than satisfy those with an interest in mining and technology.

The book is 368 pages long. ISBN 978-1-8383621-0-2 Price £24. It is available from: Moorebooks, 53 Vineyard Drive, NEWPORT, Shropshire TF10 7DF Website: https://www.moorebooks.co.uk/

LEVANT BOILER MIXING TANK

The mixing tank is a stand-alone container, containing unpressurised hot water combined with the required amount of liquid treatment. This is heated by a thermostat controlled steam injector before being drawn off and forced into the boiler when required.

Previously the steam supply had been taken from a flooded condensate return pipe and as a result the temperature in the mixing tank was nowhere near the required 80°C. The above caused the following problems:

- The boiler was being topped up by lukewarm water, killing a large quantity of steam.
- 80°C is required to drive out all suspended oxygen and help prevent corrosion inside the boiler.
- There was insufficient temperature for the treatment to mix with the water which caused a chain of problems:

  1. Overdosing with treatment in an attempt to get the correct pH level.
  2. Treatment congealing in the feed pump and pipework.
  3. A huge build up of scale inside the boiler.
  4. Note - the boiler manual states that 1.5mm thickness of scale will reduce boiler efficiency by 11%.

To rectify the above, the steam supply was moved to the highest part of the steam main which resulted in more than 30% reduction in boiler fuel oil consumption.

John Woodward

IRON, STEEL, TINPLATE, AND OTHER WELSH TRADES

Marcus Croome kindly sent in a photocopy of chapter XV from *The History of the Iron, Steel, Tinplate, and other trades in Wales* by Charles Wilkins which was published in 1903 by Joseph Williams, Printer and Publisher, Merthyr Tydfil.

Chapter XV deals with Penydarren Works; Trevethick [sic] and his locomotive; Great wager between Homfray and Richard Crawshay. This paper is interesting in that it adds a Welsh perspective to the Penydarren locomotive, albeit a century after the events took place.

"Trevithick was a Cornish inventor who had for some time been occupied in bringing a steam locomotive into notice, and he appears to have travelled down to Wales and brought his plans before various ironmasters - in particular, before Mr. Homfray, of Penydarren. The result of a long and keen investigation was to convince Homfray that it was a great discovery, and, in order to bring it to a thorough practical trial, he made a bet of one thousand pounds sterling with Richard Crawshay that he would convey a load of iron by steam-power to the Navigation from his works .... Trevithick selected as his assistant a Mr. Rees Jones, an ingenious mechanic, of Penydarren .... The Cornish genius brought most of his materials to Merthyr, and he and Jones went to work with vigour ... At last it was ready. With a tall, clumsy stack made of bricks, it had a dwarf body, perched on a high framework, and large wheels. The cylinder was upright, and the piston worked downwards, and every movement was attended with a clang of discord and a grating that sometimes put everyone's teeth on edge. [Apart from the brick chimney this description fits the Puffing Devil and not the usual layout of the Penydarren locomotive] With the completion of this, which was gracefully called "Trevethick's High-pressure Tram Engine" came the day of the trial, February 14th, 1804. And such a day! .... All the population turned out, and crowded about the strange creation of iron and brick and wheels. It breathed stertorously, and moved. .... bold men to the number of 70, crowded on the iron and trams and about the engine. Ten tons was the quantity of bar iron in the trams. ... a jet of steam burst forth, the people yelled, the wheels moved, they hurrahed, and the whole mass, with the crowd of workmen perched on it, slowly it glided away. ... everything went smoothly until the bottom of the village was gained, and then in passing under a bridge the stack of the engine not only carried it away, but also came to grief itself, and the engine was at a standstill ...Trevithick soon re-built the stack and away it went at the rate of five miles an hour to the Navigation. It was unfortunate for Crawshay that he did not stipulate a return journey, for this the driver could not do, and every effort on the part of Trevethick failed, on account of gradients and curves, to bring the empty trams back again." The article then went on to say that the contemporary Cambrian newspaper noted "It performed the journey without feeding or using any water". Furthermore the article went on to say "the engine, after serving a long time on the tramway, was removed to a pit, called Winch Fawr, and in after years was again taken to the top of the incline owned by the Penydarren Company, and there it was restored, patched and re-patched, until only the original cylinder remained. .... Trevethick assisted after this in forming an engine for Tredegar and another for the tramroad between Hirwain and Aberdare, and then disappeared from Wales". This extract from the book does not closely match the story of the Penydarren engine we believe today and it would be wonderful if some of it could be corroborated, particularly the second tramroad engine at Aberdare.

CNF

TREVITHICK 250 MEMORABILIA

The Society have been busy creating a couple of logos to appear on garments and on mugs to celebrate the 250th anniversary of Richard Trevithick's birth.

If you wish to order visit the website shop, order and pay.

https://www.straymutz.com/trevithick-society

Prices include delivery and VAT.

Some of the variant sizes and colours may be out of stock, but, if so, the system won't let you order them until they come back into stock.

Sheila Saunders

TAYLOR'S SHAFT, EAST POOL MINE c. 1930

The building in the picture on the left is the dry. Adjacent to the headframe with the long sloping roof is the crusher and in front of it is the hopper with its loading shutes clearly visible for loading trams. The track leading out to the public tramway is visible in the foreground. The pumping engine boilerhouse is seen through the struts of the headframe. In front of the stack is the capstan house with a horse in front of it. The capstan provided slow winding for use during shaft maintenance. The main building with the windows open is the compressor house and to the right of it is the electrical transformer house. Steam was used for pumping and winding but all other power requirements were provided by mains electricity. The small black shed with a long roof vent and the building on the extreme right are no longer extant.

K.J.T.R.

MEMBERS' BENEFITS

Trevithick Society members are entitled to free entry (on production of the membership card) to the following attractions:

- King Edward Mine
- Cornish Engines at Pool (East Pool Mine and Michell's Whim)
- Levant
- Geevor Museum
- Poldark – free entry to site and reduced fee for underground mine tour

Also:

- 10% off book purchases at Tormark.
- 10% off purchases at KEM shop.

BEAM ENGINES IN NORTH AMERICA XV: AMERICA'S FIRST BEAM ENGINES

The development of the beam engine in youthful North America understandably lagged its growth in Britain, but it also took a rather different path. In Britain, the dawn of the steam age can be traced to 1712 with the public launch of Thomas Newcomen's atmospheric pumping engine (having been tested earlier at Great Work in Cornwall) at a colliery near Dudley Castle in Staffordshire. Later, with the dramatic improvements to the Newcomen engine introduced by James Watt in 1776, in particular those that allowed the reciprocal action of the beam engine to be converted to rotary motion, the use of the beam engine spread to manufacturing and, in doing so, ushered in the Industrial Revolution. The most important improvements in this regard took place in 1782, with Watt's development of the double-acting engine (in which the piston pushed the beam as well as pulled), and 1784, with his invention of parallel motion (which enabled the piston to move vertically in the cylinder whilst being rigidly connected to the swinging beam).

In North America, on the other hand, the use of steam power for pumping and manufacturing was overshadowed by its role in navigation. Lacking deep mines and large cities, and blessed with an abundant supply of running water, the American colonies had little need for large pumping engines and their emerging manufacturing industries were adequately served by waterpower. As a result, only three beam engines are known to have been worked in America prior to 1800 (by which time hundreds were at work in Britain), and it was not until the 1850s that a beam engine as big and complex as the Cornish pumping engine gained any kind of foothold in the country.

This account attempts to summarize the early history of the beam engine in America, broadly between 1750 and 1820, and is drawn from too many sources to acknowledge in full. But two, in particular, contain a wealth of information: "Early Stationary Steam Engines in America – A Study in the Migration of a Technology" (1969) by Carroll W. Pursell, Jr., and "A History of Industrial Power in the United States 1780-1930, Volume 2: Steam Power" (1983) by Louis C. Hunter.

First Beam Engines in America

Despite the paucity of 18th century beam engines in America, their introduction to the continent occurred quite early, whilst America was still a British colony. The first beam engine erected on the continent left London on the American-built snow-brig Irene on June 6, 1753 in the custody of Josiah Hornblower, youngest son of the celebrated British engineer Joseph Hornblower who, at that time, was engaged in building Newcomen atmospheric engines in Cornwall. The order for the engine had come from the owner of the Schuyler Mine, a copper working in what is now North Arlington, New Jersey (just 8 miles east of New York City), which had been worked since 1715 by the influential Schuyler family in what was then the New Netherlands. The mine was worked profitably, producing around 100 tons of ore a year, until about 1747, when operations were suspended because the shaft could be sunk no further without a better means of pumping water. To resume profitable mining, Colonel John Schuyler, then the mine manager, placed an order for a Newcomen engine through his London agent in 1748 or 49 who, in turn, engaged Joseph Hornblower for its manufacture at a reported cost of £1000. Schuyler further requested that an experienced engineer should accompany the engine to America to oversee its assembly and operation, a role that Hornblower entrusted to his son Josiah. The engine parts arrived in New York on September 9, 1753, and reached the mine site about a week later. But with limited skilled labour to assist him, it took Hornblower a further 18 months to complete the construction of an engine

house and assemble the engine within it. So it was in March 1755 that the engine was finally set to work. No drawing of the engine, if one existed, survives. However, Henry Beighton's engraving of the 1714 Newcomen engine at Griff Colliery in Warwickshire published by Desagulier in 1744 (Fig. 1) was described in 1875 by U.S. Supreme Court Justice Joseph P. Bradley (husband of Josiah Hornblower's granddaughter) as showing "almost exactly the plans of the engine, engine house and fixtures, such as were put up by Mr. Hornblower in the Schuyler Mine." The engine is thought to have developed about 5 horsepower and, operating a 10-inch diameter pump, raised almost 200,000 gallons/day.

Rather than returning to England once the engine was set to work, Hornblower accepted the position of mine superintendent and was at hand to order a new cylinder (cast in two parts) from England in 1760 and repair the engine when it was damaged by fire in March 1762. During the previous year Hornblower had leased the property from Colonel Schuyler and, in partnership with John Stearndall, continued to work the mine until fire again damaged the engine in July 1768. With

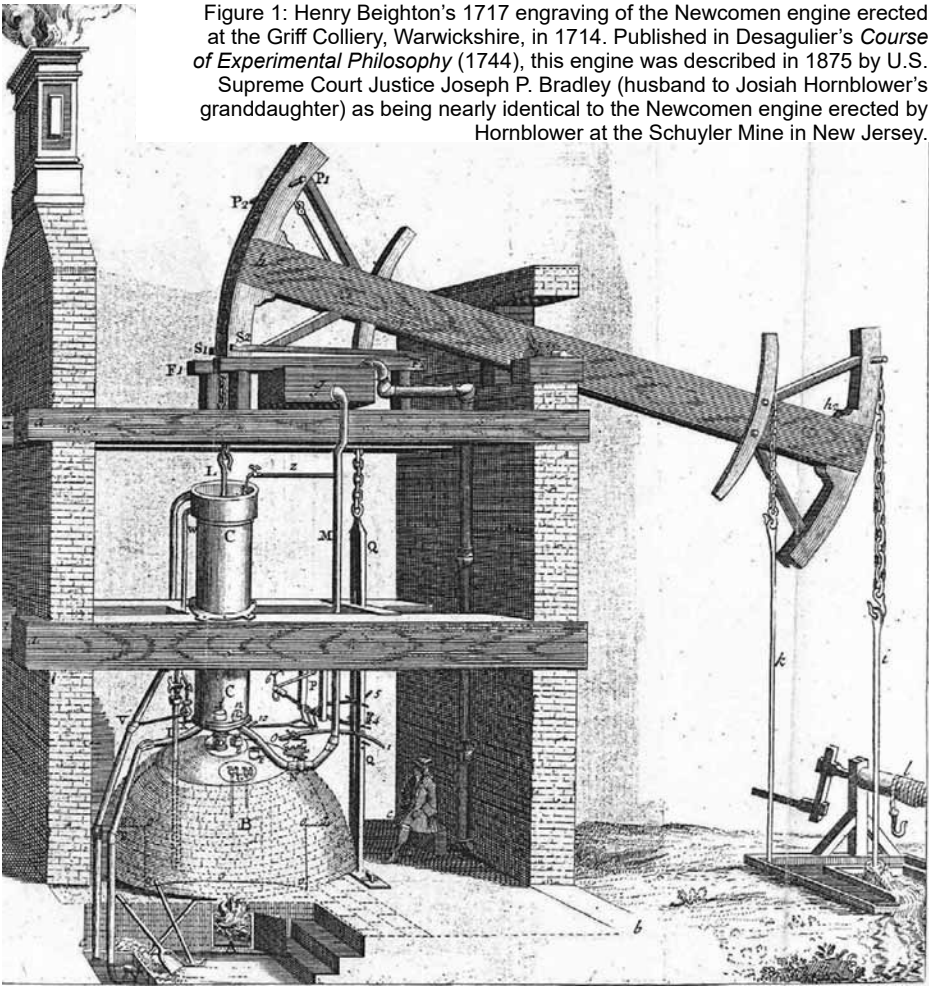


Figure 1: Henry Beighton's 1717 engraving of the Newcomen engine erected at the Griff Colliery, Warwickshire, in 1714. Published in Desagulier's *Course of Experimental Philosophy* (1744), this engine was described in 1875 by U.S. Supreme Court Justice Joseph P. Bradley (husband to Josiah Hornblower's granddaughter) as being nearly identical to the Newcomen engine erected by Hornblower at the Schuyler Mine in New Jersey.

the mine already in financial difficulty, all underground work ceased at this time, although Hornblower continued to extract copper from the mine waste.

A quarter of a century later, in 1793, Philip A. Schuyler, Jacob Mark and Nicholas Roosevelt formed the New Jersey Copper Mine Association to reopen the mine, and Hornblower was hired to rebuild the engine and supervise the erection of a stamping mill and foundry. The latter would later become Roosevelt's Soho Works, which played an important role in early American beam engine construction. Dissatisfied with the association's management, Hornblower retired in 1794 and the mine was finally abandoned early in the nineteenth century, at which time its depth is said to have been little more than 100 feet. Having stood idle for some time, the engine was broken up, although a casting believed to be the bottom half of the replacement cylinder survived. This was displayed at the Centennial Exhibition in Philadelphia in 1876, where its diameter was recorded as 34½ inches (ca. 6-foot stroke), and was presented to the Smithsonian Institution in Washington, DC, in 1889. The mine continued to be worked intermittently after Hornblower's death in 1809 and is recorded as being worked by a steam engine in 1833 and again in 1847, when it was said to be of 40 horsepower.

The second beam engine erected in North America was installed in 1774 by the Irish immigrant, Christopher Colles. Having unsuccessfully begun work on a small Newcomen-type steam engine for a Philadelphia distillery in 1773 (to pump water into cooling tanks around the distilling coils), Colles was commissioned to build a waterworks engine for New York City. The 18-inch cylinder of this second atmospheric engine (6-foot stroke) was cast in New York at the air furnace of Peter Curtenius and Richard Sharpe and, by March 1776, it was at work pumping an estimated 418,000 gallons/day into a reservoir from whence the water could be distributed to the city. The engine likely developed about 4-4½ horsepower. However, neither the engine nor the waterworks survived the British occupation of New York during the War of Independence, which began later that same year and ended in 1783.

In 1780, a third American atmospheric engine with a 30-inch cylinder was built by Joseph Brown of Providence (with the aid of skilled workers sent from New York by Peter Curtenius) to drain the mine in Cranston, Rhode Island, supplying iron ore for the Hope Furnace in nearby Scituate. With a 20-foot beam, this engine is thought to have developed about 8-9 horsepower and raised about 600,000 gallons/day. Hope Furnace had been established by Brown and his brothers in

Figure 2: Full-size replica of the Clermont built by the Staten Island Shipbuilding Company and launched on 10 July 1909 as part of the 1909 Hudson-Fulton Celebration in New York (Library of Congress; https://www.loc.gov/item/2016806494).

1765 and, in 1780, was being used to make cannons for the Revolutionary War. The furnace was sold to a cotton mill company in 1806, but the engine is recorded as still being at work two years later.

Dawn of America's Age of Steam

Despite the success of these early engines, steam power failed to gain a foothold in North America in the 18th century and it is generally held that the start of the Steam Age in the New World began with the launch of Robert Fulton's North River Steamboat (better known as the Clermont). This made its maiden round-trip voyage on the Hudson River (then known as the North River) from New York City to Albany (a distance of 150 miles) on August 17, 1807 (Fig. 2). Fulton was an American engineer who, for the previous 20 years, had worked in Britain and, later, France. Here, the success of his company in building a small steamboat and testing it on the River Seine drew the attention of former U.S. Minister to France, Robert Livingston, who encouraged Fulton to build a larger vessel for commercial service on the Hudson River, on which he had acquired an exclusive right to steam navigation. Built at the Charles Browne shipyard in New York City, this larger steamboat (originally 133-foot by 12-foot but increased to 149-foot by 18-foot after an 1808 rebuild and drawing just 2 feet of water) was powered by a 24-horsepower condensing "beam" engine designed by Fulton and manufactured in Birmingham, England, by Boulton and Watt in 1804. The engine's 24-inch cylinder (4-foot stroke) was mounted vertically with a gallows-frame guide for the piston rod, from the crosshead of which two connecting rods rocked a pair of inverted T-shaped lever beams (bell cranks) closely resembling balance bobs, being weighted at the far end (Fig. 3). The 15-foot by 4-foot paddlewheels were then turned by way of cranks linked by connecting rods to each kingpost and geared to a 10-foot flywheel. In later engines, the beams were done away with and the connecting rods attached to the crosshead were applied directly to the cranks of the paddle wheels. The inauguration of what would become a regular run between New York and Albany by this side-wheeler paddleboat (with auxiliary sails) marked the real birth of steam power in America and the start of a new era of steam navigation on America's rivers.

Following the launch of Fulton's Clermont, growth in the number of steam-powered ferries and riverboats was rapid. Fulton's Hudson Boat River Company launched two further paddle steamers in

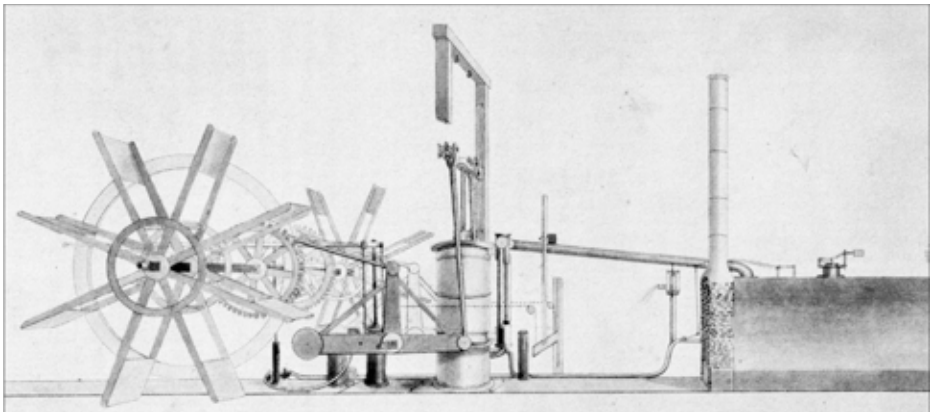


Figure 3: Steamboat engine of Robert Fulton (from Hunter, L.C., 1985, *A History of Industrial Power in the United States 1780-1930*, Volume 2: *Steam Power*, p. 23. Original with Library of Birmingham: Boulton and Watt Collection).

1808 (the Raritan and Car of Neptune) and, within a decade, the number of steamboats on America's rivers had grown to more than fifty. Many of these vessels were powered by horizontal engines or vertical engines lacking a beam, but for side-wheel paddle steamers, the "walking" beam engine became the dominant means of propulsion (see Newsletters 176 and 179) and, by the end of the 19th century, their tally numbered in the thousands.

Ironically, Fulton was not the first American to pioneer steamboat transportation. The American engineer and inventor, Colonel John Stevens, for example, had successfully crossed the Hudson River in the small screw-driven, high-pressure steamboat Little Juliana three years earlier, in May 1804. But the honour of being first goes to Connecticut native, John Fitch. After successfully testing a 45-foot vessel (12-foot beam) on the Delaware River in August 1787 propelled by 12 rowing oars set in motion by a 12-inch, double-acting horizontal engine (3-foot stroke), Fitch launched a 60-foot boat (8-foot beam) in June 1790 that carried 30 passengers on round-trip voyages between Philadelphia and Burlington, New Jersey, throughout the summer. Rather than oars, the vessel was propelled by several "walking" paddles mounted at the stern that are shown in a sketch published in 1857 as being driven by a Watt-type beam engine (Fig. 4), the 18-inch cylinder of which was cast at Warwick Furnace, New Jersey. Despite being granted a patent in 1791, however, Fitch was unable to make steam navigation financially viable, in part because Fitch had little or no experience of steam engineering and lacked the necessary industrial infrastructure. As a result steam power as a prime driver failed to take off in America until well after his death in 1798.

Nor was Fulton the first American to take advantage of Watt's improvements in beam engine performance. In fact,

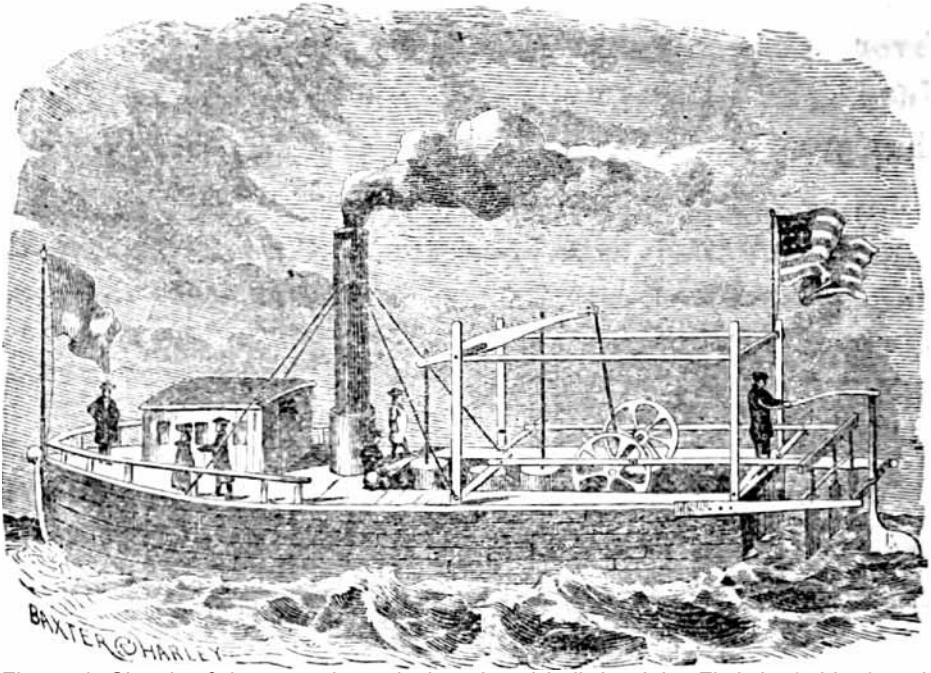


Figure 4: Sketch of the steamboat designed and built by John Fitch in 1788-79 and successfully tested on the Delaware River in June 1790 (from Westcott, T., 1857, *The Life of John Fitch*, p. 284).

by the turn of the 19th century, several American-born and emigrant engineers were developing expertise in beam engine technology in New York, Philadelphia and, later, Pittsburgh. As early as 1794, for example, the New York inventor and engineer, Nicholas Roosevelt, a distant cousin of both presidents of the same name, had developed an interest in steam engines and, with Joseph Hornblower's help, had established a foundry, smelter and machine shop for their manufacture. Named the Soho Works after Boulton and Watt's establishment in England, this stood across the Hudson in what is now Belleville, New Jersey. Having unsuccessfully pioneered the steamboat Polacca (20-inch cylinder, 2-foot stroke) in partnership with Robert Livingston in 1798, Roosevelt's Soho Works (now employing James Smallman, previously an engineer with Boulton and Watt) undertook in 1799 what was then by far the most ambitious project in steam engineering ever attempted in America. This was to build two large, Watt-type rotative beam pumping engines for Philadelphia's Centre Square Waterworks, each engine being capable of

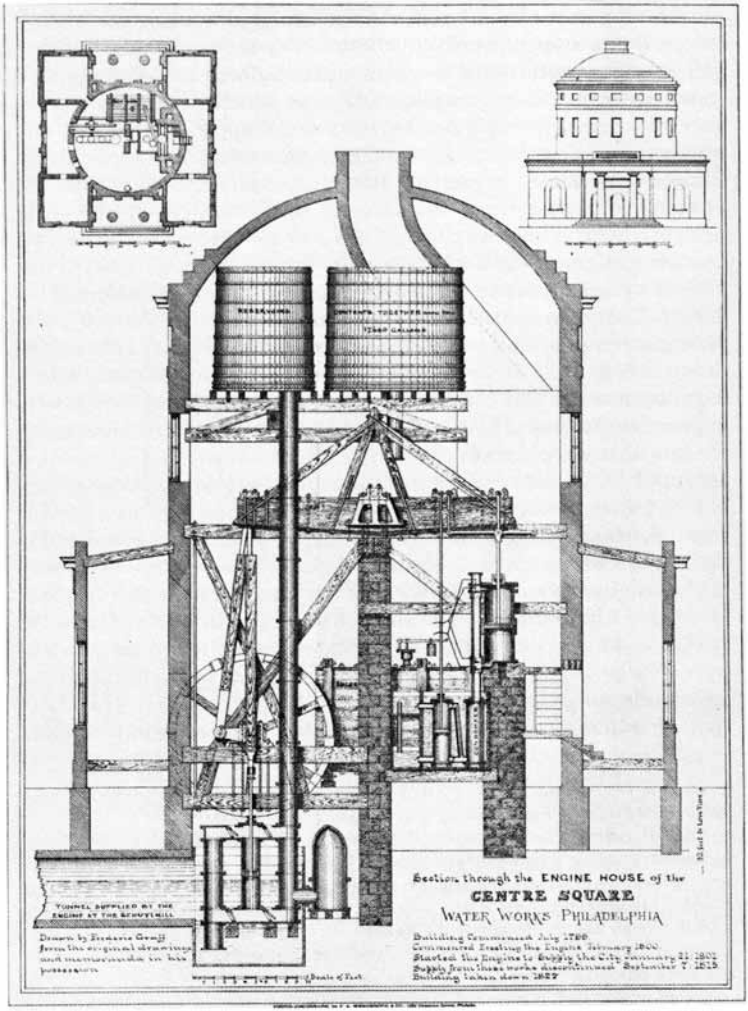


Figure 5: Nicholas Roosevelt's 32-inch rotative pumping engine installed at the Centre Square Waterworks in Philadelphia in 1800 (from Louis C. Hunter, 1985, *A History of Industrial Power in the United States 1780-1930*, vol. 2, p. 52, after original in Journal of the Franklin Institute vol. 102, 1876).

raising daily 3 million gallons of water to a height of 50 feet. Designed by the British-American architect and engineer, Henry Latrobe, the plan to supply the city with water called for a 40-inch engine (6-foot stroke) to pump water from Philadelphia's Schuylkill River through a kilometre-long tunnel to the town centre. Here, a 32-inch engine (6-foot stroke) would lift the water to a reservoir set in the dome of the Greek revival waterworks (Fig. 5), from whence it could be distributed to the city. Both engines had wooden beams and wooden flywheel arms and shafts (the Centre Square engine received a new beam and its original 16-foot flywheel was replaced by one of 20-foot diameter in 1807) and drove, respectively, 17½-inch and 18-inch double-acting pumps (6-foot stroke) at 12 strokes/minute. The larger engine, the cylinder of which was cast in two parts united by copper, additionally drove a rolling and slitting mill during the day at up to 20 strokes/minute. After some difficulty, the two engines were put to work in December 1800 and January 1801, respectively, and in a subsequent 24-hour test, the larger engine raised almost 1.5 million gallons to a height of 39 feet at 16 strokes/minute whilst the smaller one raised almost 1 million gallons/day to a height of 51 feet.

Just two years later, another pair of early Boulton and Watt-type engines (with sun-and-planet gearing) were erected in New York City to run the Manhattan Company's new waterworks, plans for which were under consideration soon after the British evacuation of the island in 1783 (the occupation having halted the earlier project of Christopher Colles). One of the two 18-horsepower engines (an imported engine built by Boulton and Watt) was erected by Robert McQueen in 1802, whilst the other (built by McQueen in New York) was erected in 1803. Together they raised over 690,000 gallons of water/day to a height of over 50 feet and are thought to have remained in

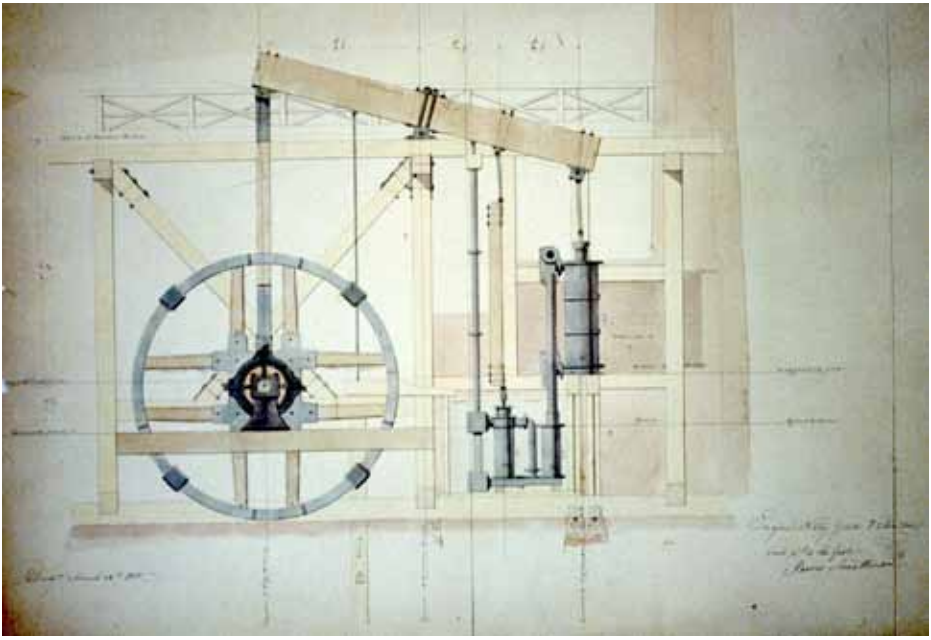


Figure 6: Smallman-Latrobe 21-inch rotative engine (4-foot stoke) of early Watt design built for the Navy Yard in Washington, DC, in 1810. Cams on crankshaft where to operate a forge hammer (U.S. Library of Congress, www.loc.gov/item/2001697345).

Figure 7: Fairmount Waterworks, Philadelphia, viewed across the Schuylkill River with 1815 engine house to far right (photo by Jack Boucher, 1984: U.S. Library of Congress, www.loc.gov/pictures/item/pa0837.color.314409c).

service until the system was replaced by an aqueduct in 1842.

These four engines were principal among those listed by Henry Latrobe in a May 1803 report to the American Philosophical Society made in response to an enquiry from the Society of Rotterdam as to "whether any, and what improvements have been made in the construction of Steam-Engines in America?" To these he added a small engine, erected as an experiment by Oliver Evans and used to grind plaster of Paris at his works in Philadelphia (see above), and two further engines, one on Rhinelander's Dock in New York belonging to Roosevelt and employed to saw timber, and one in Boston employed in some manufacture. However, no further information has come to light on the Boston engine and its existence is questionable.

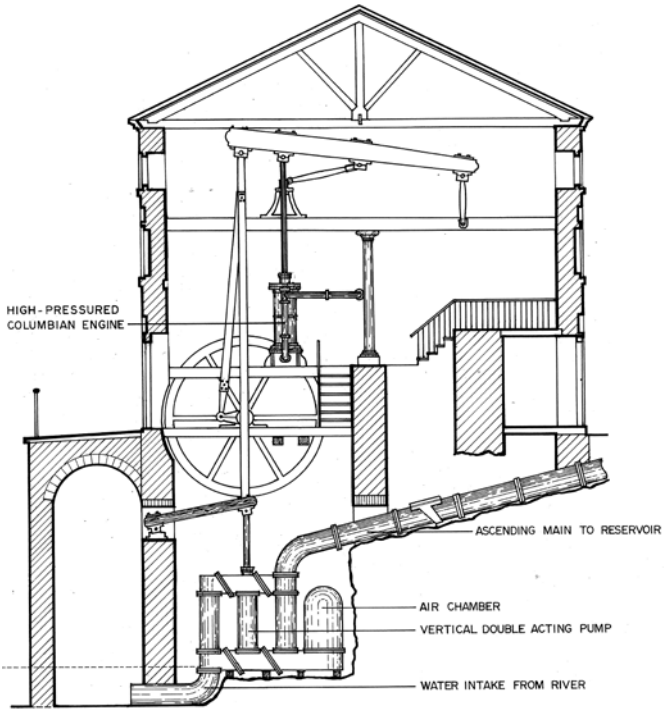
Growth of Steam Power in America

This tally of just seven (and likely six) beam engines in 1803 is in sharp contrast to the widespread and rapidly growing numbers of such engines at this time in Britain and Europe. And whilst the decade following Latrobe's report saw rapid growth in the use of steam power in navigation, the application of American-built beam engines to pumping and manufacturing was slow to develop. Former Soho Works mechanic, James Smallman, who had supervised the erection and early operation of Latrobe's waterworks, went on to make several engines in Philadelphia, including one for a copper mine in Pottsgrove, Pennsylvania. But none were particularly successful until 1810, when Latrobe had him build a 21-inch rotative engine (4-foot stoke; 14-foot flywheel) for the Navy Yard in Washington, DC (Fig. 6). Here, despite being of somewhat old-fashioned Watt design (with sun-and-planet gearing and no parallel motion), it successfully drove a forge hammer, scrap-metal stamper, grindstones, two pairs of bellows and a sawmill until 1830. Smallman had been building engines in Philadelphia since 1804 and, by this time, was in competition with Daniel Large, who had emigrated to America in about 1807 and, by 1808, had installed a more contemporary 10-horsepower, low-pressure engine for grinding paint at the city's white lead works of Samuel Wetherill & Sons. Latrobe had also sent his son Henry to New Orleans

in late 1810 to secure a franchise for a steam-powered waterworks pumping station, which he successfully accomplished the following year. But both Latrobes died of fever before it was completed and the system, which never proved satisfactory, did not begin working until 1823.

In Philadelphia, neither of Roosevelt's waterworks engines had performed particularly well and, in 1815, both were replaced by more powerful beam engines erected side-by-side at a new waterworks built some 2 kilometres away on the east bank of the Schuylkill River at Fairmount (Fig. 7). One of the two engines at the new Fairmount Waterworks (the South Engine) was a 44-inch Boulton and Watt-type engine (6-foot stroke) built nearby in Philadephia and at Weymouth Furnace, New Jersey, by Samuel Richards (Fig. 8 - see front cover). It was described at the time as being one of the best ever constructed in the United States, with a cast iron beam in two leaves and a 20-inch double-acting pump. The other (the North Engine) was a 20-inch non-condensing, high-pressure engine (5-foot stroke) of a type known as "Columbian" pioneered and built by the gifted American engineer, Oliver Evans, at the Mars Works, an engineering facility he had established in Philadelphia in 1807. This enabled the two types of engine then in competition in America – Watt's low-pressure engine and Evans' high-pressure engine (in this case 2.5 psi above atmosphere versus 120-150 psi) to be weighed against each other, a comparison that revealed the marked superiority of the Evans' engine, which at less than half the price, raised twice as much water in the same time for the same fuel cost.

Figure 9: Cutaway view of the Evans' high-pressure "Columbian" engine (North Engine) at the Fairmount Waterworks in Philadelphia (U.S. Library of Congress, www.loc.gov/pictures/item/pa0837.sheet.00007a/resource).



Evans' high-pressure Columbian engine was a grasshopper design in which one end of the beam was attached to a vertical, rocking support anchored at the base that accommodated the curvilinear movement of the beam end, whilst the pump rod, the connecting rod to the ca. 12-foot diameter flywheel and, a short distance indoors of these, the piston rod, were all attached to the other end (Fig. 9). Smaller versions of the engine had been successfully used in milling since 1802, the first, which was used to grind plaster of paris at Evans' works in Philadelphia, having a 6-inch cylinder and 18-inch stroke (Fig. 10). By 1814, twenty eight such

engines had been installed in sawmills, rolling mills, flour mills and textile mills from New Orleans to Connecticut, and in 1816, Evans spoke of 50 of his engines being in use, including one supplied that year to America's first steam paper mill in Pittsburgh. Evans died in New York in April 1819. In Philadelphia, the use of both engines was discontinued in 1822 and, after remaining on-site for a decade, they were sold off and removed in 1832.

With the rapid expansion of America into the Ohio and Mississippi valleys following the War of 1812, steam engine manufacture moved west of the Appalachian Mountains, initially to Pittsburgh and later to Louisville, Kentucky, and Cincinnati, Ohio. The first engine assembled in Pittsburgh was a 34-inch low-pressure steeple (crosshead) engine produced by Nicholas Roosevelt for the 138-foot steamboat New Orleans, the launch of which would bring Roosevelt national recognition. Most of the engine, however, was made in New York and transported overland because Pittsburgh lacked the necessary facilities. Built in partnership with Fulton and Livingston, the epic 1811-12 voyage of this side-wheel paddle steamer down the Ohio and Mississippi rivers to New Orleans (which coincided with the Great Comet of 1811 and was made all the more perilous by the first of three catastrophic earthquakes on the Mississippi River at New Madrid, Missouri, on December 16, 1811) ushered in the era of commercial steamboat navigation in the mid-western and western United States. In 1812, Oliver Evans established the Pittsburgh Steam Engine Company with his son George, and in 1813, Latrobe joined Fulton in Pittsburgh, although he succeeded in building only a single engine for a woollen mill in Ohio. Others in Pittsburgh included Thomas Copeland, who received orders for a 24-inch engine and two 20-inch engines in 1814, and James Arthurs, who began building Boulton and Watt-type engines in 1815. In 1819, Mark Stackhouse, a former employee of the Pittsburgh Steam Engine Company, set up the Columbia Steam

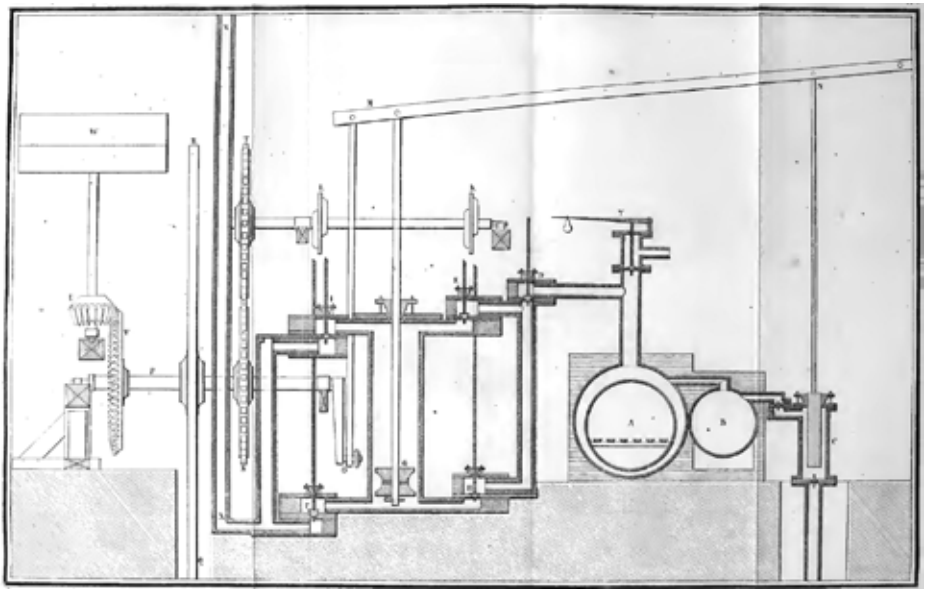


Figure 10: Evan's original high-pressure Columbian engine used for grinding plaster of Paris (from Evans, O., 1805, The Abortion of the Young Steam Engineer's Guide, Philadephia, Plate I).

Engine Company. This would become one of the largest Pittsburgh foundries and, by 1826, was producing seven engines per year, all of over 60 horsepower.

Engine building in Louisville began with the purchase of an existing foundry by the Scottish millwright, David Prentice, in 1816. Prentice, who had previously run a foundry near Philadelphia known as the Eagle Works, was joined in Louisville by Thomas Bakewell and, by 1819, their firm had produced 8 steamboat engines and 3 stationary engines in a single year. The partnership ended in 1821, when Bakewell moved to Cincinnati, but the growth of Louisville engine building continued apace and by 1838 the city had seen 246 engines produced by ten separate firms. Of these engines, 181 were for mills.

The growth of engine building in Cincinnati began a few years later, but was equally rapid and by 1826 steam engines were being produced at five foundries. This growth would continue as the population of the American Midwest and South expanded, and manufacturing, mining and an increasing demand for waterworks and riverboats spread, first into the Ohio and Mississippi river basins, and later into the cities, mines and waterways of the American West.

Damian Nance

PUBLICATIONS

Our Autumn 2020 book on the Redruth & Chasewater Railway is now out of print. Sales, particularly in the local area, have been very strong. There are no plans currently to reprint, while we seek to assess the level of unfulfilled demand.

Published at the end of May was John Hurr's volume of history and reminiscence, *Mount Wellington: A Forgotten Cornish Mine, 1969-1981*. John was involved with the mine throughout its short life on the engineering side and his book documents the huge efforts and struggles to bring Mount Wellington into production. Overshadowed by neighbouring Wheal Jane, in its lifetime and since closure, the story of Wellington is an important, and hitherto untold, part of the brief 1970s Cornish Mining boom. The book is a large format paperback of 170 pages and sells for £15. It is illustrated with John's own photographs. ISBN 978-1-8384245-0-3.

The 2021 Journal is also complete and will be issued to members with the autumn mailing.

Graham Thorne

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The Trevithick Society, a registered charity, is a recognised body of the study of industrial archaeology in Cornwall. Membership is open to all who are interested in the region's great industrial past, whether or not they live in Cornwall. The Society takes its name from one of Britain's foremost inventors and pioneers of the Industrial Revolution, Richard Trevithick, a Cornishman whose name is inseparable from the development of steam power. This newsletter is published quarterly and, together with the annual journal, is distributed free to members. Letters and contributions are always welcome and should be sent direct to the editor.

The views expressed in this newsletter are those of the authors and not necessarily those of the Trevithick Society.

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