nationalgrid

A history of the gas industry in Great Yarmouth

Preface
This booklet has been written to commemorate the connection between Great Yarmouth and its gas industry which is demonstrated by it's surviving listed gasholder. It coincides with the refurbishment of the gasholder frame on Admiralty Road, one of the last surviving gasholders in the country. The booklet provides a brief description of the development of the gas industry in the town, with a more detailed description of the former gasworks.

Great Yarmouth, like many British holiday resorts, would have been quick to adopt gas lighting to keep up with contemporary fashions and attract tourists who would be used to gas lighting in the big towns and cities. Gas first arrived in Great Yarmouth in 1824, twelve years after the world's first gas company, the Gas Light and Coke Company (GLCC) was established in London, quite early for a provincial town. This original gasworks was designed by George Holsworthy Palmer, a colourful and innovative character, who had worked for the GLCC and been involved in the design of many early gasworks, with varying degrees of success. There was also a private gasworks built to light Grout's silk mill in the north of the town. Across the River Yare, the population of Gorleston and Southtown had to wait until 1854 for their own gasworks and the benefits of gas lighting. Great Yarmouth was also the home of the chemical works constructed by the British Gas Light Company whose gasworks was in Norwich.

The gasworks faced increased demands and, by the 1860s, an entirely new gasworks had been built on an adjacent site, moving eastwards from the River Yare. This new gasworks had been designed by the consulting engineer, Robert Paulson Spice, who was a keen traveller and travel writer. The gasworks was built in an unusually decorative gothic style which he favoured, which was reflected in the surviving gasholder.

In 1949, the Great Yarmouth Gas Company became part of the Eastern Gas Board (EGB). It covered a predominantly rural area, supplied by small independent gas undertakings. It was a major challenge for the EGB to reorganise the manufacture and distribution of gas, concentrating production at fewer larger gasworks across the region, so an extensive regional gas network was required. A gradual change to the use of oil and refinery by-products occurred with new gas reforming plants built by the major regional gasworks. Great Yarmouth was eventually connected to the gas supply from Norwich and the gasworks closed. Britain's first natural gas supply came ashore as liquefied natural gas at Canvey Island, just to the south of the EGB region, the North Thames Gas Board area. This gas was distributed via the national methane pipeline, which distributed the gas to eight of the Area Gas Boards, including the EGB at Hitchin. With the discovery of a plentiful supply of natural gas in the North Sea, a decision was made to convert to natural gas. The most significant terminal at Bacton in Norfolk, required extensive new gas transmission pipelines to be built across East Anglia, forming the National Transmission System for Gas.

From 1967, the country gradually converted to the use of natural gas. The manufacture of gas ceased, but the sites were retained for gas storage, until this was provided by line pack storage in the high pressure gas pipelines. It is hoped that this booklet will bring to life some of the notable events connected with the gas industry in Great Yarmouth over the past 200 years.

The heritage of the gas industry in the United Kingdom is maintained through the three preserved gasworks sites at Fakenham (England), Biggar (Scotland) and Carrickfergus (Northern Ireland), the National Gas Museum in Leicester and the National Gas Archive in Warrington (England). There is a web page on the Historic England website which provides a series of reports on the history of the gas industry and description of the technologies used and known locations of former gasworks in England. They are all excellent resources for learning more about the long and interesting history of what has for a long time been a major UK industry and employer.

Acknowledgements
The author wishes to thank National Grid Property which has supported the preparation and production of this booklet. The author also expresses his thanks to the National Grid Gas Archive, fellow members of the Institution of Gas Engineers and Managers History Panel for their support in the production of this booklet.

About the author
Russell Thomas has a keen interest in the gas industry. He has been working on former gasworks sites since 1997, a subject he has grown to find fascinating. Russell works as a Technical Director for the International Engineering Consultancy, WSP, advising on former industrial sites, with a special focus on former gasworks. He also manages research projects on behalf of clients and is a visiting lecturer at the University of Manchester and a visiting professor at the University of Strathclyde, both universities where he has been involved in research studying the legacy of Britain's industrial past. Russell is a member of the Institution of Gas Engineers and Managers and the Chair of their History Panel.

Front cover:
The Grade II Listed Gasholder at Great Yarmouth.
Source: Jam Butty Photography and Video and IPB Communications.

Back cover insert:
A hyperlapse image of the gasholder site at night.
Source: Geoffrey Frost.

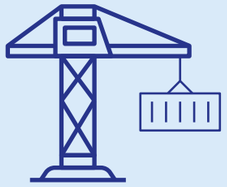
Contents

Establishment of the gas industry 4
A gasworks for Great Yarmouth 8
The formation of the Great Yarmouth Gas and Coke Company 12
Robert Paulson Spice and the building of the new Great Yarmouth Gasworks 15
A lasting legacy 18
Engineering misadventures 20
The Hermit of Westminster 21
The loss of a unique individual 22
A gasworks across the Yare 23
The gasworks at Grout's Silk Mill 26
The surviving gasholder 27
Samuel Cutler and Sons 30
The threat of municipalisation and electricity 31
The 1901 and 1910 gasworks extensions 33
The tar works and the by-products of gas manufacture 34
The remodelling of the Great Yarmouth Gasworks and a centenary of gas 36
The impact of the two world wars 40
The First World War 40
The Second World War 41
Nationalisation and the move away from coal under the Eastern Gas Board 42
The transition to a natural gas future 46
Today 49
A sense of community 49
An energy transition and a changing landscape 50
Suggested further reading 50
A brief description of the gas manufacturing process 52

Facts about gas in Great Yarmouth

Great Yarmouth's **first gasworks** was built in 1824, designed by the engineer George Holsworthy Palmer.

On 3 December 1866, a **terrible storm** hit Great Yarmouth, causing many ships to sink and a great loss of life, it also very badly damaged a new gasholder at the gasworks.

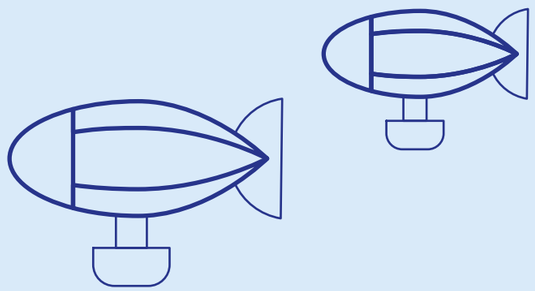


The second gasworks had no direct access to the river frontage to import coal. Instead, **two hydraulically powered cranes** were used to unload specially designed skips of coal from colliers on the fish wharf.

From 1894 the gas company faced competition from the Great Yarmouth Corporation electricity department who had built a power station in the town. The towns **gas lamps were then gradually replaced by electric lights**.

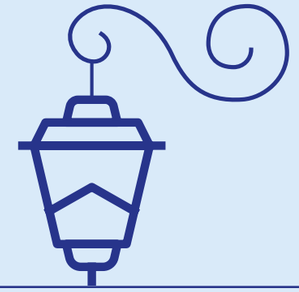
1915

The Gorleston Gasworks was the first to have suffered aerial bombardment from **Zeppelin airship raids** in 1915.



There were **two other gasworks in Great Yarmouth,** a public gasworks across the River Yare which supplied Gorleston and Southtown, and a private gasworks which supplied Grout's silk factory in the north of the town.

The **unusual gothic design** of the gasholder was a trademark of Robert Paulson Spice. It was a later addition to the gasworks, added in 1884, but had to be re-built a year later.



Second gasworks

In the 1860s, a new gasworks was required in Great Yarmouth. It was designed by the Norwich born **Robert Paulson Spice,** he was self-taught and built the first gasworks which survive in Fakenham today.

During both world wars, women undertook some of the most **arduous jobs** on a gasworks.

World War Two

During World War Two, **Great Yarmouth was attacked several times.** With the Gorleston Gasworks severely damaged, gas was supplied from Great Yarmouth via a temporary gas main built under the River Yare.

Establishment of the gas industry

The ability to flick a switch to turn on a light is taken for granted today, however, up until the start of the 19th century, the choices for lighting were limited. The best options available at the time were candles and oil lamps, but many could only afford rushlights. Candles and oil lamps burnt with a smoky flame, but only gave off a dim light. These were the same options for street lighting and did little to make the streets safer at night.

The new factories of the industrial revolution were dark and risky places to work. The original South Mill building of the silk factory built in Great Yarmouth by George and Joseph Grout burnt down in May 1832. Such fires were frequent and often caused by accidentally knocking over an oil lamp.

The home, if you were lucky enough to afford lighting, was at best dimly lit with rushlights, candles or oil lamps. People were still living at the whim of daylight hours. This started to change with the invention of gas lighting, at least for the wealthy.

The story of gas lighting starts with the Scottish engineer William Murdoch (1754-1839) who, aged 23, travelled to find work with Boulton and Watt, an engineering firm formed by Matthew Boulton and James Watt, which constructed the most efficient steam engines available at the time. Steam engines were important in powering machinery and pumping water out of deep mines.

William Murdoch like many before him had experimented with distilling coal to produce gas. As a child, he was reputed to have used a kettle to distil coal in a cave near his home at Bello Mill, near Lugar in Ayrshire. He was the son of a millwright who tenanted a farm and water mill on the Bosworth family estate. Trained by his father as a millwright, William inherited his father's engineering talents. He was known to entertain the locals by riding around on a wooden horse (a forerunner to a bicycle) which he had built with his father.

Homes were at best dimly lit with rushlights, candles or oil lamps.

Murdoch was first employed as a mechanic by Boulton and Watt, having walked from his home in Ayrshire to its works in Smethwick. Boulton who interviewed him was taken by the oval wooden hat he had turned on a lathe of his design and offered him a job. His endeavours impressed them so much that, in 1778, he was sent to Cornwall and given the task of constructing steam engines for the Cornish mine captains. They were the most important but also the most difficult customers, but Murdoch was a match for them and even married one of the mine captains' daughters, Anne Paynter.

In 1792, whilst he was based in Redruth, he built an experimental plant to manufacture gas from coal. It used a cylindrical iron pot as a retort to make the gas. Murdoch piped the gas 70 feet (21 metres) into his house and office where he used it to light both, as depicted in Figure 1. It was not his only notable invention whilst in Redruth; in 1784, Murdoch also built the first working model of a steam carriage in Britain.

Murdoch experimented with the gas making process, trying different coals and different burners for gas lights, but his attempts to develop gas lighting stalled for a few years. In 1795 and 1796, he visited the Neath Abbey Iron Works in Wales, where he again experimented with gas lighting, reputedly lighting the counting house of the works.

In 1797, Murdoch advised James Watt Jr (James Watt's oldest son) to apply for a patent for the gas lighting apparatus he had developed but the patent was declined. He was recalled to the factory in Smethwick in 1798. Murdoch continued to experiment with gas lighting; he had an iron retort vessel cast, which he used to test different coals. The gas from the retort was used to light all the principal workshops.

Murdoch had continued his interest in gas lighting with little support from his employers until 1801, when Gregory Watt (James Watt's youngest son) visited Paris and discovered the rival work on gas lighting being undertaken by the Frenchman Philippe Lebon.

With renewed interest, he installed two gas lights as part of a wider lighting of the works with oil lamps to celebrate the Peace of Amiens in 1802. Murdoch was given the financial backing and technical assistance he required to advance the manufacture of gas. Murdoch was assisted by some of the finest engineers in the country, such as John Southern, the Creighton brothers and Samuel Clegg. These engineers provided vital input into the gas making process including the design of the gasholder.

Figure 1.
A diorama of William Murdoch demonstrating gas lighting at his home in Redruth, Cornwall.
Source: National Gas Archive.

Samuel Clegg (Figure 2) was the son of a wealthy businessman, Wheatley Clegg. He benefited from an education from the eminent scientist and mathematician Dr John Dalton at Manchester's New College between the years 1794 and 1797.

Clegg did not settle in his initial role working in the counting house of his uncle's (Ashworth Clegg) business at Rushworth. Reluctantly Samuel Clegg was allowed to follow his interests in mechanical engineering.

Clegg was apprenticed to Boulton and Watt's in 1798, working on steam engines. Completing his apprenticeship in 1798, Clegg worked with William Murdoch on the development of gas lighting from 1802. Whilst Murdoch continued his extensive experimentation with gas lighting, Clegg wanted to start installing gas lighting plants. He could see a bright future for gas lighting and left the company in 1805, establishing himself as a rival gas engineer based in Manchester.

Another key figure in the development of gas lighting was George Lee of neighbouring Salford. He was a keen technology enthusiast and customer of Boulton and Watt. He was an owner of Philip's and Lee Salford Twist Mill. He persuaded Boulton and Watt to allow William Murdoch to design a plant to light his home, adjacent to the mill, which was installed in 1804. The success of this gas plant led to Lee persuading Boulton and Watt to provide gas as a commercial proposition. The first order for a commercial gas plant was raised for the Salford Twist Mill, located on Chapel Street in Salford. This was no small task as the mill, at the time, was one of the biggest factories in the country.

Whilst Murdoch was trying to resolve the challenges of this complex project, Samuel Clegg had been approached by Henry Lodge to light his house and the much smaller Willow Mill in Sowerby Bridge, near Halifax, Yorkshire.

Clegg beat Murdoch to install the first commercial gas plant by a few weeks and such rivalry continued for the next ten years.

By the end of 1807, the Salford Twist Mill installation was complete with its own gas plant and fitted out with a network of pipes utilising two types of gas light fittings. This included 271 Argand and 633 Cockspurs light fittings, using 1,250ft^3 of gas an hour (35m^3 per hour). It was designed to provide lighting for the mill for 2 hours daily, but sometimes for longer, replacing oil lamps or candles which were more expensive and the cause of many factory fires.

Not only was the gas lighting of the Salford Twist Mill a significant development in the lighting of buildings but the 300ft (91m) of Chapel Street between George Lee's house and the mill was also lit by gas, becoming one of the first examples of gas street lighting in the world.

Figure 2
Samuel Clegg, regarded as the world's first gas engineer. Source: The Mechanics' Magazine, 1835.

The industry was still in its infancy and the gas produced could have a certain stink associated with the sulphurous compounds present within the gas. These could produce sulphur dioxide when burnt and even Murdoch admitted that it was rather smelly. It would be the work of Samuel Clegg and the Manchester based chemist Dr William Henry that would demonstrate how lime could be used to purify gas and apply it commercially to manufactured gas.

The gas plants designed by Murdoch and Clegg were built to provide gas lighting to factories and mills, improving working conditions and extending working hours during the dark winter months.

Murdoch principally lit the larger factories of Boulton and Watt's steam engine clients. Clegg went on to light a wider range of establishments as well as factories. These included Thornton's Drawing Academy in Manchester, the first gas lit school; Stonyhurst College near Preston, where he worked on a system to remove sulphur from gas with lime; Ackermann's printers (who published the first book on gas in 1816); and the Royal Mint. The latter project has significance as George Holsworthy Palmer supported Clegg on this project and, along with others from the Royal Mint, was involved in Great Yarmouth's first gasworks.

With the increased competition from Clegg and other engineers, the gas lighting market became less attractive to Boulton and Watt and their last gas plant was installed in 1816.

Murdoch did vital work in creating the gas industry. He was awarded the Rumford Gold Medal in 1808 by the Royal Society for his work and recognised as the inventor of the gas making process. He was to spend his entire working life with Boulton and Watt. A notable engineer and inventor, Murdoch chose to avoid the limelight.

Murdoch and his rivals had focussed on building plant to provide gas to a single factory or institution. Meanwhile, it was the German impresario Friedrich Winzer (Figure 3) who provided the wider vision of a public gas network providing a supply to streetlights, public buildings and private properties.

Winzer came to Britain in 1803, with the aim of establishing a gas company, anglicising his name to Frederick Winsor. Based in London, it was a long journey for Winsor as he lectured, wrote pamphlets, sought royal favour and wealthy backers. He rented houses in Pall Mall in London and displayed two large gas lamps to celebrate the King's birthday on Thursday the 4 June 1807. He lit both sides of Pall Mall with gas in 1808, which continued intermittently until 1810. Winsor eventually achieved his aim, helping to establish the Gas Light and Coke Company, when it received its Royal Charter in 1812. The gas industry became the first public energy utility, with the first gasworks providing a public supply in London in 1813. Over the next 50 years, the gas industry would expand across the British Isles and abroad.

Figure 3.
Portrait of Frederick Winzer.
Source: National Gas Museum.

A gasworks for Great Yarmouth

The gasworks in Great Yarmouth was constructed in 1824 and the streets first lit with gas on the 6 December that year. This was relatively early for a small town like Great Yarmouth, especially as the first railway station in Great Yarmouth (Yarmouth Vauxhall) did not open until June 1842.

But as a long-standing holiday destination, a gas lit promenade and main thoroughfares were a way of promoting the town to would be visitors. This is evidently something the town was very proud of, and it was described in such a way by J.H. Druery in his Historical and Topographical Notices of Great Yarmouth (London: Nichols, 1826).

"The town is very brilliantly lighted with coal gas, for which the spacious and level streets, at all times clean and dry, are well adapted. Perhaps there is scarcely a town in England that appears to greater advantage with these lights: the quays, when illuminated, are particularly splendid and it is very general in the shops."

Such a description suggests that Great Yarmouth was quite ahead of most provincial towns. Unlike Norwich, which had adopted gas made from oil through its connections with Taylor and Martineau, proponents of this technology, Great Yarmouth adopted gas made from coal. Norwich followed suit a few years later and both gasworks were supplied with coal brought up the River Yare.

A good description of Great Yarmouth's original gasworks was recorded in "A Guide to Yarmouth" which was printed and published by F Skill in 1835, but it repeats a similar description from Druery in 1826 (J H Druery, Historical and Topographical Notices of Great Yarmouth, London: Nichols, 1826, p. 88.). The published descriptions of works suggest the gasworks was located in the South Denes area of Great Yarmouth. The description of the gasworks reads,

"The gasworks was erected by Mr G.H. Plamer of London, upon the South Denes, near the water's edge. The buildings occupy a square piece of ground, surrounded by a brick wall; the front entrance is between two handsome lodges, one of which is the residence of a superintendent, and the other is used as an office. In the centre of the yard, a neat building, in separate division, contains the retort house, the condensing and purifying houses, the lime shed, the tar receiver, and a capacious storehouse for coals. There are two circular gasometers, each of 10,000ft^3 (283m^3) capacity, working in cast iron tanks, which are suspended upon columns by three chains having their counterbalance in the centre. In a separate apartment is the gas meter, which measures the whole of the gas, as it comes from the purifiers previously to it entering the gasometer; and there is also a machine for regulating the density of the gas supplied to the town, by which means it is kept in the mains at a uniform pressure. There are about 150 street lamps, and the gas contractors are required to furnish them with light during eight months in the year, except three nights immediately before and three nights directly after full moon, until three o'clock in the morning, during the months of April and September; and an hour later, on the mornings of October, November, December, January, February, and March. The contract for lighting is now vested in a company of persons in London (Mr Palmer, who was the original contractor, having disposed of his interest in the concern) and their affairs are managed by five directors, who also reside in the metropolis. The whole length of cast iron mains pipes deposited in the town is about five miles: the street lamps were lighted, for the first time, on 6 December 1824."

The original gasworks as described was located on a different site to the later gasworks where the gasholder stands today (see the plan of the gasworks). The original gasworks was located adjacent to the River Yare on land to the west of South Gates Road and the current site.

The only published map from around this date, the Bryant map (held by the Norfolk Records Office), was produced by Adam Bryant in 1826 and shows a gasworks to be in the North Denes area of Great Yarmouth. There is, however, no other description of the gasworks being built in this part of Great Yarmouth at this date so it would appear to be a cartographic error.

The engineer for the gasworks was certainly an interesting character. George Holsworthy Palmer had been born in Rotherhithe, London in 1792. He was the son of a shipwright and had followed his father into the profession. By 1814, he was working as a storekeeper at the Gas Light and Coke Company. George Holsworthy Palmer had worked with the renowned gas engineer Samuel Clegg whilst at the Gas Light and Coke Company.

He was an innovative if not entirely successful engineer involved in numerous gasworks and it would be fair to say that Palmer's gasworks were met with varying degrees of success. Some required a fair amount of remedial work or rebuilding to render them effective working gasworks. Such examples include those built on the Old Kent Road in South London for the South Metropolitan Gas Company and at Kensal Green in West London for the Western (Cannel) Gas Light Company. The gasworks he built at Great Yarmouth would appear to be one of his success stories.

Palmer was a bit of an innovator. He filed for multiple patents including a patent for a new method of purifying coal gas. The gas was to be passed through iron retorts heated to a dark red colour. The retorts were half filled with various oxidizable substances, such as broken pieces of cast iron, iron filings or turnings, iron ore, or other similar items.

It was in many ways similar to the method patented years later by Frank Hills, which purified gas by passing it through boxes containing granular bog iron ore. Palmer's idea would be that his process would get rid of both the hydrogen sulphide from the gas and the generation of the wet lime waste known as "Blue Billy" when it was saturated with sulphur and cyanide. Disposal of the Blue Billy was made difficult by the nuisance from the smell of the wet lime when saturated with hydrogen sulphide.

The plan was found to possess great disadvantages. The complicated construction of the apparatus and the attention it required to operate it, combined to prevent its extensive use.

There were several Palmers associated with Great Yarmouth and the Gas Company over its long history. There is some confusion over those involved at the start. Whilst the contracts signed by the Great Yarmouth Gas Light and Coke Company and the Town Commissioners included George Holsworthy Palmer, the length of his involvement is uncertain. Other documents suggest a G.S. Palmer was stated to have contracted with the Paving Commissioners to light the town and to provide private gas supplies. His contract ran 21 years until 1845.

This Mr G.S. Palmer was said to have been known as a vendor of tar, known as "Palmer's paint", whereas George Holsworthy Palmer was known as an engineer who designed and operated gasworks. According to Druery's Historical and Topographical Notices of Great Yarmouth from 1826, George Holsworthy Palmer had "disposed of his interest in the concern" early on, however, he was still signatory to contracts in 1829. Other directors of the company were involved with George Holsworthy Palmer from his work on the Royal Mint. They included Sir Jasper Atkinson, the Provost of the Royal Mint; Henry William Atkinson Esq, also of the Mint and Provost of the Hon. Company of Moneyers; and two London based engineers, William Stratton and Francis Bramah.

In 1840, the Gas Company was reported to have made a great improvement in lighting the town with gas. They had made extensive improvements in their equipment at the gasworks and laid a new large gas main, allowing them to provide a more consistent and extensive supply to the town. This also allowed them to reduce the price of gas by 25 per cent from 13s. 4d per 1,000ft^3. This price was, however, only for those customers who had gas meters, which at the time was still quite rare. They had an alternative pricing system for customers without meters, based on the number of lights and the hours for which they were used. The pricing system is shown in Figure 4.

A further reduction in the price of gas occurred in 1844 (10s. to 8s. per 1,000ft^3). The company directors were all based in London and had been receiving 5 per cent on their shares.

Summer Quarters.

Description of Burners.	Six Days per Week. Nine o'Clock.	Ten o'Clock.	Eleven o'Clock.	For every Extra Hour.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Argand, 14 jets . .	0 9 6	0 11 6	0 14 0	0 2 6
,, 10 ,, . .	0 7 6	0 9 6	0 11 6	0 2 0
Cockspur	0 6 3	0 8 0	0 9 9	0 1 9
	Seven Days per Week.			
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Argand, 14 jets . .	0 10 6	0 13 6	0 16 6	0 3 0
,, 10 ,, . .	0 8 9	0 11 1	0 13 5	0 2 4
Cockspur	0 7 3	0 9 3	0 11 3	0 2 0

Hall-light, until bedtime, £4 per annum, or 10s. per summer quarter.

Winter Quarters.

Description of Burners.	Six Days per Week. Nine o'Clock.	Ten o'Clock.	Eleven o'Clock.	For every Extra Hour.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Large argand . . .	1 8 6	1 14 6	2 2 0	0 7 6
Small ,, . . .	1 2 6	1 8 6	1 14 6	0 6 0
Cockspur	0 18 9	1 4 0	1 9 3	0 5 3
	Seven Days per Week.			
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Large argand . . .	1 11 6	2 0 6	2 9 6	0 9 0
Small ,, . . .	1 6 3	1 13 2	2 0 3	0 7 0
Cockspur	1 1 9	1 7 9	1 13 9	0 6 0

Hall-light, until bedtime, £4 per annum, or £1 10s. per winter quarter.
Charge per meter, 10s. per 1000 cubic feet.

Figure 4.
Costs for different types of burners at different times of the year in 1840. Source: IGEM History Panel Archive.

The formation of the Great Yarmouth Gas and Coke Company

The gasworks remained under the control of G. Palmer and the directors until 1845, when the Great Yarmouth Gas and Coke Company was formed to take over the business. The company was formed for the purpose of carrying out existing contracts or arrangements with the Commissioners under the Act of the 50th year of King George III. (1810), and for making and executing any similar contracts or arrangements with the Commissioners, for lighting the streets, highways, lanes, passages, etc., with coal gas. On 11 April the following year, the gas company had reduced the price of gas from 8s. to 6s. 8d per 1,000ft^3. Later in December 1846, they agreed to put gas lamps on South Market Road.

On 20 November 1847, the construction of a new gasholder with a capacity of 47,000ft^3 (1,330m^3) was completed, which supplemented the two existing smaller gasholders which could hold 10,000ft^3 (283m^3). This new gasholder had been "dignified" by being named after Queen Victoria and is believed to have been built on the opposite side of Southgate Road to the original gasworks.

The business proved to be successful with a profit of £625 17s. 7d, from a total income £2,720 3s. and an expenditure of £2,094 6s. 11d in 1849. It was a notable occasion when a church adopted gas lighting as it allowed them to undertake evening services. In 1849, St. Peter's Church (now St. Spyridon) had been lit with gas for the first time and 9 years later St. Georges Chapel was also lit by gas.

Further reductions to the price of gas were made in 1850, with the price reduced to 5s. 6d per 1,000ft^3, which was followed with a further price reduction to 5s. per 1,000ft^3 in 1852. Such reductions were enabled by improvements made in gas making technology, which enabled the company to make more gas from the same amount of coal.

Balloon flights were a spectacle closely associated with gasworks. Unlike hot air balloons which use the lower density of hot air to make them rise into the air, other air balloons were filled with town gas, which was lighter than air because of its high hydrogen content. On 25 September 1852, such a balloon flight took off from Vauxhall Gardens, known as the "Prince of Wales" Balloon, holding 36,000ft^3 of gas and piloted by a Lieutenant Chambers. It's short journey ended up with him descending on a marsh near the Norwich Road.

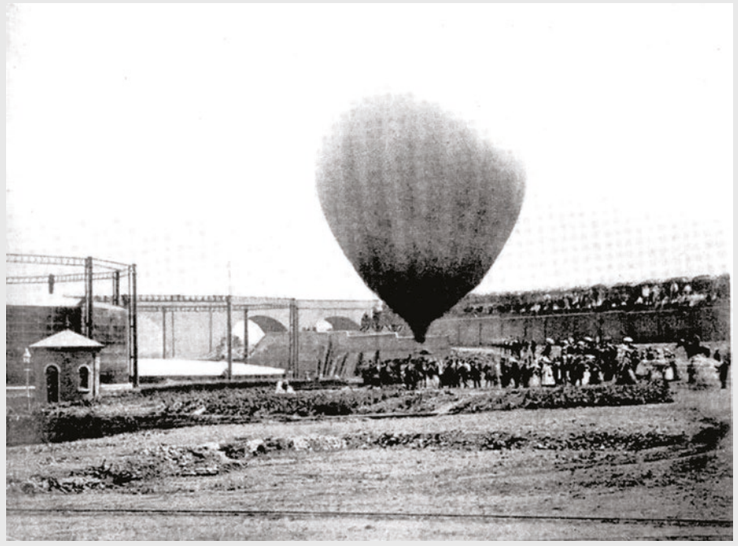


Figure 5.
Coxwell and Glaisher's balloon flight from Wolverhampton Gasworks. Source: National Gas Archive.

Photographs from this period are rare, however a photograph (Figure 5) from 1862 exists, showing the famous balloon flight from Wolverhampton Gasworks, where James Glaisher and Henry Coxwell reached a record altitude of six miles, which almost cost them their lives.

The company's secretary was recorded as a Mr William Henry Willis in 1854, having been in office since about 1849. He was still secretary until he retired in 1889. For some of the preceding years he had also acted as manager. Mr Charles Panchen, who was associated with Mr Willis for about 27 years, replaced him as secretary. Mr W.H. Willis earned the profound respect and confidence of the directors of the company by his hard work, consummate tact and skill, and success in administering the company's interests during this critical and important time. Much progress was made in the development of gas lighting, which proceeded with the continuous enlargement of the works, purchases of land, and other important matters. Thomas Bightwen was Chairman from around 1863, he was succeeded by J.H. Orde, then G.S. Shingles, then Sir Robert Harry Inglis Palgrave who, by 1907, had been the Chair about 20 years.

In 1855, gas lighting was extended to the workhouse and additional gas lamps were added to Wellington Pier. The gas supply failed on 29 December 1860 due to the effects of a hard frost, with the gas cut off from 5-9pm, and then only partially restored. At this time, Adolpus Frederick Waller was the manager of the gasworks in Great Yarmouth.

The price of gas had been reduced to 4s. 6d per 1,000ft^3 in 1863, the same year the corporation built a public clock on the town hall for the benefit of the inhabitants of the town. It was also jocularly suggested that the Gas Company would be most willing gratuitously to illuminate the dial, and through it the inhabitants.

Between 19 March 1863 and 29 June 1863, the Yarmouth Gas Bill was read before the Houses of Parliament. Its objective was to incorporate the Great Yarmouth Gas Company which would give it statutory powers to dig up roads to lay gas pipes. It also provided further provision for lighting the town and certain neighbouring places with gas. It received its royal ascent on 29 June.

In 1863 the local council were evidently not overly happy with the Great Yarmouth Gas Company. In 1863 the Town Council had asked their clerk to investigate the costs of opposing the Gas Bill, which would have cost £800. The Great Yarmouth Board of Health had contacted the British Gas Light Company who ran the gasworks in Norwich, stating that the Board was at variance with the local Gas Company, and asked them to consider the idea of erecting a gasworks for the purpose of supplying gas to the public buildings and about three hundred street lamps. Despite the offer, the directors of the British Gas Light Company did not accept the invitation. Despite this tension with the council, the gas company continued to be successful with the gasworks enlarged in 1862 and 1864.

The site on which the gasworks was built was leased from the Great Yarmouth Corporation to the gas company. In 1864, this amounted to three different leases for the adjacent sites on which the company operated. The first lease was dated 1847, assumed to be the original gasworks west of South Gates Road; the second site leased in 1857, assumed to be land east of South Gates Road and north of Barrack Road. The third site was leased in 1863 and included part of the later gasworks between South Denes Road and Admiralty Road. The Great Yarmouth Gas Company and the Great Yarmouth Corporation had to go to arbitration to agree a price. The case was brought before a Mr Hunter Rodwell Q.C. on 8 December 1863. Both sides argued their case for a higher value in case of the corporation or a low value for the Gas Company.

Within the transcript of the legal case, which featured in the Gas Journal in 1864, the name of Robert Paulson Spice is mentioned. He was acting as a witness in the case providing a value of the gasworks, he mentioned he had resided in Great Yarmouth for one to two years and had grown up in Norfolk and would have been known to the Gas Company. This is an important name we shall return to later.

There was reasonable agreement over the two earlier leases, however, it was the third lease for a site which occupied 10,000 square yards that there was disagreement over. The corporation demanded £7,646, but the Gas Company were making an argument for substantially less. In the final decision, the arbitrator (Mr Rodwell, Q.C.) awarded a value of £4,100 15s. to the land, which the gas company had to pay the corporation.

3 December 1866 was a dark day for both the town and the gas company. At about 7pm, a huge storm developed off the coast of Great Yarmouth, with several ships and their crew lost at sea. At the same time, the storm severely damaged a newly built gasholder of 100,000ft^3, which was supported by massive iron columns at Great Yarmouth Gasworks. The gasholder, which was nearly full, was still being commissioned by the contractor. The bell of the gasholder rolled over in the strong winds and capsized and several of the columns were damaged and parts of the cast iron tank fractured. As a result, the town was put in total darkness, with the loss of gas estimated at about 100,000ft^3. The damage was valued at between £1,000-£1,400.

Town gas was dangerous, just like any other fuel, and the potential for gas to leak and accumulate in a building was always a major problem. The carbon monoxide could asphyxiate you through poisoning, or the gas could mix with oxygen forming an explosive gas. It was this latter situation which occurred on Monday 20 December 1869, when a serious gas explosion occurred at the offices of Messrs. Bracey and Son, located on the corner of Exmouth Road East and Queen's Road. Messrs. Bracey were proprietors of a steam ropery. Next to the rope factory was a neat brick building with a lead roof, used as an office.

A chimney, 50ft (15m) in height, and connected with the factory's engine-room, stood to the south side of the building. Having dealt with an issue of an unpleasant gas smell two days earlier, the offices were closed as usual. Early on Monday morning, the clerk, Mr C Bunn, found the premises filled with the smell of gas. He opened the windows, and Mr J Bracey arriving soon afterwards, sent for a gas-fitter, named Rainer, who soon attended the scene. Unfortunately, he went searching for the leak beneath the floor with a candle. Instantly there was a terrific explosion. Mr Rainer was hurled some distance through the air and burnt about the face and body. The building was destroyed, but somehow the engine room attached to the offices was not damaged. Luckily, no one died but the damage was estimated at over £200. The gas leak was later found to have come from a fractured gas pipe leading from the meter in the steam ropery to the offices. It was not the only such occurrence. In June 1883, a gas explosion occurred in Apsley Terrace, when Mr Rushmer entered his drawing room, where gas had built up, with a lighted candle; the resulting explosion severely injured him and destroyed the windows and doors of the house.

By 1870, the cost of lighting the towns 330 gas lamps was £1,178 12s. The increased cost of coal and labour in 1872 had led to an increase in the price of gas from 4s. to 5s. per 1,000ft^3.

In 1869, the Great Yarmouth Gas Company had been obliged to surrender its lease and remove its gasworks from the original site between South Gates Road and the River Yare. It had bought a new site nearby from the council for its gasworks in 1863. This was located between South Denes Road and Admiralty Road and this would have involved a considerable sacrifice of the capital. The company had already built a gasholder on this land by 1868, visible on the John Laing map of 1868. It also kept a site east of the original gasworks on the corner of South Gates Road and Barrack Road, where two gasholders were located. The new gasworks was to be designed by the gas engineer, Robert Paulson Spice, whose name features on the surviving gasholder.

Robert Paulson Spice and the building of the new Great Yarmouth Gasworks

A key figure in the development of the gasworks in Great Yarmouth was Robert Paulson Spice (Figure 6). He lived a fascinating life which would merit a book of its own.

He was born on 1 January 1814, a day after the Gas Light and Coke Company lit the first public gas lamps in the world on Westminster Bridge. Robert was the son of Norwich grain merchant, Thomas Spice. However, being one of many children, his parents could not afford the engineering education he wanted. Instead he was apprenticed to William Warren, an iron founder and ironmonger, based in the Norfolk market town of Fakenham. He married Elizabeth Thompson in 1837 and took over Warren's business in 1840.

He had moved his premises to a larger site on Swan Street by 1845 and had also become the secretary of the Savings Bank, which is another role he had taken over from William Warren in 1840, on his death. Robert and Elizabeth Spice had two children, Anna born in 1841 and Robert born in 1846.

The first gasworks with which he was associated was Fakenham (Figure 7), the town in which he was living and working as a blacksmith. This was built in 1846. By 1848, he was selling his Fakenham house and business by auction, whether this was for business issues or that he just wanted to move near to London, it is uncertain. Despite taking on three gasworks contracts over a few years, he managed to avoid bankruptcy, a fate which affected many similar engineers.

One of the early gasworks projects Spice was involved in was the construction of a gasworks at Odiham in Hampshire. This company was provisionally registered in November 1846. The promoting engineer was Mr John Ormsby Culyer of Wokingham and its construction supervised by the engineer Robert Paulson Spice of Fakenham, Norfolk, with the apparatus provided by the Gas & Steam Apparatus Manufactory of Holborn, London. It was completed in 1847.

Spice was very closely linked with the Hoddesdon Gas Company, from its foundation in 1847 to his death in 1889. Directors of the company even attended his funeral to express their sympathy. Spice had been the engineer for the construction of the original gasworks in 1847, after which, Spice was retained as Consulting Engineer for various alterations, extensions and the construction of a new gasworks in 1886.

Figure 6.
Robert Paulson Spice photographed in 1882. Source: A Hermit's Experiences of Social Life with English Friends in Germany.

Spice prepared the plans and Samuel Cutler and Son, under his superintendence, constructed the gasworks; this relationship would be repeated on future projects. Spice even assisted in obtaining statutory powers for the company.

It is recorded that when Spice moved from Fakenham to Richmond he operated the West Surrey Chemical Works in Egham, Surrey. His expertise in running a gasworks would have been useful and this chemical works processed residual by-products of gas manufacture.

The site was located on the riverside, so the river could be used for the transport of residual by-products from the gasworks and to export finished products. The site made printing inks from coal tar and the site's operation led to a court case by local farmers for nuisance and pollution affecting neighbouring fields. However, Spice won the legal case.

By the 1850's, Spice was the lessee of three gasworks, these were located at Wandsworth, Hampton Court and Richmond. As a lessee, he did not own the gasworks but operated them under lease from the owners for a set period of time. He later became the lessee of the Watford Gasworks.

Robert Spice was very well regarded by those who worked for him. On his birthday in 1859, a testimonial as a mark of their gratitude for his kindness was presented to him by a deputation of his workers. Those present included the engineers in charge of the Wandsworth, Richmond, Hampton Court and Godalming Gasworks.

It read,
"Richmond, Jan. 1, 1859.

To Robert Paulson Spice, Esq.

Honoured and dear Sir,—We, the undersigned, being at present (or recently) in your employ, beg to be allowed respectfully to congratulate you on the return of another birthday, and to join with others in wishing you health and happiness.

We wish to take this opportunity of expressing our warmest thanks for the kind treatment we have ever received from you as a master. Whenever we have applied to you under any circumstances of trial or difficulty, we have always received, not only your kind sympathy, but a most ready and liberal response. We know that through your and Mrs Spice's kindness many a heart, bowed with sorrow and suffering, has been made to rejoice, and many a sick room has assumed a less saddened aspect through your liberality. We now beg your acceptance of the accompanying inkstand. It is not of much value, but you will confer happiness on us by receiving it as a token of our respect, esteem, and grateful remembrance of your kindness. May you, as you journey along life's chequered pathway, enjoy health, happiness, and prosperity. Our hearts' desire and prayer to God is that his richest mercies may descend upon you, Mrs Spice, and your dear children, and that you may long be spared to enjoy the blessings which your Heavenly Father shall bestow; and that when earth's joys and trials are over, may you enter into that rest which alone is to be found in the brighter and better world. We remain, honoured and dear Sir, yours very respectfully."

Figure 7.
The Fakenham Gasworks, originally designed and built by R.P. Spice. Source: IGEM History Panel Archive.

The address was signed by 50 people.

In return Mr Spice said,
"He would receive it from them with thankfulness, as a highly valued testimony of their kind feelings towards him and Mrs Spice. He should ever look upon it with the greatest pleasure, as an indication of the oneness of feeling and interest that existed between them, which he trusted would long remain."

In 1860, he opened offices in London. In an article in the Gas Journal in 1861, he described himself as,
"I reside at Richmond and have offices in Lombard Street. I am a contractor for the erection of gasworks and have been for many years engaged in designing and enlarging gasworks. I am also lessee of three gasworks, at the present time. I am, therefore, familiar with the construction of such works, and with all questions connected with the manufacture of gas."

His engineering work extended over a period of half a century and his experience meant his services were in great demand as an adviser, witness, or umpire in all questions about gas supply and manufacture. As a result, he had an extensive parliamentary practice as well, being involved in parliamentary bills and acts relating to gas.

He found himself as a witness in legal cases, such as a case brought against Hoddesdon Gas Company in 1858 (whose gasworks Spice had designed), where he argued in favour of the company as to why a customer's gas supply had been cut off. He acted as a witness in other cases, such as the cause of a gas explosion which had occurred from a leaking gas fitting in Weymouth in 1869.

In 1862, Spice produced a report in support of the establishment of a new consumer's gas company in St. Helier, Jersey and, a few years later (1869), he was a witness in the case of the Aberdare and Aberaman Gas Consumers Bill, to comment on the design of a proposed new gasworks to be built by the company.

He regularly found himself called in to assess or value a gasworks. He provided such service, valuing the Weymouth Gasworks in 1868 and in 1869 was called to act as a witness for arbitration between the Dundee Gas Company and the Local Gas Commissioners. In 1887, he was called in to assess the state of the Dundalk Gasworks, he was decidedly unimpressed with the obsolete plant, leaking pipes and sulphurous gas. In the same year, he was involved in the valuation of the Whitby Gasworks, undertook a review of the Pudsey Gasworks for the Pudsey Gas Bill and had reported for the Government in Malta on the gas supply in the country which was operated by the British "Malta and Mediterranean Gas Company". He was a very busy man.

A lasting legacy

Robert Paulson Spice's lasting impact on the landscape was the gasworks he designed such as the surviving gasworks at Fakenham, and the gasholder at Great Yarmouth. As mentioned, he was closely linked to the gas company in Hoddesdon, but he was also employed as the engineer for the construction of the gasworks at Boston (Lincolnshire), Tattershall and Coningsby, Swanage, Abingdon Gasworks extension and Hartley Wintney.

The exact design of Spice's gasworks at Great Yarmouth is not clearly recorded at the time of construction. They were visited by the Chairman of Cambridge University and Town Gas Company who described how the gasworks was laid out on the principle that there were two sets of works, everything being designed and constructed in duplicate, and this was admirable.

From viewing later plans of the gasworks, the likely design of Spice's gasworks is shown in Figure 8. They show the buildings to consist of a retort house, meter house, purifier house and two gasholders. The retort house containing two beds of retorts, one either side, and then purifying plant (condensers, scrubbers and purifiers) was duplicated and two gasholders. Some of this symmetrical design still survived in 1907 (Figure 9). The contractor Samuel Cutler and Sons built the surviving gasholder which was a later addition to the gasworks.

The larger Tunbridge Wells Gasworks, which Spice was later to go on and design, followed a similar philosophy and like the surviving gasholder at Great Yarmouth it expressed his interest in art, culture and engineering and it had similar artistic merits (Figure 10). In the 1870s Robert Paulson Spice was employed as the consulting engineer to Tunbridge Wells Gas Company. The company had nearly outgrown its original gasworks which could not meet demand for gas for much longer and was becoming obsolete.

The gasworks had been surrounded by urban sprawl since their construction. Spice regarded spending extra money on these gasworks as folly and strongly supported the building of a new gasworks in the 1870s.

The original gasworks had been built on a hill which meant that coal had to be carted uphill, and gas forced downhill (as it was lighter than air) under pressure, increasing leakage. Spice proposed to build a new gasworks at a lower point in the town and away from habitation, using new more efficient technology and reducing storage, leakage and pressure issues – it would save money and reduce the cost of gas to consumers.

He designed the new gasworks and later extensions to be economical and added to without alteration, being able to meet the growing needs of the town. As with many of his other gasworks, much of the contracting support came from the contractor Samuel Cutler and Sons, including the gasholders which had included one of the first examples of the Cutler patent guide framed gasholder, a unique design exported all over the world. These ornate gasworks can be seen in Figure 10.

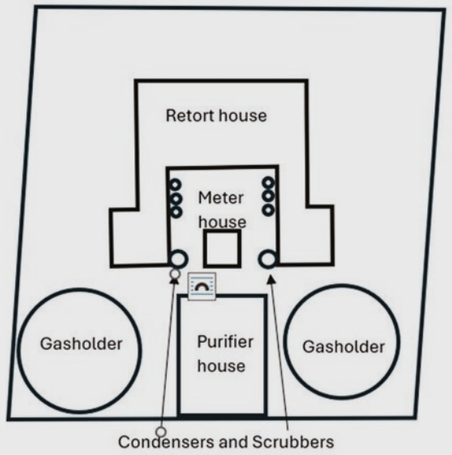


Figure 8.
The likely layout of the gasworks designed by R.P. Spice at Great Yarmouth. Source: Russell Thomas.

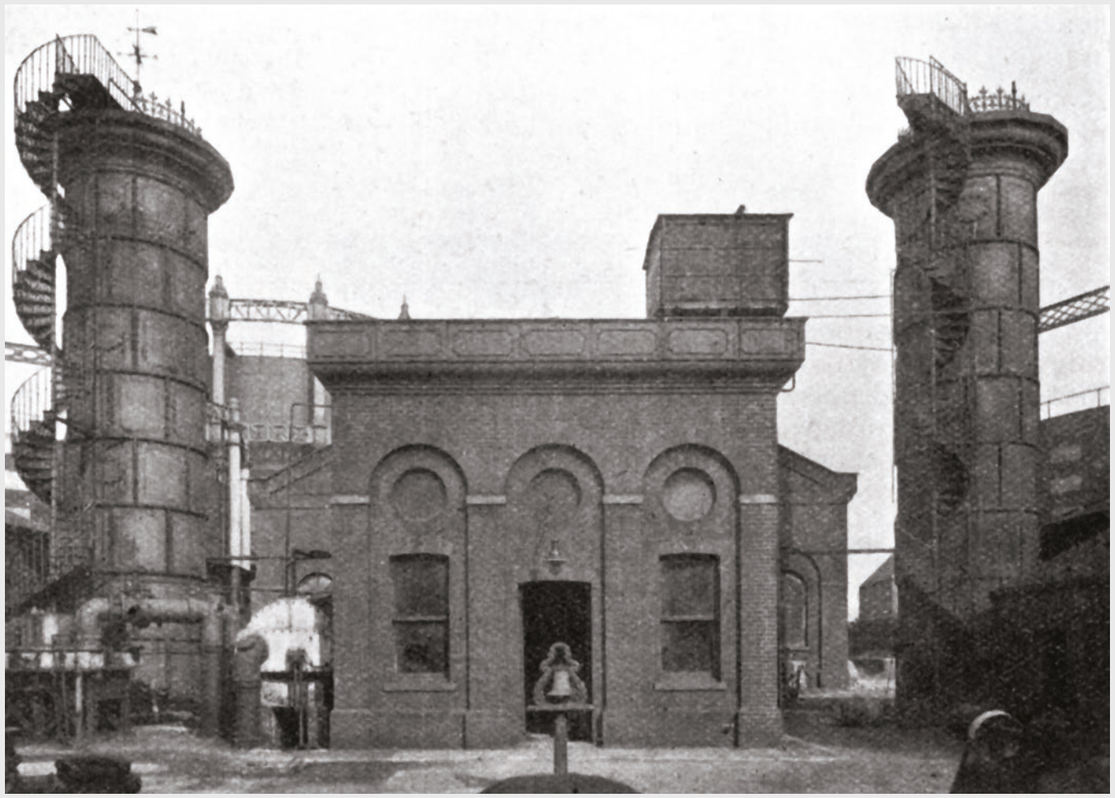


Figure 9.
The original Meter House and two Scrubbers from the Retort House, taken later in 1907. Source: National Gas Archive.

Figure 10.
Two views of new Tunbridge Wells Gasworks designed by R.P. Spice. Source: IGEM History Panel Archive.

Engineering misadventures

Spice was an innovator and tended to get caught up in schemes which were not always a proven success. Unfortunately for himself as well as for others, Spice was prone to adopt, with excessive warmth, projects in which he was professionally engaged, whether they turned out good or bad. Some of these are described below.

In the 1870s, Spice was at one time involved with a water-gas scheme, which he described before the British Association of Gas Managers in 1876. He became the general manager of the New Gas Company who were promoting this early form of Carburetted Water Gas, where a water gas was created by passing steam through heated iron retorts and could be enriched with petroleum vapours. It had been trialled at the Chichester Gasworks, prior to the formation of the company. The New Gas Company acquired the gasworks of the West London Junction Company, who had supplied the Great Western Railway Station and Hotel at Paddington but failed due to the high price of coals. They had also arranged for the adoption of the process at the gasworks of the Crystal Palace District Gas Company. Sadly in both cases it failed, as had a similar attempt by the Leeds based engineer Samson Fox. The American Thadeus Lowe was finally credited with making an effective process for water gas manufacture, by developing a process which alternated between heating and gas generating phases.

Some years later Mr Spice became a supporter of the St. John and Rockwell condensing and carburetting apparatus, which he presented to the Gas Institute in 1881. It was installed after the hydraulic main and claimed to increase the amount of gas produced from coal without reducing its lighting power. The technology was tried at the Rochdale Gasworks, but the result did not present a convincing enough argument of its success, so therefore it was not adopted, despite Spice's generous support.

In the 1880s, Spice was the engineer to the Coal Distillation Company who promoted the Cooper's liming process. It involved mixing the coal with a small percentage of slaked lime before it was placed in the retorts and carbonised. The basis of the technology was that the lime would absorb the impurities and at the same time it would remove the problem of disposing of the lime. It was used at the Swanage Gasworks, which had been designed by R.P. Spice, for three years in the 1880s.

Despite these engineering misadventures by Spice, they did not significantly harm his reputation, and he continued to work until his death.

The Hermit of Westminster

Spice had a second life as a travel writer who published under the title of the "Hermit of Westminster". His publications were his own private musings but gained a popular following, with his two lives occasionally crossing over, as they did in the Gas Journal in 1884 which covered his travel writing in Madeira.

Whilst most of his contemporaries took up other interests of the time, Spice took to his walking sandals and travelled. His heart was said to be in the Highlands of Scotland and he left his trousers at home, donning the kilt and hoping to see a glimpse of a stag.

His travel writing covered Norway, France, Madeira, Germany, Italy, Portugal and the United States of America (USA). He professed both a love of travelling at ease and nature, and always appreciated a good dinner.

He would write his observations down in a notebook along with his sketches (Figure 11). He would cover all aspects of his travels including nature, society and even the politics of the country he visited.

Great Yarmouth still appears to have had a special place in his heart. His travel booklets mention his stays at the Royal Hotel in Great Yarmouth and his appreciation of the Town Hall, which featured in one of his books.

One of his favourite travels was to the USA, visiting the beautiful scenery such as Yosemite Valley (Figure 12). Travelling to the USA often allowed him to combine his interests in gas and travel. In 1885 whilst travelling in the USA and attending meetings of the American Gaslight Association (AGA), he was made an honorary member of the AGA. His travelling life must have rubbed off on his son who moved to America. By 1888, the American Gaslight Journal report "that a son of Mr R.P. Spice, C.E., of Westminster, has been appointed Gas Inspector at Brooklyn, N.Y.". His son achieved the title of Professor.

Figure 11.
A sketch of R.P. Spice by himself from his Westminster Hermit book series.
Source: The Wandering of the Hermit of Westminster from the Thames to Bordeaux.

Figure 12.
Spice's sketch of the Yosemite Valley 1881.
Source: The Wandering of the Hermit of Westminster between New York and San Francisco.

The loss of a unique individual

Robert Paulson Spice died aged 75, in 1889. He had been fully engaged in his work up to within a short time before his death. The Gas Journal reported that "The profession of gas engineering has lost one of its veterans. Robert Paulson Spice – hero of many a hard parliamentary fight, champion of many a desperate cause, and warm-hearted friend of two generations of young gas managers. His was a unique place in the ranks of professional men, which can never be filled by another. He belonged to an order of gas engineers who have almost died out."

Thus, like most other gas engineers of his generation, he grew into his place by experience and held it by an aptitude for the business of his choice. He possessed the gifts necessary for an expert – ready wit, keen appreciation of the situation, and the ability to express himself.

Mr Spice was a member of the Institution of Civil Engineers, a member of the Institution of Mechanical Engineers, a Past-President of the Society of Engineers and a Fellow of the Royal Geographical Society. He was a regular supporter of the British Association of Gas Managers; often speaking at the meetings. He was elected a member in 1868, was President between 1876 and 1877, and was behind the establishment of the Benevolent Fund.

Benevolent to a fault, many went to him in distress and received relief. He was only too open with his hand, and too ready with his support for all who appealed to him for help.

His funeral was attended by a large number of his private and professional friends including those companies who he had represented.

A gasworks across the Yare

It took some time before Gorleston and Southtown, which were located across the River Yare, got the benefits of gas. The construction of a pipeline across the River Yare was not really an option at the time so they had to wait for the formation of their own company.

On 7 August 1852, a meeting was held to consider the idea of forming a company to supply Gorleston and Southtown with gas. A meeting of local dignitaries was chaired by George Danby-Palmer, Esq., which led to an influential committee being formed and a considerable sum of money subscribed in the room, to enable a company's creation. In 1852, the Trustees of the Southtown Turnpike had obtained power to light that road with gas, which would be possible once the gasworks had been constructed.

The company, the Gorleston and Southtown Gas Company, was formed on 30 July, 1852, provisionally registered under the Joint Stock Act, with a capital of £3,500, in shares of £10 each. The new gasworks was estimated to have cost £2,800 to build. The first gas lamps on the streets of Gorleston were lit 6 September 1854.

The company's own history, from 1929, records that the Gorleston and Southtown Gas Light and Coke Co. Ltd. was formed in 1855. The popularity of gas meant that the gasworks had to be enlarged only a few years later in 1859.

In 1865, Charles J Palmer was secretary and Z Eastick, the manager. A violent explosion of gas occurred on 4 June 1869 at Mr Gambling's office in Southtown, which caused damage in and around the premises to the value of £200 or £300.

An advert in the Gas Journal of 1871 placed by the Gorleston and Southtown Gas Company stated, "Wanted, a steady, respectable married man, who thoroughly understands the manufacture of gas, and is competent to take the general management of a small gas establishment". It appears that the successful applicant was Henry Weller, who was in position in 1875. Sadly though he died aged 47 in 1878 and was replaced by Frederick Weller.

In 1871, £2,700 was spent on improving the gasworks and, in March 1876, a Bill was put before the House of Commons, known as the Gorleston and Southtown Gas Bill. The Bill passed through the House of Lords on 1 May without opposition. Subsequently, a new gasholder (No.3), capable of holding 63,000ft^3 and its tank which held 406,350 gallons of water, was erected at the gasworks, which, along with other improvements, cost the company £5,000.

Figure 13.
The Gorleston Gasworks from the road in 1924.
Source: IGEM History Panel Archive.

The Secretary between 1875 and 1890 was William Palgrave Brown, who was the owner of the Yare Saw Mills in Southtown, Great Yarmouth.

Having reviewed the gas company for the Town Council, the renowned engineer Corbett Woodall described this gasworks in 1887. They were a much smaller undertaking than the Great Yarmouth Company and in a less prosperous condition, but its business had grown at a more rapid rate, increasing 66 per cent between 1876 (6.3m ft^3) and 1886 (10.6m ft^3). Over this time, the price of gas (per 1,000ft^3) had dropped from 6s. in 1876 to 5s. in 1886. The company had expended heavily in new plant and was still doing so to meet its increasing demand, including the construction of a new gasholder built in 1883. Its finances were such that the company struggled to pay the 5 per cent dividend to its shareholders.

In 1890, members of the Eastern Gas Association, who were holding a meeting at Great Yarmouth, took a short visit to the gasworks of the Gorleston and Southtown Gas Company. At this time they were under the charge of the engineer and manager Mr F Weller. The works were small, but well appointed; and Mr Weller was complimented upon the neatness which prevailed throughout the place. The retort house contained five beds of six retorts; and there were two well-constructed gasholders each of a capacity of 62,000ft^3 (1,755m^3). The annual gas production at the gasworks was about 14mft^3 (396,435 m^3).

In 1910, the manager of the Gorleston Gas Company was a Mr J. Witten. In 1924, the Gorleston and Southtown Gas Company works hosted a visit from the Eastern Counties Gas Association (Figure 14). The meeting was chaired by Mr C.S. Orde who was the Chairman of the Gorleston and Southtown Gas Company, but also held similar positions with the Great Yarmouth and the Lowestoft Gas Companies and with the local textile company Messrs. Grout and Co. Ltd.

The Gorleston Gasworks was described in the visit of 1924 and a summary of this is given below.

The gasworks are situated on the west bank of the River Yare and receive coal by sea, in vessels of about 400 tons (362 tonnes) capacity. The coal had to be discharged by hand. The River is also used for transporting by-products.

In the retort house there are six beds of six horizontal retorts, with five regenerator furnaces and one generator furnace. The retorts were loaded by a Biggs-Wall “Rapid” manual charging machine; and the coke is removed by hand using a rake. On the foul main, there is a Parkinson retort house governor above the beds, and an Everitt tar extractor on the inlet to the condensers. There are two sets of Bryan Donkin exhausters, each of 30,000ft^3 per hour capacity; a blower being run in conjunction with them to provide air for purification. A Hunt washer of the bubbling type is at present worked with a very light seal, being undersized; and there is a Kirkham, Hulett, and Chandler vertical centrifugal washer of 300,000ft^3 per day. Two purifying boxes are by Robert Dempster, and four by Cockey.

The work operated a Kramer and Aarts water-gas plant which could produce 250,000ft^3 a day, and it was possible to lightly enrich the gas. The gas was passed to one of the older 60,000ft^3 relief holders. The gas was then heated prior to mixing with the coal gas stream at the outlet of the retort house governor, before reaching the inlet of the tar extractor. The coal gas and water gas meters are of the “Rotary” type.

The mixed-gas storage holder, of 200,000ft^3 capacity, is in a steel tank, standing on a concrete raft and piles.

The holder inlets and outlets are situated in one building. For each district, there is a Parkinson water-loaded district governor. In addition to two Cornish type boilers, fitted with Wilton’s forced-draught furnaces, there is a Kirke waste-heat boiler connected to the retort-bench main flue, and also a Kirke gas-fired boiler as a stand-by. The tar, liquor, and water pumps are mostly by Joseph Evans.

A Hird-Chambers tar plant with a capacity of 3 tons (2.7 tonnes) a day capacity. The sulphate plant was an early type by Samuel Cutler and Sons and it was later fitted with a Taylor saturator.

1929 marked a big change in the gas production plant at the gasworks. A Woodall-Duckham vertical retort plant was installed in a steel framed retort house (Figure 16). It was equipped with a waste-heat boiler, coal breaking and elevating plant, a coke gantry and water softening plant. In 1935, control of the Gorleston and Southtown Gas Company was acquired by British Gas Light Co., who operated several other gas undertakings in the region such as Norwich and Fakenham.

Figure 14.
Eastern Counties Gas Association Meeting at Gorleston 1924. Source: National Gas Archive.

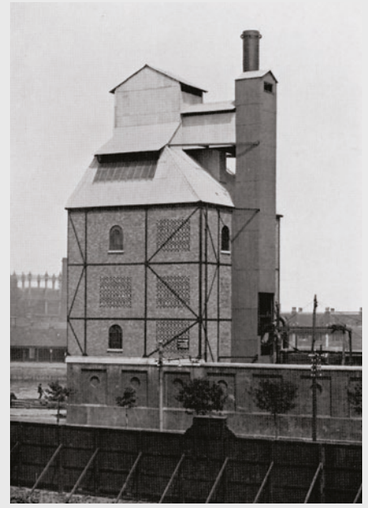


Figure 16.
The vertical retort house installed at the Gorleston Gasworks in 1929 by Woodall-Duckham.
Source: IGEM History Panel Archive.

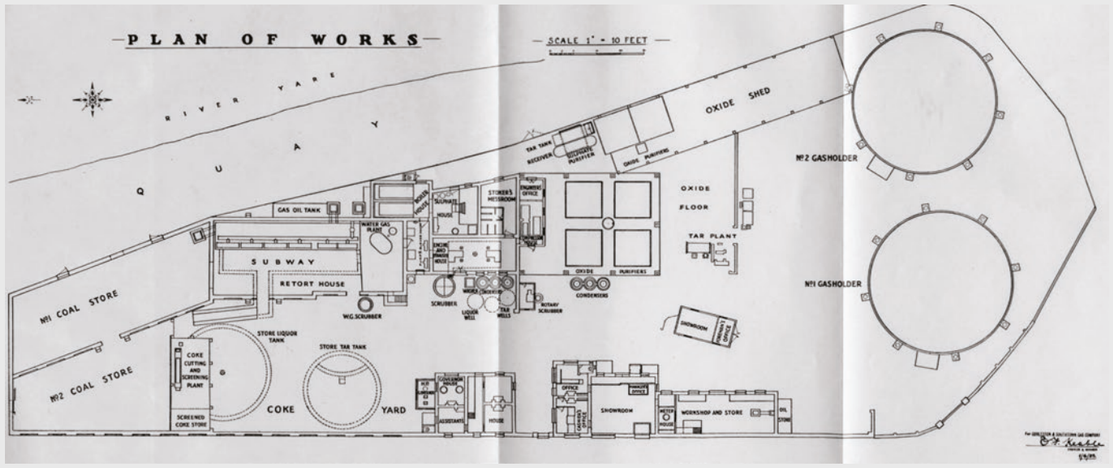


Figure 15.
Plan of the Gorleston Gasworks in 1929.
Source: IGEM History Panel Archive.

The gasworks at Grout's Silk Mill

There was another gasworks in Great Yarmouth, this gasworks was immediately east of St. Nicholas' Church, in the north of the town. A building marked gasworks and two gasometers were marked on the 1:500 OS Town Plan from 1885. It appears to be disused on the OS revision of 1904.

It was located at Grout's Silk Mill. Grout and Company were silk and crepe manufacturers and had factories in Great Yarmouth (St. Nicholas Road), Norwich, Bocking Churchstreet and Ditchingham. Each mill had its own private gasworks, despite Norwich and Great Yarmouth having existing public gas supplies.

The original factory constructed for Grouts in Great Yarmouth was built in 1823, but it burnt down in May 1832, with a new factory constructed in its place. A lot of light and energy was required in silk manufacture and the amount required may have originally been more cost effective to provide from a private supply. However, as the cost of gas provided by the Great Yarmouth Gas Company reduced, it is likely a supply was taken from them and the private gas works made redundant. The Goad Fire Insurance map of 1909 showed that the buildings had been repurposed for textile manufacturing by this date and the mill would have been supplied from the gasworks.

Figure 17.
OS Town Map showing the private gasworks at Grouts Silk Mill.
Source: Reproduced with the permission of the National Library of Scotland.

The surviving gasholder

The surviving gasholder which was referred to as Gasholder No.5 or No.172 Gasholder (Figure 18) is a three-lift, column-guided holder built with a cast iron tank. It was Grade II listed in February 1998. The gasholder was designed by Robert Paulson Spice and constructed by Samuel Cutler and Son. The above ground tank was typical of many gasholders built in the mid-19th century, but by the time of its construction they had become a bit of a rarity.

By 1884, building a cast-iron tank under ordinary circumstances was seldom undertaken on account of the great cost compared with other types of tanks. Their construction was then reserved for ground liable to flooding, under tidal influence or where the site was of a sandy or peaty nature, and groundwater at a relatively shallow level to render the construction of a brickwork or masonry tank impracticable, if not impossible. The ground at Great Yarmouth was sand and when the ground was excavated into the groundwater, it became very unstable and would collapse, so this was the reason why such tanks were chosen for gasholders at Great Yarmouth.

Cast-iron tanks were either sunk into the ground to such a depth as can be economically accomplished without expensive water pumping or constructed wholly above ground on a timber floor, as was originally done at Great Yarmouth. In those cases, substantial piers had to be built against and around the tank, or the columns of the guide-framing of the holder lengthened and made stronger.

The No.5 gasholder was reported to have been first erected on the site of the original gasworks between Southgates Road and the River Yare in April 1885. They used a timber plank floor as a foundation. It had to be dismantled the following year due to the instability of the foundations and it was re-erected at the current location on site in 1885. Works undertaken at the site have shown that the tank is currently a couple of metres below ground. This suggests that when it was re-erected it was sunk into the ground to provide greater stability, rather than adopting the original wooden planking.

The date of 1884 which was written on the wall of the tank seems to relate to the year the gasholder was manufactured at Samuel Cutler and Sons, rather than first erected.

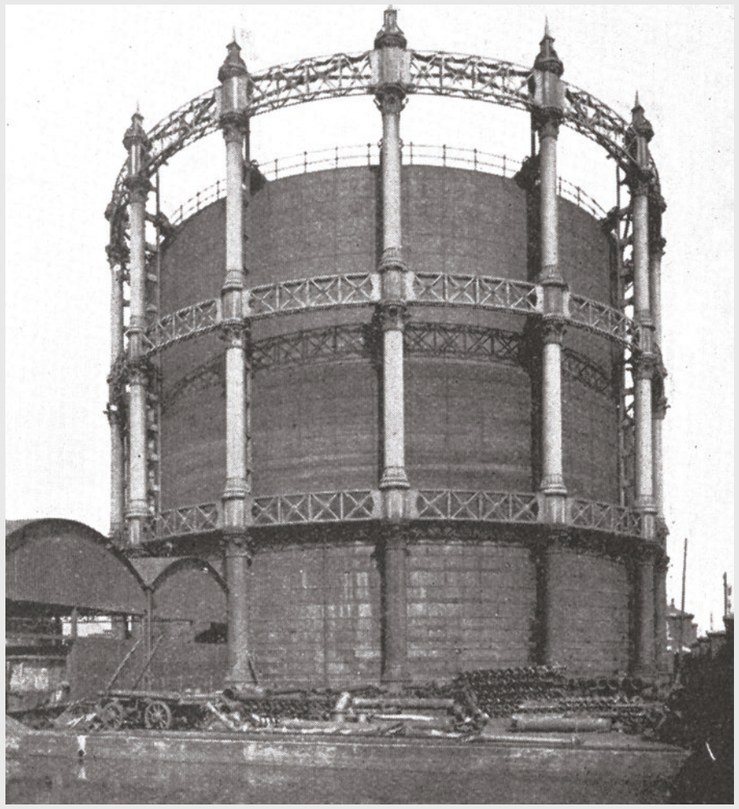


Figure 18.
The No.5 (No.172) Gasholder designed by R.P. Spice, in 1907.
Source: National Gas Archive.

The side walls of the cast-iron tank were constructed from several tiers of plates, having external flanges and caulking beads. These plates were bolted together and to the bottom plates; and the joints made with an iron cement, well caulked by hammer and set. The Great Yarmouth tank had 3-4 wrought iron belts placed around it to help support the wall from buckling.

The base of the cast-iron tanks, as observed at Great Yarmouth, was formed from concentric rows of plates with internal flanges (Figure 19). These would be laid on a bed of concrete, tiles set in cement, elm planking or, in some cases, directly on the sand or gravel, which was generally not recommended.

The key statistics for the gasholder are as follows:

Nominal capacity	400,000ft³ or 11,326m³
Height	26.8m excluding finial, 29.0m including finial
No. of lifts	2
Tank diameter	29.8m
First lift diameter	29.0m
Second lift diameter	28.2m
Depth of tank & lifts	8.54m tank & lifts
Crown rise	1.68m
No. of columns	14
Columns diameter	0.99m
No. of lattice beams	42 (14 on each of the 3 tiers)

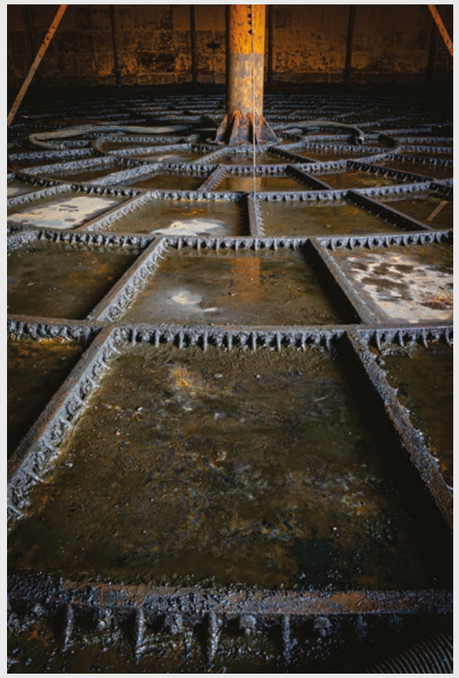


Figure 19.
The cast iron flanged plates on the base of the tanks.
Source: Mike Glyde.

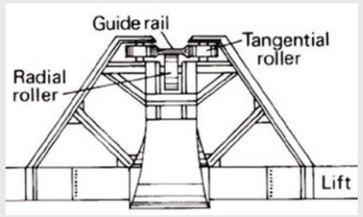


Figure 20.
A schematic of a Tangential Roller.
Source: Brian Sturt 1990.

As was the design of the cast iron columns, they were fabricated from three cylindrical sections which were bolted to connection boxes which also served to attach the horizontal girders. These were fixed on a plinth at their base and had a finial atop a scrolled volute. The horizontal lattice girders are unusual as they were specially made to be curved. Had they been straight then the lifts of the gasholder would have jammed against them. Each of the three tiers used curved girders; however, on the upper most, stiffeners are used to brace the columns more firmly together.

The gasholder is quite quirky in that it appears firmly old fashioned with its cast iron tank and its Gothic design but has advanced features for its time. This is apparent in its guiding system. The two lifts were guided up and down the columns by tangential rollers (Figure 20). Unlike the rollers used on most British gasholders, which just used a single roller running on rail, tangential rollers used three rollers.

They were composed of a central roller running on the centre of the guide rail, with two additional rollers placed at 90° on either side of the central roller which ran on the outside of the guide rail.

Inside the gasholder the innovative design continued. The crown was supported by very light framing, with the main supporting bars interconnected by a herringbone pattern of connecting purlins. The supporting ironwork beneath the crown was also very light, composed of circular iron rods and the supporting kingpost likewise quite small (Figure 22). It very much reflected the personality of Spice, with his love of arts and culture, combined with his interest in innovation.

Figure 22.
The inside of the gasholder crown.
Source: Mike Glyde.

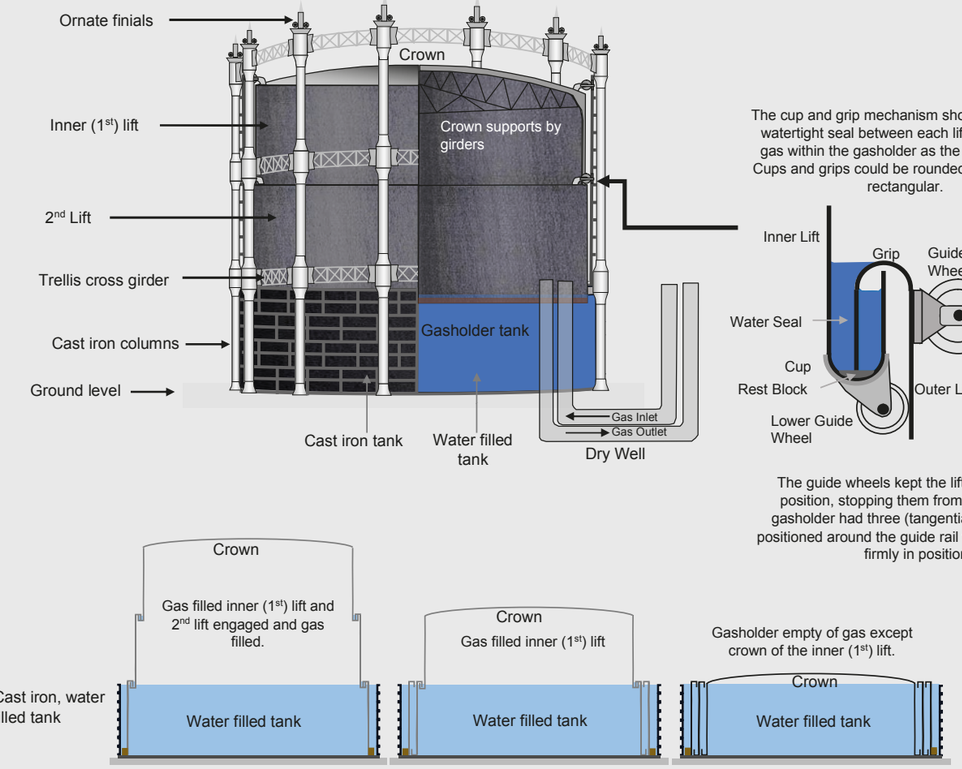


Figure 21.
A schematic of how the gasholder operated. Source: Russell Thomas.

Samuel Cutler and Sons

The gasholder was built by the company Samuel Cutler and Sons, who were based in Millwall, London. This company was established in 1844 by George and Samuel Cutler Sr on City Road in North London. They specialised in gasholders and gasworks plant, before branching out into general construction engineering. The business soon outgrew the original factory and was transferred to larger premises at Millwall in 1858. Continued growth led them to move again in 1868 to an extensive Thames-side premises, The Providence Ironworks in Millwall. They were London's only gasholder manufacturer.

Despite the death of Samuel Cutler Sr in 1870, the company continued to grow. Samuel Cutler Jr being regarded as the driving force responsible for this continued success. Throughout most of its existence the company had been run by the Cutler family.

Although they manufactured a large range of products, they were particularly associated with gasholder construction and had a world-wide reputation, adopting new manufacturing methods time and time again. They were one of the most sought-after manufacturers of gasholders and tendered for work of all sizes across the country, from new builds to repairs or extensions.

The development of the spiral guided gasholder by Gadd and Mason and produced by other firms did impact sales initially.

The triangular framing system devised by the company, known as the "Cutler patent guide frame" (Figure 24), was a development of the design devised by George and Frank Livesey at the South Metropolitan Gas Company's Gasworks on the Old Kent Road in London. Cutler's design was very popular for many years, with examples of this design exported to Denmark, Italy, India, Germany, Hong Kong and South America. There are still examples preserved in Italy and working examples in Hong Kong. Cutler also later made improvement to many aspects of spiral guided gasholders.

The 8 million ft³ capacity gasholders erected by the company at Kensal Green Gasworks of the Gas Light and Coke Company and at the Neepsend Works of the Sheffield Gas Company were some of the largest gasholders ever built.

In addition to gasholders, Cutler also manufactured condensing and purifying plant (also used at the Great Yarmouth Gasworks). They also co-introduced, with the Great Yarmouth born engineer Mr Charles Hunt, the 'Dessau' intermittent vertical retort system, one of the first vertical retort types developed. The company continued to operate through both World Wars. During the First World War they produced hydrogen generating plant for inflating airship and kite balloons. The factory closed its doors in the 1960s relocating to Telford and the site since redeveloped. Many other Samuel Cutler gasholders survive around the world, including redeveloped former gasholders in Dublin, Berlin and Rome.

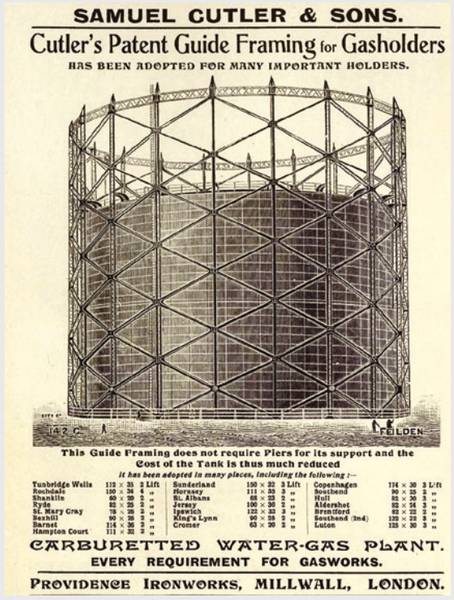


Figure 24.
An advert for the Cutler Patent guide framing gasholder.
Source: Russell Thomas.

Figure 23.
External detail of the tank wall showing the names of both R.P. Spice and Samuel Cutler and Sons, with the date 1884.
Source: Jam Butty Photography and Video and IPB Communications.

The threat of municipalisation and electricity

In 1887, the town considered the purchase of the gas companies in both Yarmouth and Gorleston. This was a time when many local councils had considered purchasing their local gas undertakings, if they did not own them already. The town's Gas and Water Committee had commissioned the renowned gas engineer, Corbet Woodall, to investigate the financial and material condition of the gasworks of the two companies, and the practical results which might be fairly expected from the acquisition of the works.

He reported that the Great Yarmouth Gasworks was in excellent order, had considerable extra capacity, was well designed, substantially built and maintained in excellent condition. The condensers and exhausters were the only limiting factors but could be improved relatively cheaply. The other issue being that there was no direct connection between the river and the gasworks for unloading and storing coal which was costly.

Woodall had suggested that in purchasing both gas undertakings, the gasworks at Great Yarmouth was large enough to manufacture the gas required at Gorleston, without special extension and the Gorleston Gasworks could be closed whilst retaining the gasholders and gas distribution network. The driver for this was the cost of gas made at Great Yarmouth was 23d per 1,000ft³ compared to that made at Gorleston which cost over 32d. Allowance would have to be made for a connecting gas main to be carried across the river.

Corbett Woodall concluded his report by saying,
"that he did not doubt, if the purchase could be achieved on fair terms, that the acquisition of the gasworks by the town would be as satisfactory in Yarmouth as it had invariably been elsewhere."

It appears that the main reason that the gasworks was not purchased was a lack of confidence in the future success of the gas industry. Corbett Woodall's conclusions were contingent upon his terms being accepted, and based upon the assumption that gas would continue to maintain its supremacy as the principal form of lighting used in the borough. Mr Worlledge, a committee member, thought that with the rapid strides taken by science, and the removal of the legislative restrictions around the Electric Lighting Act (1882), that electricity may soon rival and then overtake gas in the lighting market, making it obsolete and affecting any profits of the gas undertaking should they purchase it.

The trend to purchase the municipal gas undertakings had been strongest in the 1860s and 70s and had started to wane, often due to the perceived threat of electricity, and the fact that electric lighting had become a reality and in use in public streetlighting and at railway stations, hotels, clubs, and other large buildings which were capable of generating their own electricity.

In the end it was decided not to be a prudent investment to purchase the gas undertakings when the threat of electricity seemed real and "That it is not desirable at the present time for the corporation to enter into any negotiations for the purchase of the Yarmouth and Gorleston Gasworks."

Municipalisation never happened to the gas industry in Great Yarmouth and both gas companies remained in private hands until nationalisation in 1949.

The predicted threat of electricity was real, as with gas, Great Yarmouth was an early adopter of electricity. The Great Yarmouth Corporation obtained a provisional order for electric lighting in 1890.

Electricity became a rival to gas in Great Yarmouth following the construction of its first electricity generating station in 1894. It was located south of the Great Yarmouth Gasworks on Swanstons Road between Admiralty Road and South Denes Road. It was built and operated by the Yarmouth Corporation Electricity Department.

This power station initially used a gas engine to drive a generator to provide a private electricity supply and four steam engines to drive dynamos and alternators to supply DC electric arc lighting and AC incandescent public lighting. It soon displaced gas powered street lighting at 15 locations across the town, including Marine Parade on the seafront. Demand for electricity led to a new more powerful gas engine and two additional steam engines.

By 1898, electric lighting had grown significantly and there were 6,600 electric lights across the town. These all went off when an accident at the power station damaged some of the steam engines, a bit of hasty rewiring and power was restored 4 hours later. The competition from electricity had persuaded the gas company to invest in incandescent gas lamps which produced a brighter light than previous gas lamps. Despite the competition, gas and electricity operated side by side supplying different needs and markets. Gas moved into heating and cooking markets and electricity dominated lighting and powering new appliances and industrial applications. Electricity adopted many of the devices developed in the gas industry, notably meters and prepayment meters.

Further extensions were made to the power station and, by 1902, there was sufficient electricity to power an electric tramway which operated until 1931. Electricity reached Gorleston in 1904, when a power cable was placed in a trench in the bottom of the River Yare between Great Yarmouth and Gorleston.

The power station was upgraded again in the 1920s with steam turbines. This power station was eventually closed in 1958, with a new supply coming from the larger more efficient power stations being developed and the electricity supplied through the National Grid of the Central Electricity Generating Board (CEGB), which was formed in 1958.

By 1898, electric lighting had grown significantly and there were 6,600 electric lights across the town.

The 1901 and 1910 gasworks extensions

In 1901, W.J. Carpenter, the engineer of the Great Yarmouth Gas Company, wrote a paper on changes he had made at his gasworks. The changes related to the movement of coal to the gasworks. Unfortunately the gasworks did not have a wharf frontage on the River Yare to unload coal directly. Lord Londonderry's Durham coals were usually taken, shipped from Seaham Harbour. Sailing colliers of 250 to 700 tons (226 to 635 tonnes) carrying capacity would deliver coal which had to be unloaded by hand and weighed in 1 cwt. scales, placed in sacks, carted to the works, carried up plank-ways, and deposited in the stores by ordinary labourers. As the amount of coal required increased, this method became problematic and highly inefficient, a more cost-effective approach was required.

The solution implemented used two hydraulically powered cranes (Figure 25) running on rails along the quayside. This was difficult to implement as the quay was owned by the council who prioritised the herring fleet activities most of all. The 750 pounds per square inch power for the crane came from a pumping engine and hydraulic accumulator built in the gasworks buildings (Figure 26). This power was transmitted by hydraulic power pipes to the quay side which had hydrants at frequent intervals. The crane was fitted with travelling gear.

At the same time, an automatic charging and discharging machine was installed so that the process could be automated as far as possible. The charging (loading) and discharging (unloading) machines were pneumatically powered from a compressor and air receiver, located in the works buildings by the hydraulic engine (Figure 26) designed by John West of West's Gas Improvement Company.

The coal would be delivered into the 20ft (6m) long retorts in a perfectly even layer, by an arrangement patented by the Engineer Mr W.J. Carpenter. The retorts were laid out in benches of eight, heated by regenerative furnaces, which were designed and built by the works staff. This equipment made gas making much less laborious, as the company was already struggling to find people willing to take up stoking as a living, especially at times of full employment in the town. The new installation improved efficiency at the gasworks; in the 10 years between 1896 and 1906, there was a 30 per cent increase in gas production from 127.6m to 166.9m ft^3 (3.6m to 4.7m m^3). Mr W.J. Carpenter's son, Claude Clarence Carpenter, also worked for the Great Yarmouth Gas Company on leaving school, before taking a position at the Beccles Gasworks, Suffolk in 1910.

By 1914, the gasworks was making 185m ft^3 (5.2m m^3) of gas from 16 tons (14.5 tonnes) of coal. The company had 2,372 customers with a normal gas meter and a further 5,292 customers with prepayment meters. Of these customers, 3,495 were also renting cookers from the company. The town's public lighting was divided into 8 districts, each with its own lamplighter, however there were now only 384 street lamps remaining, as the street lighting had been switched over to electricity, which was owned by the corporation supply.

Figure 25 (above).
The hydraulic crane in action, unloading skips onto framework carts.
Source: National Gas Archive.

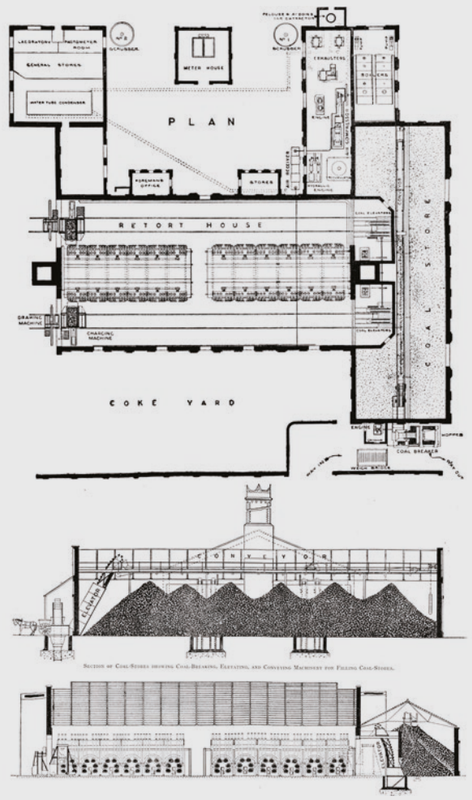


Figure 26.
The redevelopment of the gasworks showing the new coal handling plant, charging and discharging plant and associated equipment. Source: National Gas Archive.

The tar works and the by-products of gas manufacture

The gasworks in Great Yarmouth was constructed in 1824 and the streets first lit with gas on 6 December that year. This was relatively early for a small town like Great Yarmouth, especially as the first railway station in Great Yarmouth (Yarmouth Vauxhall) did not open until June 1842.

Coke was composed primarily of carbon and could be used to heat the retorts by burning it in the furnaces or producers below the retorts. As coke had most of the impurities removed, it was a smokeless fuel and reduced air pollution. It also found use in domestic, commercial and industrial heating, in open fires, boilers, stoves and industrial furnaces. Coke was sold directly from the gasworks, collected by local people in carts or delivered to customers by horse and cart or wagon.

Coal tar was another by-product of gas manufacture. It was collected when the gas was cooled and washed, forming a black viscous and odorous liquid. Initially it was regarded as of little or no value and was problematic to dispose of. However, by 1838, the merits of coal tar and the numerous different compounds it contained were discovered. By 1923, the annual British production of coal-tar by gas undertakings alone had reached the significant amount of 182 million gallons.

Likewise a use for another potential waste product, the ammonia rich water produced from washing the gas, was identified in 1842. It was discovered that when this alkaline solution was neutralised with sulphuric acid, it produced a salt called sulphate of ammonia. It had many uses, most notably as a fertiliser. The annual UK production by 1923 had reached 117,000 tons (106,140 tonnes) and it continued to be manufactured from coal gas by-products until the 1960s.

By heating the coal tar in a tar distillery, it could be separated into different fractions based on their boiling points. These fractions included light oil, middle oil, heavy oil (or creosote oil), anthracene oil and pitch. Light oils were used to produce insecticide fruit tree washes and varnishes, creosote oil used for treating wood, and pitch used for constructing tarmac roads. The crude tar or refined fractions could be sold to the chemical industry, who would make a variety of products ranging from morphine and aspirin for pain relief, dyes for textiles, to plastics like nylon and bakerlite, as is demonstrated by Mr Therm the gas industry mascot in Figure 27.

The Great Yarmouth Gas Company had its own tar distillery. This was originally located off the Caister Road in the north of the town on the banks of the River Bure, a site quite separate to the gasworks. It had been present on the OS maps back to 1884. It may have been present much earlier as the owner of the Great Yarmouth Gasworks from 1824 to 1845, a G.S. Palmer, also produced a tar-based product called ‘Palmer’s Paint’. However, it would question why, in 1868, the company’s Secretary, Mr W.H. Willis, placed an advert on behalf of the Great Yarmouth Gas Company, stating they were prepared to receive tenders for the surplus tar produced at their gasworks for one, two, or three years, from 1 March 1868. The quantity of coal tar available was estimated at between 20,000 to 30,000 gallons.

By 1922, plant for new chemical works had been installed which included a new sulphate plant, a tar distillation plant and benzole extraction plant for the service of the company’s lorries. By 1924, to avoid the heavy cost of transport and to ensure more economical and efficient working, the company’s tar works were removed from the site on Caister Road to a new site on the gasworks.

The Gorleston Gasworks was operating its own tar works and a sulphate of ammonia plant, which in 1929 could produce 3 tonnes per day.

Great Yarmouth was also home to a chemical works operated by the British Gas Light Company, who operated a portfolio of gas companies, including the one in Norwich and later the one in Gorleston. Its Norwich Gasworks was split over two cramped sites, and they eventually lacked the land available to operate a chemical works in Norwich. The company purchased land some twenty miles away on North River Road, Runham Vauxhall in Great Yarmouth to build a tar and chemical works to process the by-products from the Norwich Gasworks. The area was already home to a chemical works which made fertilizer from fish guano, no doubt benefitting from the fish wastes produced by the town’s fishing industry.

The British Gas Light Company built its works in 1883 and operations commenced there in May 1884. The raw products were conveyed from Norwich to Great Yarmouth by river. The chemical works undertook the distillation of tar and the manufacture of sulphate of ammonia. The markets for these by-products fluctuated and at times, when markets were depressed, it was more profitable to close the works temporarily and dispose of the products direct from Norwich. A useful addition was made to them during the First World War when a benzole plant was installed for supplying refined spirit required by the government’s war effort.

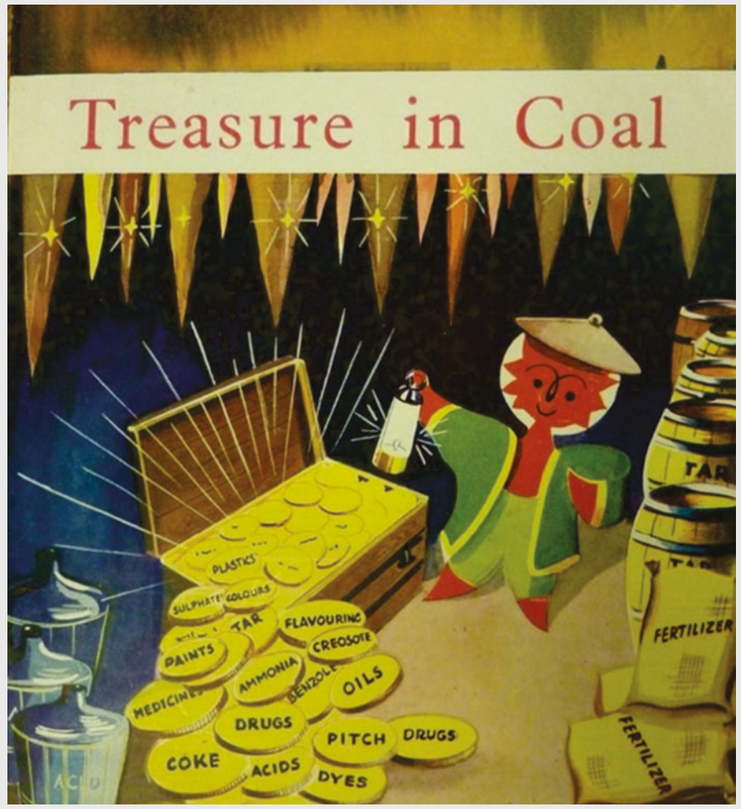


Figure 27.
Mr Therm, the gas industry mascot, demonstrating the valuable by-products obtainable from coal. Source: National Gas Archive.

The remodelling of the Great Yarmouth Gasworks and a centenary of gas

In 1919, a new engineer and manager took over at Great Yarmouth, Mr P.D. Walmsley. By 1921, he had remodelled the Great Yarmouth Gasworks and made significant improvements (Figure 28). He installed a new retort-bench, built by Guest-Gibbons with a charging (loading) and discharging (unloading) machine and a new coal and coke plant.

The retorts had been replaced with new through retorts 24ft long and 18 inches wide. A new Water Gas Plant was installed by Humphreys and Glasgow's which could be brought into action rapidly to produce 0.5m ft^3 (14,000m^3) per day to supplement coal gas production at times of high demand. A powerhouse was constructed by Keighley Gas and Oil Engine Company which contained two electricity generating sets (Figure 28). The two electricity generating sets were powered by two gas engines. A new 60,000ft^3 station meter was also installed during the works. Much of the construction work was undertaken by workers of the gas company, an added complication being that it coincided with the busy holiday season which brought the biggest demand to the business.

The new plant installed had meant that although they had carbonised over 3,000 tons (2,721 tonnes) less coal in 1922 on account of the depressed local economy, they had produced practically the same amount of gas, although the coke sold was reduced, but by only 558 tons (506 tonnes) less than in the preceding year. This figure would have been better but for the inferior coal (which produced little saleable coke) available during a miner's strike. These improvements had allowed the company to introduce two reductions in the price of gas by 1s. and potential further opportunities for reductions whilst maintaining the dividend they paid to their shareholders.

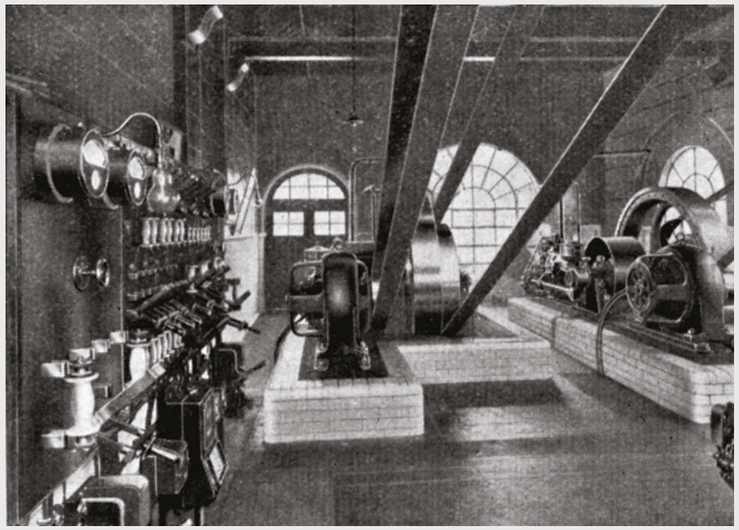


Figure 28. Powerplant installed at the Great Yarmouth Gasworks. Source: National Gas Archive.

Despite the installation of the electricity generating plant, Mr Walmsley stated his position in a speech in 1924,
"We must practise what we preach; why advocate the use of gas engines if we do not follow the practice ourselves?"

For this among other reasons, gas engines were adopted as the main electricity generating plant at the works and the power house was made a show place for potential users of gas engines. He also pushed that the gasworks should practice what it preached in adopting gas for industrial lighting within the works, using the latest incandescent flames.

A Special Order was raised in the Houses of Parliament in 1824 to enable the Great Yarmouth Gas Company to extend its gas supply to the large rural districts of East and West Flegg to the north of the town and to enable them to use scheduled land for gasworks purposes.

In 1924, the Great Yarmouth Gas Company held its centenary celebrations. The directors celebrated by holding a banquet which included representatives of the leading town people and various public bodies. The event was presided over by Mr C.S. Orde, the Chairman of the company and was supported by the Mayor (Mrs Ethel Leach) and the Deputy Mayor (Alderman R.F.E Ferrier). Among the visitors was Mr H Townsend, who had served his apprenticeship with the Yarmouth Company fifty years ago and had now retired, after an active and successful career in gas management.

Mr Orde said they could look back with much pride upon their history, which had been practically the history of gas undertakings all over the country. From small beginnings, it had become a great industry of public utility; and they might look for developments far transcending anything that had previously taken place. In 1824, the Yarmouth Company was formed by some enterprising men, only twelve years after the first statutory gas company was founded, so that Yarmouth might pride itself on being among the pioneers of the industry.

He went on to say,
"The applications of gas were not one-thousand-and-one, but two-thousand-and-one, apart from the products of carbonisation. In 1866, the capital value of the gas companies was £20,000,000; today it was £165,000,000 and if you included the non-statutory and private gas undertakings, the total value might be put at £200,000,000. In 1882, the number of consumers was something short of 2 million; whereas last year (1923), it was about 8 million. The Great Yarmouth Company was formed on 15 November, 1824, when a contract was entered into with the Paving Commissioners, whose functions corresponded with those of the present-day Town Council, for the supply of gas for public lighting. In 1845, a new company was formed for carrying on the existing contract with the Commissioners. In 1863, the company was incorporated by a Special Act of Parliament."

Mr Orde proceeded to give interesting details of the personnel of the company and the officials, recalling such well-known names as Mr W.H. Willis and Mr W.J. Carpenter. He said no better appointment could have been made than that of Mr P.D. Walmsley, their present engineer and manager. After the First World War, he carried out the re-modelling of the whole of the gasworks and the installation of up-to-date machinery. This was no mean achievement as the manufacture of gas had to go on all the time; but the policy adopted by the directors had completely justified itself.

The guest “Mr Harry Townsend”, who had been until recently the Managing Director of the Wakefield Gas Company, replied with his recollections. He said,
“that when he became associated with the Yarmouth Company in 1868, he knew nothing of gas; but he found in Mr Willis, the then Secretary, a very delightful chief who helped him in every way he could.”

He soon found a knowledge of building construction, engineering, and chemistry was required, and attended classes at the School of Art and Science on the South Quay, all the time he was an apprentice. No facilities then existed in the town for learning chemistry, and he ultimately persuaded a Master of the Navigation to form a chemistry class. To do so, he had to find a minimum of fifteen boys to form the class and he succeeded, after much trouble, in doing this. They had not an atom of apparatus, but in the following year they managed to pass the elementary stage and then went on to the advanced and honours stages.

After his time at Great Yarmouth, he moved to Yorkshire where he gradually developed his craft, learning about gasworks plant before becoming a manager of a small gasworks and then gradually working through the management of larger concerns. In the Manchester district, he met their present Engineer, Mr Walmsley, and he was sure he would bring the concern to the height of prosperity.

Mr Thomas Glover, a former president of the Institution of Gas Engineers and manager of the Norwich Gasworks also joined the celebrations, he said, “they were celebrating the beginning of a new centenary of service, rather than the past century, and they would commence the second hundred years of the industry, not bemoaning its decay; but in good health and spirits.”

The industry originated in England and was developed there at a quicker rate than in any other country, and this country had always maintained the lead. The first gas meter was made in England, and in every part of the world meters were based on the English model. He had visited Toronto, where electricity was sold at 3 cents a unit, and where there was not a gas light to be seen; yet the Toronto Gas Company each noon sent out 1.8m ft^3 of gas for cooking. Gas had found other forms of service, and had a great future; and their successors, looking back as they were doing, would say what good people they were, who kept things going during the second hundred years.”. An interesting feature of the celebration was a collection of all the various forms of gas burners which had been in use during the past century the company was in operation. The Great Yarmouth Gas Company had plans to continue growing as they had put aside £5,000 for the renewals of plant from the net profit for the year of £8,606.

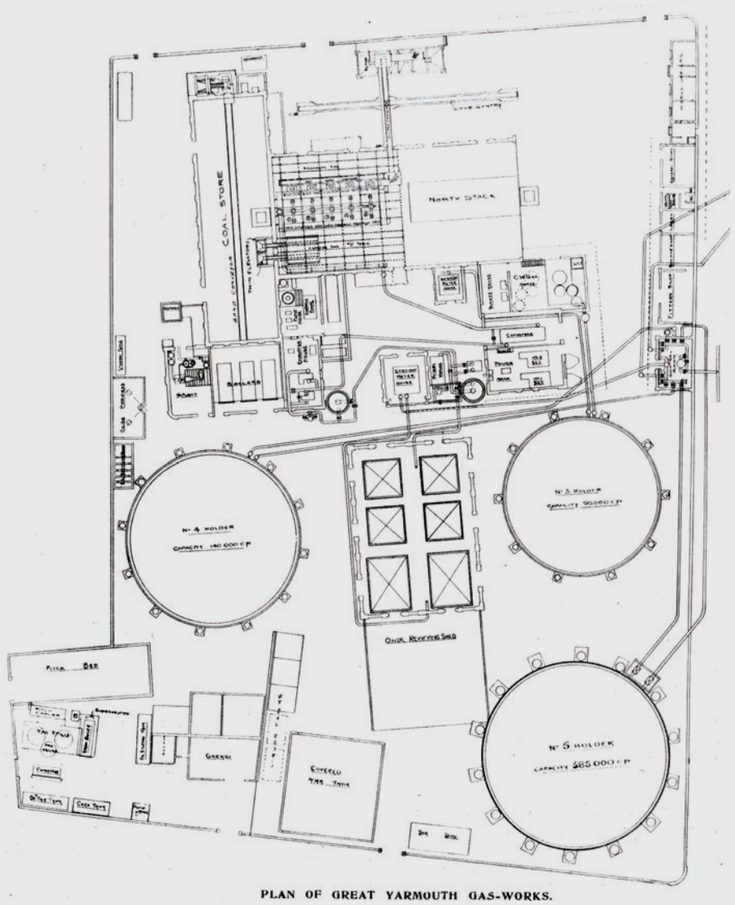


Figure 29.
The plan of the gasworks in 1923, after the new chemical works had been built on site. Source: National Gas Archive.

Number	Description
1	Presumed Early Gasholders
2	Tanks (Probable Tar Tanks)
3	Scrubber
4	Washer
5	Condenser
6	Tar extractor
7	Meter House
8	Sulphate of Ammonia plant
9	Laboratory
10	Mess Room/later CWG House
11	Hydraulic Accumulator/Pump House
12	Purifiers
13	Boilers
14	Laboratory / Later Power house
15	Office
16	Engine House
17	Stores/Workshops

Figure 30.
A plan of how the Great Yarmouth Gasworks developed, showing the principal features. Source: Russell Thomas.

The impact of the two world wars

The gas infrastructure of Great Yarmouth was impacted during both the world wars, but the gasworks at Gorleston faired much worse on both occasions.

The First World War
The Gorleston Gasworks was the first and one of the few gasworks to have been hit and damaged by German Zeppelin air raids. Firstly, during the initial Zeppelin raid flown over Great Britain on 19 January 1915 and then over a year later on the morning of 25 April 1916. This time the gasworks suffered considerable further damage during aerial bombardment, receiving about fourteen hits, of which two damaged the gasholders, setting fire to the escaping gas.

Fortunately, no lives were lost, nor were any persons injured. For his courage in putting the fires out on the two blazing gasholders, Mr William Poll, the Assistant Works Manager was awarded the British Empire Medal. The Great Yarmouth Gasworks by contrast was relatively unaffected.

The engineer and manager of the Gorleston Gasworks, Mr Edward Keable, was one of the first to provide an important service to the war effort. He installed, at the company's expense, a complete plant for the recovery of toluene from the gas, which was important in the manufacture of the explosive Trinitrotoluene (TNT). They could also recover benzole from the gas, this was used as a motor fuel in the war effort. The plant was built from materials available at the works by the company's own staff and was worked until after the end of the First World War. The plant was so effective it recovered a similar amount to that produced by larger gasworks in the country. A similar process would have been operated at Great Yarmouth.

The war caused serious labour shortages, as so many gas workers were called up during the war, with women and men over the age of 65 recruited to replace staff on military service. The women who took their places were engaged on the whole cross section of roles in the gas company, from meter reading to lamp lighting and from digging coke (Figure 31) to loading the retorts. Whilst it was not possible to find photographs of women working at either of the Great Yarmouth Gasworks, a few do survive of those at Cambridge (Figures 31) and Beckton (Figure 32).

The gas companies also provided gas to inflate barrage balloons, used to protect cities and important sites, forcing planes to fly higher to avoid hitting the balloons or the steel cables which were attached to winches on the ground. Certain gasworks such as Cambridge installed special plant to produce hydrogen, which was stored in compressed cylinders and transported to where it was needed to inflate the barrage balloons.

Figure 31.
Women digging coke from the coke heap at Cambridge Gasworks.
Source: IGEM History Panel Archive.

The Second World War
The gas industry had similar struggles in the Second World War, with the loss of staff to the war effort and the need to supply hydrogen, benzole and toluene for the war effort. However, with the development of aircraft, the threat of aerial bombardment was much greater. The Great Yarmouth Gasworks was lucky and avoided any major damage, although the gas mains were hit.

Arthur Jarrold and John Hillyard, gas main and service engineers of the Great Yarmouth Gas Company, were awarded a commendation for their bravery and devotion to duty. They had to seal a cracked and leaking gas main in the crater of an unexploded bomb which had fallen besides the Corporation Electricity Works at Great Yarmouth on 5 June 1941. This enabled the Navy to then dispose of the unexploded bomb.

Gorleston was again very unlucky in the Second World War. Its situation was best described by the Chairman of the British Gas Light Company in 1946, who then owned the Gorleston and Southtown Gas Company. He remarked,

"I must further single out for special mention Gorleston and Westgate. Both were persistently subjected to the great strain of the 'tip and run' raider. At Gorleston we did suffer some severe damage in that we had a direct hit on our vertical retort house which prevented us from making any gas there for six months, and we lost our largest holder as well as the foreman's house, laboratory and testing station; there was also the usual damage to mains on the works and district. Fortunately, when the retort house was hit, we were able to make arrangements for a supply of gas in bulk into our holders from the works of the Great Yarmouth Gas Company. This necessitated laying a supply main in a tunnel under the river, and putting in a boosting plant in connection therewith, all of which work was done, and we were ready to take the supply before it could be given, since our friends at Yarmouth had to put on additional plant for our needs."

Following the end of the Second World War, the gas industry was in a poor state. It had lacked investment and lost many skilled staff. Many of the gas undertakings were unprofitable and the need for restructuring highlighted in a review undertaken by Sir Geoffrey Heyworth. It suggested that the industry should be split into larger regional businesses which could provide gas more economically.

Figure 32.
Shovelling coke at the Beckton Gasworks.
Source: IGEM History Panel Archive.

Nationalisation and the move away from coal under the Eastern Gas Board

Nationalisation brought all the gas undertakings in the Eastern Region under the ownership of the Eastern Gas Board. Most of these gas undertakings operated independently and many were very small and barely profitable. The Eastern Gas Board was split into 5 areas, Norwich, Cambridge, Ipswich, Watford and Tottenham. Great Yarmouth became part of the Norwich group.

Following the nationalisation, one of the key objectives was to rationalise the broad array of different sized gas undertakings within the region into large and more economic business units.

This was a particular problem for the Eastern Gas Board, as it primarily covered a very rural area, made up of small towns and villages. Within the Norwich district, there were a few larger towns (e.g. Great Yarmouth and King's Lynn) in addition to the city of Norwich, but most of the undertakings were small and some distance apart, as can be seen in Figures 34 and 35. The Eastern Gas Board had to gradually connect adjacent rural towns via new pipelines to the larger and more cost-effective gasworks.

That process was easier in the south where regional networks had already existed around Tottenham and Watford, with only a slight expansion required. To the west, the Cambridge area had largely been connected by 1959, as had the Ipswich area to the southeast. The Norwich area, in which Great Yarmouth was located, still had many unconnected gasworks such as Great Yarmouth. Gorleston across the River Yare had been connected to Lowestoft and a pipeline been built from Chelmsford to Leiston which had connected most of the Ipswich area.

Investment went into the construction of new gas making plant and new gasholders at the larger gasworks in the region. This helped to minimise the cost of making gas and would aid the growth of the industry. The gas mains were also replaced and, in many areas, extended to new suburbs or villages.

By the 1950s a high-pressure gasholder had been built on Caister Road in the north of the town (Figure 36). This had the appearance of a large horizontal cylinder with domed ends. It would have been supplied from the gasworks, with the gas compressed in the cylinder at high pressure. These high-pressure gasholders were typically used to supply more spread-out rural areas through narrow gas pipes at higher pressure than typically used within the towns. This saved the cost of building the gas network, avoiding the more expensive larger pipes used.

Figure 33.
The branding of the Eastern Gas Board and later Eastern Gas. Source: IGEM History Panel Archive.

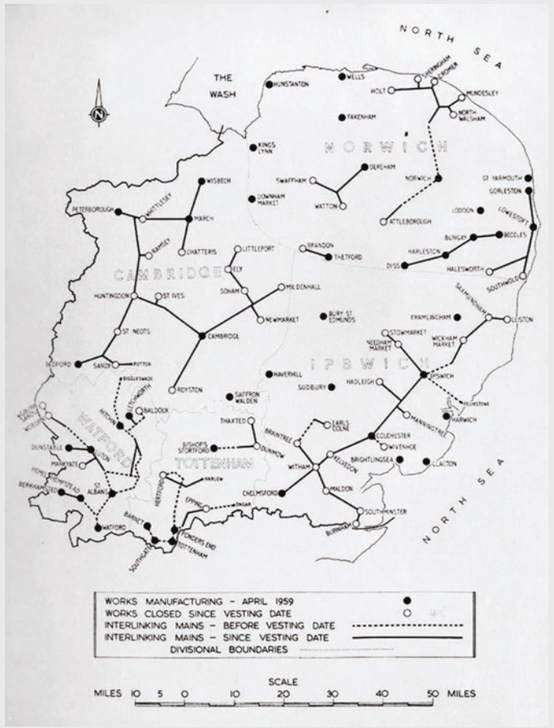


Figure 34.
A map of the Eastern Gas Board region in 1959.
Source: National Gas Archive.

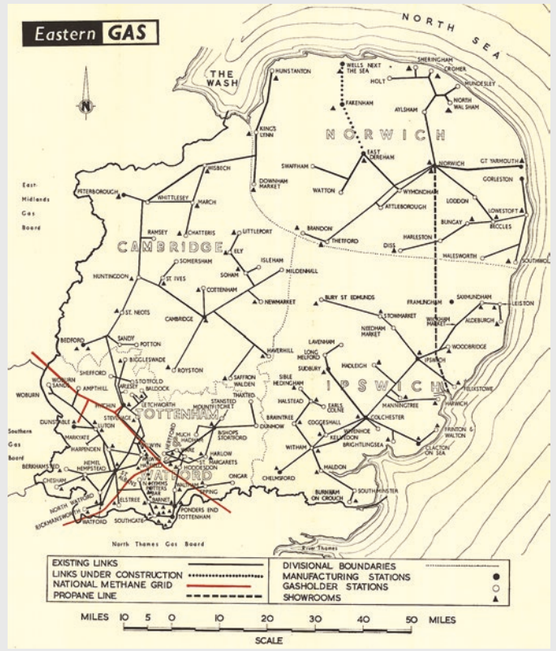


Figure 35.
Map of the Eastern Gas Region in 1965.
Source: IGEM History Panel Archive.

The 1950s started to see the marked decline in the availability and quality of gas-making coal, the main feedstock for gas production. This posed a gloomy future for the gas industry. At the start of the 1960s Britain was still producing 90 per cent of its gas from coal, however, this decade would see the gas industry experience great change. The industry turned to innovation to find answers, new research to develop more effective ways of using poorer quality coal or using the by-products of the oil industry as potential feedstocks for gas making. At the time, oil refineries in Britain had cheap by-products which could be converted into gas through a process called gas reforming.

The Gas Council's Midlands Research Station in Solihull pioneered much of the research. Dr Dent's research had looked at adapting the German Lurgi process for the gasification of the type of low-grade black coals found in Britain. This led to the construction of a full-scale Lurgi plant at Coleshill (and another in Scotland at Westfield). Alongside the Lurgi process, an ICI reforming plant of similar production capacity was built, which could make gas from refinery by-products. The reforming plant proved to be much more cost effective than the Lurgi gas plant, which had been identified as the only feasible option for future gas making from coal. The economic advantages of gas manufactured from the reforming of petroleum feedstocks marked the beginning of the end of production of gas from coal.

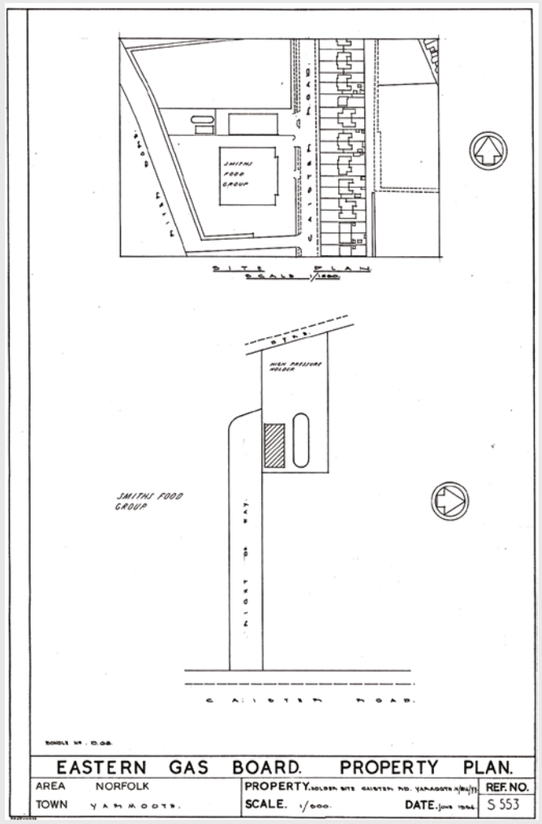


Figure 36.
A plan showing the Caister Road Gasholder.
Source: IGEM History Panel Archive.

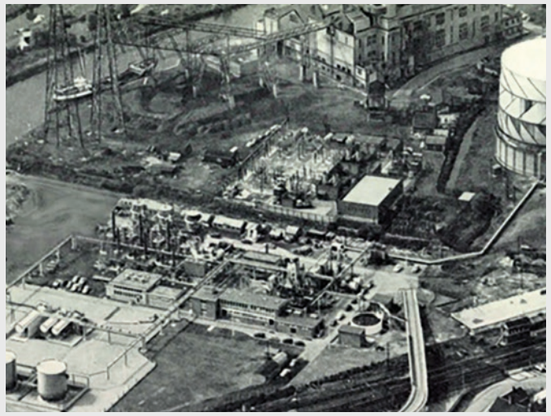


Figure 37.
An aerial photograph of the Cremorne Lane Gasworks.
Source: National Gas Archive.

By 1965 Great Yarmouth had been connected to the Norwich gas network (Figure 35). In 1962, a new gasworks had been built at Cremorne Lane in Norwich (Figure 37) which was making gas from naphtha and the liquefied petroleum gas (LPG) butane, using "Otto" gas reforming units. This was initially transported by road from the Fawley refinery in Hampshire. Additional "Otto" gas reforming units were built and a 48-mile pipeline constructed to transport LPG propane gas from a big storage tank on the coast at Felixstowe (Figure 38), to the site.

In 1964, a LPG/air plant was installed at Great Yarmouth. This small plant could help make a gas compatible with town gas to meet times of peak demand, especially in the peak summer holiday season.

With the adoption of gas reforming as the way forward, the Eastern Gas Board proceeded with the construction of plant which produced gas from refinery by-products, such as the Cremorne Lane Gasworks in Norwich and a smaller plant at Thetford. Large new gas reforming plants were built in the south of the Eastern Gas Board Region at Hitchin (Figure 39), Watford and Chelmsford.

A high-pressure gas supergrid (Figure 40) was then built from the three principal gasworks in the south of the Eastern Region (Hitchin (Figure 39), Watford and Chelmsford) to Norwich and King's Lynn. Each of these gasworks had a supply of natural gas from the National Methane Pipeline, which is discussed later.

Figure 38.
The propane storage tank built at Felixstowe, which supplied Cremorne Lane Gasworks at Norwich.
Source: IGEM History Panel Archive.

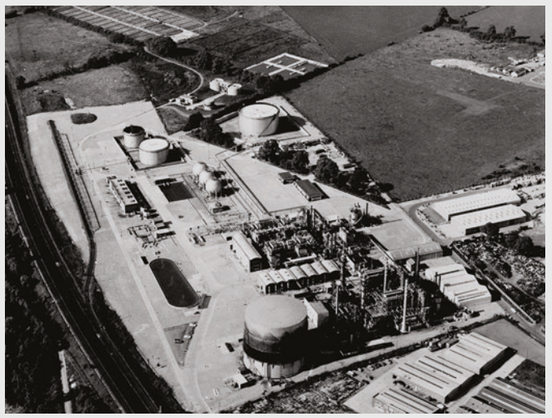


Figure 39.
The reforming plant at Hitchin.
Source: IGEM History Panel Archive.

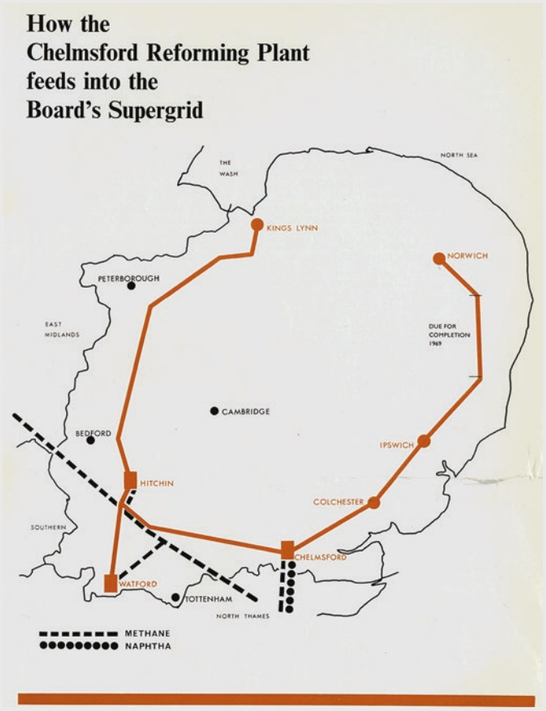


Figure 40.
The Eastern Gas Board Supergrid, showing the manufacturing stations and the extent of the supergrid.
Source: IGEM History Panel Archive.

The transition to a natural gas future

Following visits to other countries which were starting to use natural gas in the 1950s, the Gas Council requested that the neighbouring North Thames Gas Board look at how natural gas could be imported into Britain. This resulted in the development of natural gas being imported in a liquid form as liquefied natural gas (LNG). To liquefy natural gas, it must be cooled down to -162°C at atmospheric pressure by refrigeration.

Working with American organisations who had been developing the use of barges for shipping LNG on rivers, a small ex Second World War Liberty freighter was refitted to become the "Methane Pioneer". The first imports of natural gas to the UK were trial cargoes of LNG from Lake Charles in the USA, carried by the Methane Pioneer. These loads were received at a specially built terminal at Canvey Island, Essex and were the world's first ocean-going cargoes of LNG and led to the creation of today's global LNG industry.

The success of this trial led to the regular import of LNG from Port Arzew on the northern coast of Algeria from 1964. To distribute these new significant volumes of imported natural gas, a cross-country transmission pipeline was constructed from Canvey Island (Figure 41) in Essex to Manchester and Leeds, known as the National Methane Pipeline. It had connections to eight of the regional gas boards, including the Eastern Gas Board at Hitchin, where a new gasworks had been built to convert LPG and natural gas into town gas.

The National Methane Pipeline would become the first part of the National Transmission System (NTS) for gas. The NTS has since expanded significantly and is an essential part of delivering and storing gas in Britain.

Figure 41.
The Canvey Island Gas Terminal.
Source: IGEM History Panel Archive.

The use of reforming to produce town gas provided a stop-gap supply of gas. The discovery of significant natural gas reserves in the North Sea in the 1960s saw enough reserves to meet all existing demand at the time. Whilst imported LNG had previously been reformed into town gas, in 1966, the Chairman of the Gas Council, Sir Henry Jones, formally announced that Britain was switching to North Sea natural gas (Figure 42) and the manufacture of gas would gradually be phased out, with all gasworks planned to close.

Conversion between two gases of different properties was a major undertaking as the appliances being used by domestic, commercial and industrial customers had to be converted to burn the new gas or replaced. This required the largest engineering feat undertaken in Britain since the end of the Second World War. Known as the 'conversion programme', it required the physical conversion of every gas appliance in the country. This whole programme would take 10 years across the whole of Great Britain. With the work split into phases and the gas network being split into sectors which could be switched from one gas to the other over a 5-day period.

The initial pre-conversion included the replacement of the gas meter where required, the addition of a filter and governor to the incoming gas supply pipe, which would then be pressure tested to ensure it was safe for conversion. Following this, a survey of the appliances used in the premises would be made, so suitable conversion kits could be ordered or new appliances purchased at discount rates which would have been easy to convert. Customers could visit the local gas board showrooms in Great Yarmouth (Figure 43).

Figure 42.
The Orion drilling platform.
Source: National Gas Archive.

Figure 43.
The Eastern Gas showrooms Great Yarmouth c1970s.
Source: IGEM History Panel Archive.

The conversion operation, which would take a week, would involve disconnecting the gas supply from each premises, burning off the town gas and then pumping in natural gas. Once complete, gas fitters would start to enter premises and change the burners on appliances so that they could burn the new gas.

The Eastern Gas Board area would be crossed by numerous feeder pipelines, forming part of the National Transmission System for gas, emanating from the Bacton Import Terminal and distributing the gas to Southern England and the Midlands.

The Eastern Gas Board was converted between April 1968 and November 1974, starting in Hitchin, Hertfordshire and finishing in Harpenden, Hertfordshire. They converted 896,000 domestic customers, 19,700 commercial customers and 4,000 industrial customers from town gas to natural gas. The very last gasworks in Great Britain, in Millport on the Isle of Cumbrae, ceased production in 1981.

These developments led to amendments to the organisational structure of the gas industry. Halfway through the conversion programme, the Gas Act of 1972 abolished the Gas Council and the British Gas Corporation was formed which assumed control of the 12 Area Boards. This centralised the gas industry into a single business, although the regional structures were retained with the Eastern Gas Board changing to the Eastern Gas Region (Figure 44) of the British Gas Corporation.

The gasworks became surplus to requirement and were decommissioned and demolished; this same fate was met by most gasworks in the country, Fakenham in Norfolk being the only one to survive in England.

The gasholders were retained at the works to provide gas storage. These have gradually been removed through a programme of work ever since. Protected examples in the east of England, such as the gasholder frame at Great Yarmouth and the smaller gasholders at Fakenham and Lavenham, have survived.

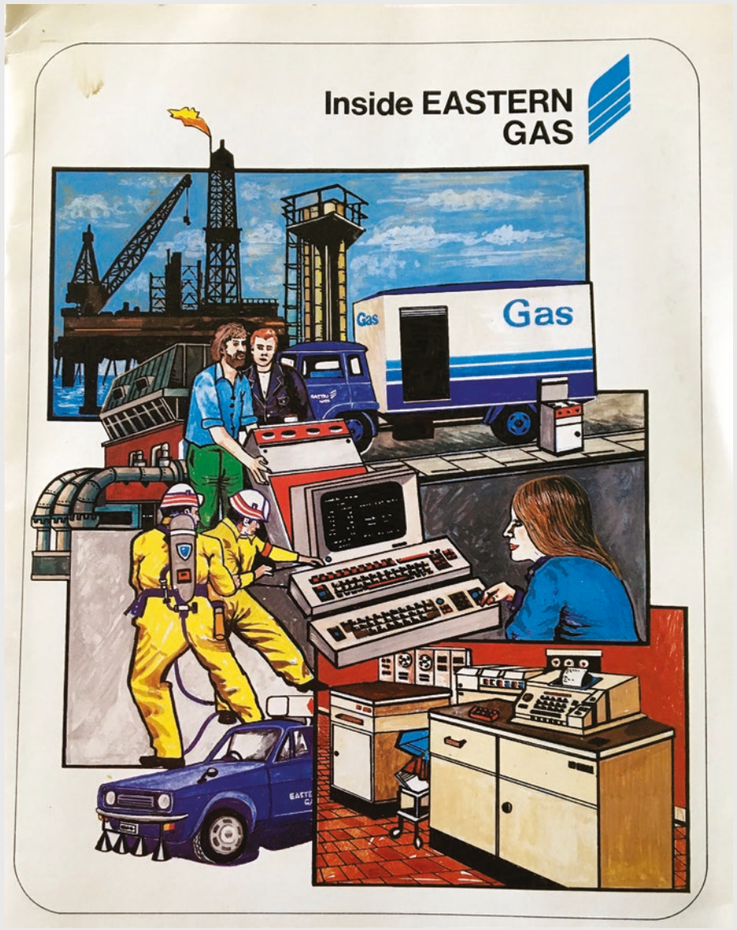


Figure 44.
Brochure for Eastern Gas, with the British Gas logo visible. Source: National Gas Archive.

Today

A sense of community

As the community relations work at Great Yarmouth has shown, the former gasholder is still very much in the collective memory of the local community.

This is not surprising as the gas industry has operated in Great Yarmouth for over 200 years, a long legacy by any stretch of the imagination. Gas had been used to light the promenade and the principal streets of the town for about 100 years and even the local silk mill, once a major employer in the town, had its own private gasworks. Being divided by the river, each side had its own gasworks. The area surrounding the gasworks had long been an industrial and commercial neighbourhood, with the ornate and soon to be restored gasholder standing over it. The ornate listed former gas offices and showrooms still stand on King Street in the town centre. These are all a lasting reminder that although Great Yarmouth has long been an important holiday resort, there had to be industrial activities such as gas and electricity production in the background, keeping all the holiday makers warm, well fed and the streets safe and well lit.

Cultures of the old and new very much clashed in October 2021, when street artist Banksy created a number of murals in the town as part of his “A Great British Spraycation.”. Adjacent to the old gasholder, a mural known as “Dancers on a bus shelter” was spray painted on the side of a house on Admiralty Road (Figure 45). The listed gasholder is now evolving, the water tank and the lifts which stored the gas are being removed. This will allow the ornate frame to be restored to its former glory and the land to be safely returned to beneficial use.

During the demolition of the gasholder tank and refurbishment of the gasholder frame, an information board has been placed on the wall of the old gasworks (Figure 46) and community visits have been organised. Interesting elements of the tank and crown have been recovered and donated to museums and community groups.

Figure 45.
Robert Paulson Spice’s gasholder and the Banksy mural. Source: Mike Glyde.

An energy transition and a changing landscape

The type of fluctuating diurnal storage that this gasholder once provided in Great Yarmouth has now been met by alternative means and this gasholder has long been surplus to requirement. Times of peak demand for gas are now being met by increased storage capacity in the gas transmission and distribution pipelines, in a process called line pack.

While the legacy of the gas industry in Great Yarmouth will be symbolised by the surviving gasholder frame, the gas distribution infrastructure is still operating out of sight. The gas industry has evolved into a segmented industry, consisting of North Sea gas producers; a National Transmission System for gas operated by National Gas Transmission; regional gas distribution companies, such as Cadent Gas who distribute gas in Great Yarmouth and eastern England, and energy suppliers who sell gas to customers.

Large LNG importation facilities, such as that operated by National Grid on the Isle of Grain in Kent, help supplement gas supplies from the North and Irish Seas and those imported from the continent through underwater interconnector pipelines.

The adjacent gas resources from the North Sea have played an important part in powering the country since the mid 1960s. Now the growing importance of renewable energy, such as the Scroby Sands Wind Farm site just off the coast of Great Yarmouth (Figure 47), are providing an ever-increasing amount of our electricity supply.

Gas fired electricity generation provides an important back up to supplies of renewable electricity when there are lulls in wind or solar powered electricity generation. New alternative forms of gas, such as biomethane, are being utilised and the potential remains for hydrogen gas to play its part in the future.

Suggested further reading

- Thomas R A P, The Manufactured Gas Industry, Volumes 1 to 5, Historic England, 2020.
- Gasholders, a History In Pictures, Liverpool University Press, 2024.

Figure 46.
The base of the gasholder tanks and information board on Admiralty Road.
Source: Ben Raine.

Figure 47.
The gasholder on the landscape with the Ferris wheel and Scroby Sands Wind Farm behind.
Source: Geoffrey Frost.

Figure 48.
A map of the gas sites in Great Yarmouth.
Source: Russell Thomas.

A brief description of the gas manufacturing process

Unlike natural gas, which is extracted from underground reservoirs, manufactured gas was produced from coal or oil heated within a sealed vessel called a retort. Retorts similar to those which would have been originally used in the gasworks in Great Yarmouth are shown in Figures 49 and 50.

The coal used to make the gas can be seen on the retort house floor in Figure 49. The retort was a long circular or D-shaped chamber with a mouthpiece containing a door on the front into which the coal was thrown. The retort was then heated by a furnace beneath the retort, releasing gas and leaving behind coke. The gasworks was a very difficult working environment, it required strength, stamina and skill to throw coal into the retorts and to remove the hot coke with a rake as can be seen in Figure 50. These images would have been similar to the early gasworks built in Great Yarmouth.

Figure 49.
The stoker and horizontal retorts at the small former gasworks at Robin Hood's Bay, Yorkshire.
Source: IGEM History Panel Archive.

With the retort door shut and sealed, air could not enter. As the coal was heated, the absence of a supply of oxygen in the air meant the heated coal did not burn. Instead, the moisture in the coal was driven off and the large organic molecules were broken down by the heat into smaller and smaller molecules. This produced flammable gases such as methane, hydrogen and carbon monoxide. Other substances were also produced, such as water vapour and impurities such as ammonia, hydrogen sulphide and hydrogen cyanide. In addition, there were also larger organic compounds that formed the oily, tarry impurities in the gas which could block the pipes.

Leaving the retorts, the gas passed up the ascension pipes and through the hydraulic main, which acted as a water seal to prevent the gas flowing back into the retorts. The hydraulic main also cooled the gas and removed some of the oil and tar. The gas then passed via the foul main to the condensers, which further cooled the gas, removing most of the tar and oil vapours from the gas.

The gas was then drawn into a pump called an exhauster. This then pushed the gas through the tar washer, removing any remaining tar trapped in the gas. The gas then passed through further washers and scrubbers; these used water to wash the gas to remove soluble compounds such as ammonia and phenol, which, when dissolved in the water, formed ammoniacal liquor. Both the coal tar and ammoniacal liquor were drained to below-ground tanks or wells for storage.

Figure 50.
Removing hot coke from the retorts.
Source: National Gas Archive.

The gas then continued its journey through the purifiers. These were large rectangular iron boxes that contained wooden racks onto which granular lime or iron ore were placed. These substances removed both sulphur and cyanide compounds from the gas. If these were not removed, they could produce toxic gases when burnt. These gases would also corrode the gas fittings and damage the furnishings in a house.

The gas would then be passed through a benzole plant which stripped volatile organic substances from the gas, such as benzene and toluene. These were used in early forms of motor fuel and for the manufacture of explosives. Both were particularly important during the First and Second World Wars, where motor fuel and explosives were both important.

The treated gas, sometimes called town gas, was measured using a station gas meter and would then be stored in the large gasholders, such as the remaining one in Great Yarmouth. The gasholders allowed the gasworks to keep a surplus of gas ready for times of peak demand such as Sunday lunchtime. The gas was then distributed to customers through gas mains beneath the streets. After the gas-making process was complete, the coke which remained in the retort was removed (Figure 50) and either shovelled into the furnaces or cooled by dousing with water. The coke was sold to industrial or domestic customers for heating purposes. Retorts were later developed which had a mouthpiece and door at each end, these were called ‘through retorts’. They allowed the processes in a gasworks to be mechanised.

When the new gasworks was built in Great Yarmouth, the horizontal retort house was gradually mechanised with special machines which moved coal from the coal store to the retort house and loaded and unloaded coal from the retorts as can be seen in Figure 51. These machines reduced a lot of the labour involved in moving the coal and coke.

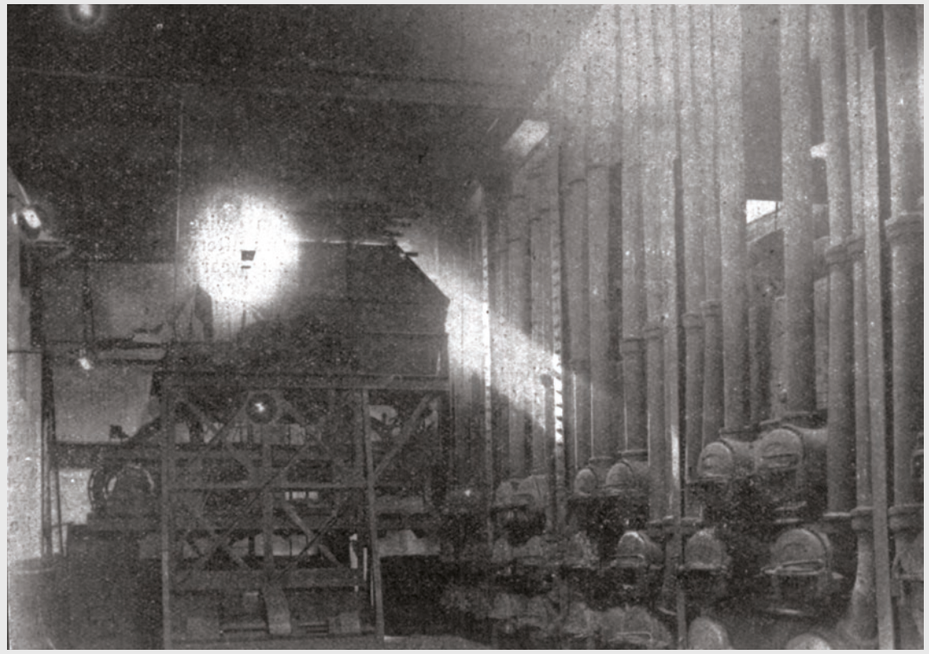


Figure 51.
Guest-Gibbons charging and discharging machine at the Great Yarmouth Gasworks. Source: National Gas Archive.

The gasworks at Great Yarmouth continued to use horizontal retorts throughout its operation. The Gorleston Gasworks originally used horizontal retorts, which were replaced by vertical retorts constructed in 1929. An illustration of these continuous vertical retorts installed by Woodall-Duckham is shown in Figure 52.

Vertical retort plants operated with the coal being fed by gravity down the retort, which was set in a vertical position. The coke produced by the process was extracted at the base of the retort. This replaced the complex charging and discharging equipment required in horizontal retorts. It also allowed the process to operate on a continuous basis and the design of the system allowed it to be enclosed so less atmospheric pollution was emitted.

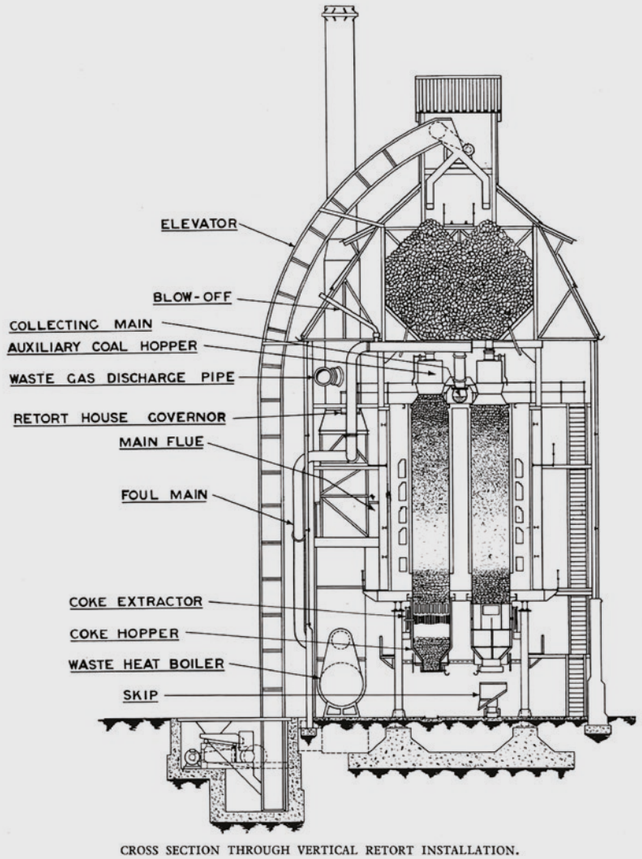
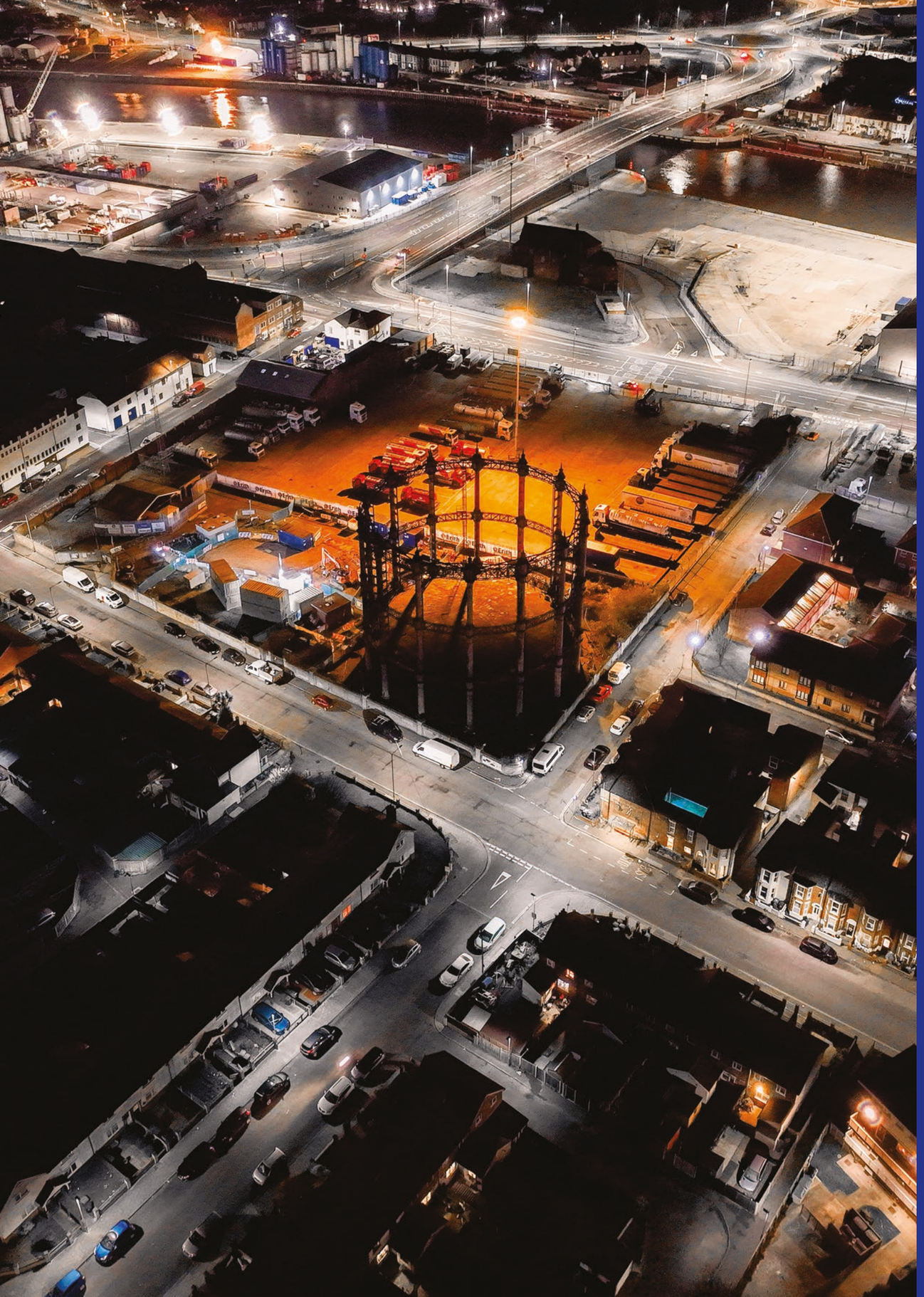


Figure 52.
A drawing by Woodall-Duckham of the installation of continuous vertical retorts at Gorleston. Source: IGEM History Panel Archive.



National Grid plc
National Grid House
Warwick Technology Park
Gallows Hill
Warwick CV34 6DA
United Kingdom

nationalgrid.com

May 2025. WPA/DP