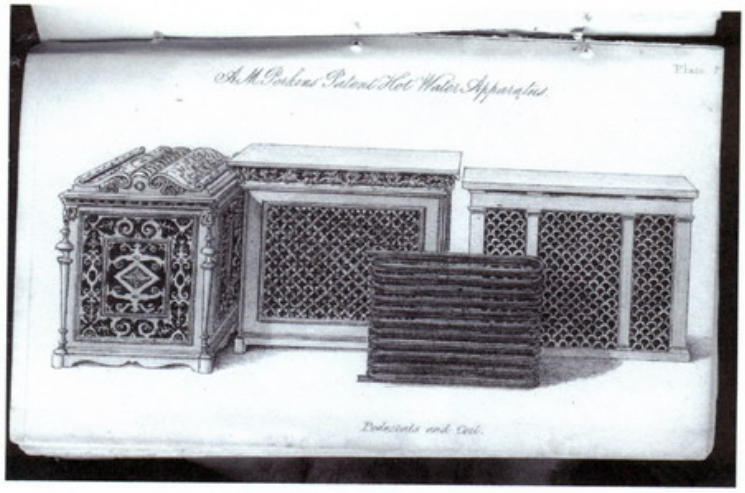
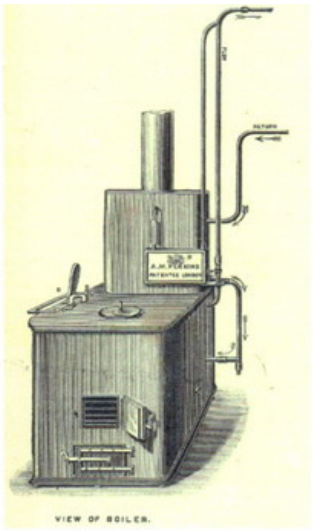


High-pressure hot water heating coil & decorative coil cases or pedestals
[Patent Apparatus for Warming and Ventilating Buildings, A M Perkins, London, 1840]

Perkins high-pressure hot water heating coil
Church of St Mary, East Brent, Somerset

Perkins high-pressure hot water heating coil
Church of St Thomas à Becket, Northaw, Herts



Perkins high-pressure hot water boiler, patented 1831

Perkins boiler in brick setting converted to oil-firing and still in use. Church of St Michael & All Angels, Bampton, Devon

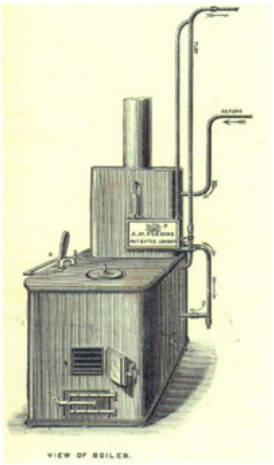
Perkins' High Pressure Hot Water Heating

Angier Marsh Perkins was born in Massachusetts in 1799. He accompanied his father, Jacob, to England in 1819. Jacob secured a number of patents relating to boilers and steam engines (and went on to patent a closed-cycle refrigeration machine in 1834). Meanwhile, Angier developed a sealed high-pressure hot water heating system utilizing small diameter piping developed by the firm of John Russell & Son of Staffordshire in 1825. This was a radical alternative to the other heating sytems then in use. In 1831, A M Perkins secured a patent (BP 6146) for this system. He used 25 mm tube (seam-welded wrought iron) with a 6 mm wall thickness and a furnace apparatus designed to maintain about 350° F, though this sometimes reached a dangerous 550°F and an unacceptably high pressure. These tubes were tested before installation to 3000 lb/in^2 gauge, but were known to fail at lesser pressures. Tubes were in lengths of about 12 feet. Right and left-hand threads were used to pull the chamfered edge of one tube into the square-cut flat end of the other to make a joint.

In Perkins' first furnaces about one-sixth of the total tube length was arranged in a sinuous coil inside a brick combustion chamber lined with firebrick. The remainder, apart from the circulating pipes, was formed into coils, either free-standing or located inside pedestals (decorative cases). By 1840, the furnace tubes were available within a metal-cased Perkins boiler, but the brick setting arrangement appears to have been widely used, as it was probably cheaper. The high-pressure hot water system also required a governor (heat regulator) an expansion tube and air plug, and various suitable stopcocks and valves. A detailed description is available in Jones (see Further Reading).

Perkins went on in 1839 to develop a medium pressure system using a water supply cistern containing a relief valve in place of the expansion tube (BP 8311). This overcame most of the objections to the very high and dangerous temperatures and pressures used in the original system. It appears not to have been extensively used at that date, but was later copied by a number of other firms who made a speciality of this system. In 1840, Perkins published his book *A M Perkins' Improved Patent Apparatus for Warming and Ventilating Buildings.* In it he lists numerous examples of installations in public buildings (including churches), private mansions, hot houses, manufactories and offices.

The temperatures and pressures of the high-pressure system greatly concerned the fire insurance companies who eventually raised their premiums to a level where new systems were rarely installed. Many continued in use, particularly in churches, well into the 20th century. Sometimes the furnace was upgraded to oil-firing. More generally the furnace was replaced and the existing piping and pedestal coils retained to warm the building.



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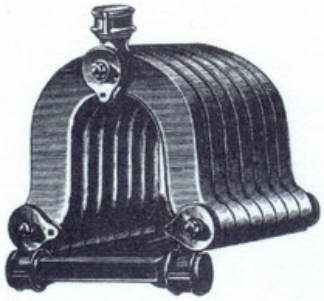
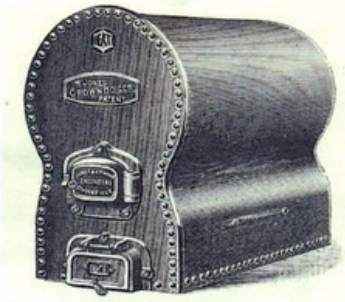
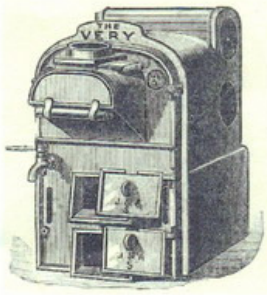
Hartley & Sugden, Gold Medal Boiler catalogue, Atlas Works, Halifax, 1872



Wagstaff sectional saddle boiler, 1874



Jones & Attwood Crown boiler, 1904



Jones & Attwood Very boiler, 1894

Hot Water Boilers

Although Britain pioneered the steam engine and the steam boiler, the use of steam for heating in other than factories was comparatively rare. Hot water heating is said to have been introduced into Britain from France c.1816, but the Price Bros of Bristol seem to have been largely responsible for its spread. They secured a patent (BP 5833) in 1829 for their system.

The first hot water boilers were smaller and cruder than steam boilers. A high-pressure hot water heating boiler and system was patented by A M Perkins in 1831, but this was an exception as most heating systems were low-pressure type (open to atmosphere) with the water temperature below boiling point. S T Crook (some say Cook) discovered "fire-welding" in 1854 and opened his Premier Works in Halifax in 1863. Yorkshire soon became a centre for the production of heating boilers. The majority were hot water type; a few were for steam heating.

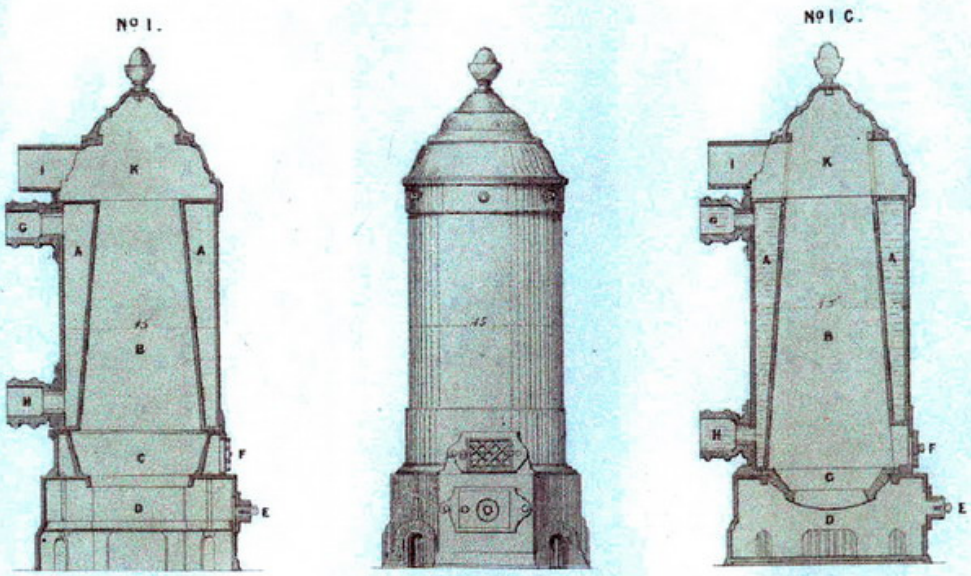
Early firms manufacturing boilers in Yorkshire include:

Graham & Fleming, Premier Works, Halifax (1863), successors to S T Crook's Exors
Lumby, Son & Wood at the West Grove Boiler & Safe Works, Halifax (1858), trade name *Solar*
Robert Jenkins, Rotherham (1856), trademark *Ivanhoe*
Hartley & Sugden, Atlas Works, Halifax (1867), trademark *White Rose*
Binns & Speight, Crown Boiler Works, Bradford

PLATE I

INDEPENDENT CYLINDER BOILERS

With Cast Ashes Box, Top Rim and Cover; fitted with Flow and Return Pipes, complete.



No 1, SECTION

ELEVATION No 1, & 1.C.
3 Feet 6 in. High
4 Feet High.

No 1. C, SECTION

Reference.

A. Water Space in Wrot Boiler
B. Inside Tube for Fuel
C. Fire Dish and Bars
D. Cast Ash Box
E. Ash Box Door & Air Vent
F. Fire Door
G. Flow Pipe
H. Return Pipe
I. Smoke Flue
K. Cast Top Sand Rim & Cover

Reference.

A. Water Space in Wrot Boiler
B. Inside Tube for Fuel
C. Fire Dish and Bars
D. Cast Ash Box
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F. Fire Door
G. Flow Pipe
H. Return Pipe
I. Smoke Flue
K. Cast Top Sand Rim & Cover

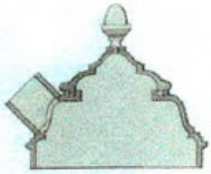
W. I. WX

Lumby Independent Cylinder hot water heating boiler, Halifax, 1861

PLATE 3.

LUMBYS IMPROVED PORTABLE CONCENTRIC SADDLE BOILER.

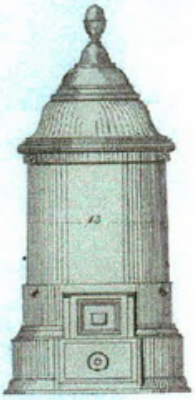
with double sliding Fire and Ashes Pit Doors, Fire Brick Flues & Lining, Flow and Return Sockets, Flue Doors & Damper, Dead Plate & Fire Bars complete; comprising all the advantages of the ordinary Saddle Boiler without requiring any brickwork or setting, giving the largest possible heating surface & power and thereby greatly economizing both Fuel & Room.



See Plate. I.

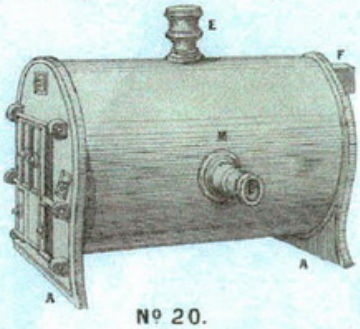
INDEPENDENT CYLINDER BOILER

With Cast Ashes Box, Top Rim and Cover, fitted with Flow and Return Pipes, complete.

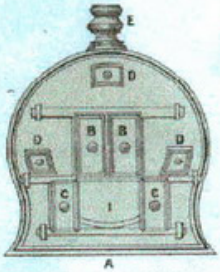


N° 1 B.
2 Feet 8 in. High.

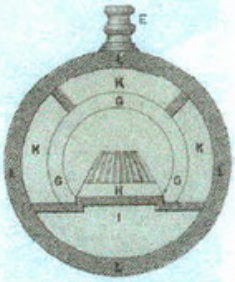
F. L. HX



N° 20.



N° 20 END ELEVATION

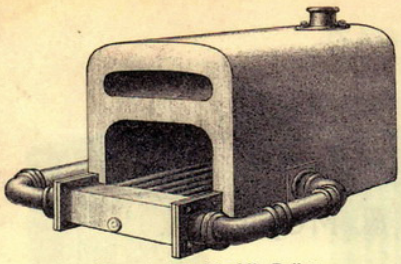


N° 20 END SECTION

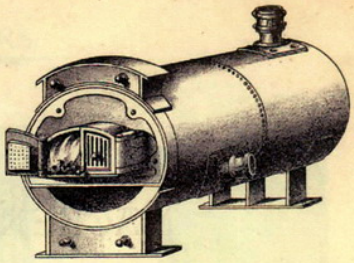
Reference.

A	Cast Frontage & Back Plate	C	Wrought Welded Boiler
B	Sliding Furnace Doors	H	Furnace Bars & Dead Plate
C	D° Ashes Pit D°	I	Ashes Pit
D	Flue Doors	K	Flues
E	Flow & Return Sockets	L	Fire Brick Lining
F	Smoke Flue & Damper	M	Iron Boiler Case

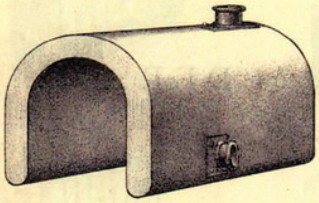
Lumby Independent Cylinder boiler & Improved Concentric Saddle hot water heating boiler, Halifax, 1861



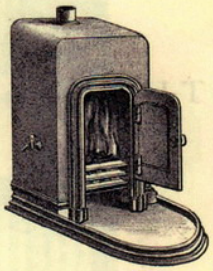
Terminal End Saddle Boiler
with tubular water bars



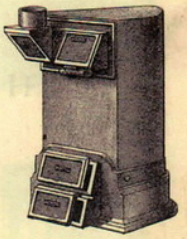
Cornish Boiler



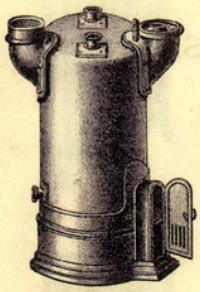
Plain Saddle Boiler



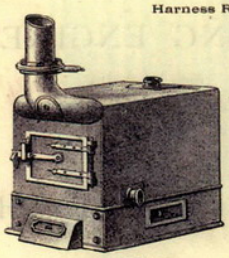
Harness Room Boiler



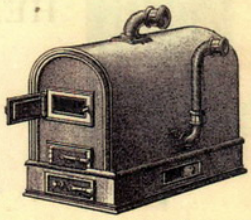
Finsbury Boiler



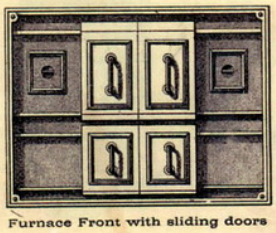
Dome-top Boiler



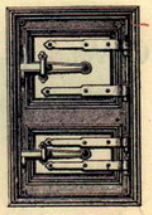
Beeston Boiler



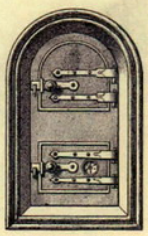
Independent Saddle Boiler



Furnace Front with sliding doors



Double Door and Frame
square top

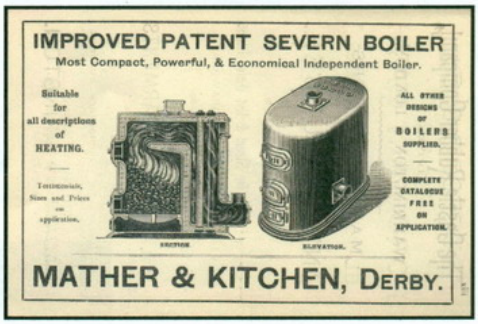


Double Door and Frame
arched top

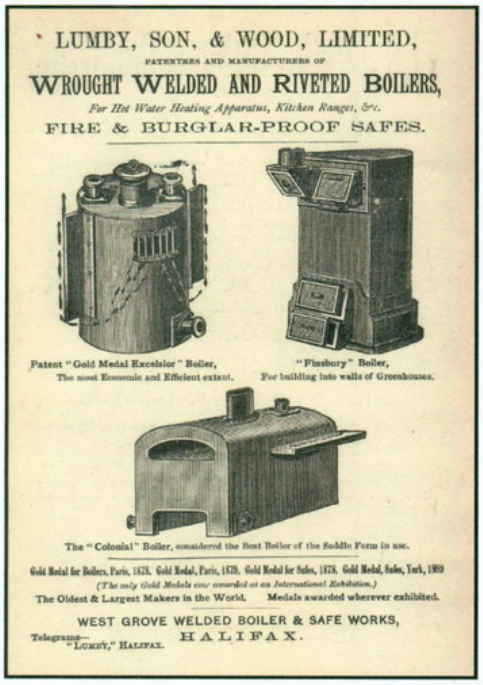
J. Melville & Sons Leith Edinr

MACKENZIE & MONCUR, EDINBURGH, GLASGOW, AND LONDON.

Graham & Fleming, Halifax, 1894
Established 1854



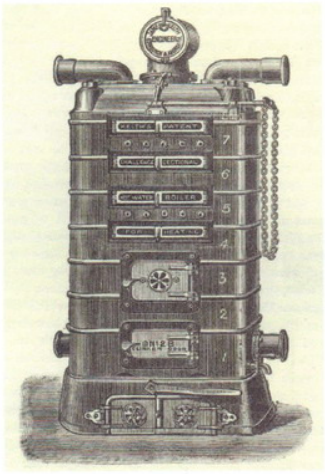
Mather & Kitchen, Derby, 1894



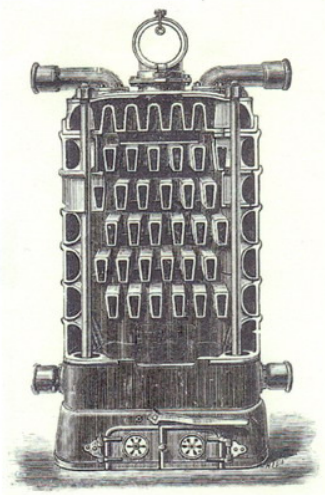
Lumby, Son & Wood, Halifax, 1890
Established 1858

Robert Jenkins, Rotherham, 1891
Established 1856

Opposite
Mackenzie & Moncur, Edinburgh, c.1900



James Keith horizontal section
hot water heating Challenge boiler, 1891
Horizontal sections are unusual



Cut-away view Challenge boiler

Lumby hot water service boiler, c.1900
discovered at Kingston Lacy

Jones & Attwood hot water Pot boiler, c.1890
discovered at Tyntesfield

Beeston Robin Hood domestic boiler [Thomas Potterton, 1933]

Ideal Domestic hot water boiler

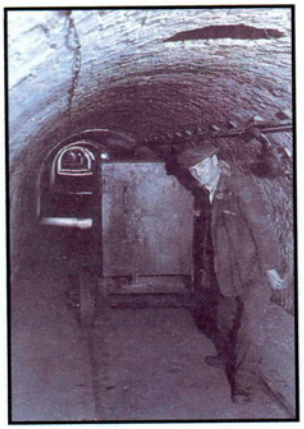
The Institution of Heating & Ventilating Engineers (now CIBSE) was founded in 1897 and by 1900 had nearly 200 members; today there are some 15,000. In 1897, Kelly's Directory listed over 600 firms as Heating Apparatus Manufacturers and Fitters. The most prominent manufacturers included:

The Beeston Foundry Co, Beeston, Notts
T Fletcher & Co, Warrington
The General Iron Foundry Company, Broken Wharf, London
William Graham & Sons, Castle Yard, London
Jones & Attwood, Titan Works, Stourbridge
James Keith, Holborn Viaduct, London
Kinnell & Co, Southwark, London
Mather & Kitchen, Derby
Thomas Potterton, Cavendish Works, Balham
J Ashton Riley, Canal Boiler Works, Huddersfield
Steven Bros & Co, St Andrew's Wharf, London
Weeks & Co, Kings Road, Chelsea, London
T C Williams & Sons, London Street Ironworks, Reading

From around 1890, H Munzing of Upper Thames Street, London, who styled himself "American Merchant," was a major importer of both hot water and steam boilers from the USA.

One of the earliest, possibly the first, sectional boiler (i.e. made and delivered in sections for site assembly) was Wagstaff's saddle type of 1874. Another early and unusual boiler was the *Challenge* by James Keith, which had horizontal sections (this had the disadvantage that the grate area was constant regardless of height). Hartley & Sugden produced a sectional boiler, the *European,* in 1902. American imported sectional boilers were superior at this time and used taper nipples instead of rubber rings for jointing. British firms quickly adopted this practice, one of the first such cast-iron sectional boilers being the *Robin Hood* of Beeston. The first American company to set up a factory in Britain was probably the American Radiator Co, who started manufacturing under the name of the National Radiator Co in Hull in the early 1900s. They introduced the *Ideal* boiler and the company later became Ideal Boilers & Radiators.

The major manufacturers of hot water heating boilers can often be recognised by the brand name of their main boiler series: Hartley & Sugden *White Rose*, Beeston *Robin Hood*, Ideal *Britannia*, Lumbys *Solar* and the Mather & Kitchen *Severn.* However, many makers each had half-a-dozen or more trade names. The list is considerable.



Palm House, Kew, 1848
Originally, coke for the boilers was delivered by underground railway

Patent cinder sifter
[Strand magazine, 1904]

Fuels & Firing

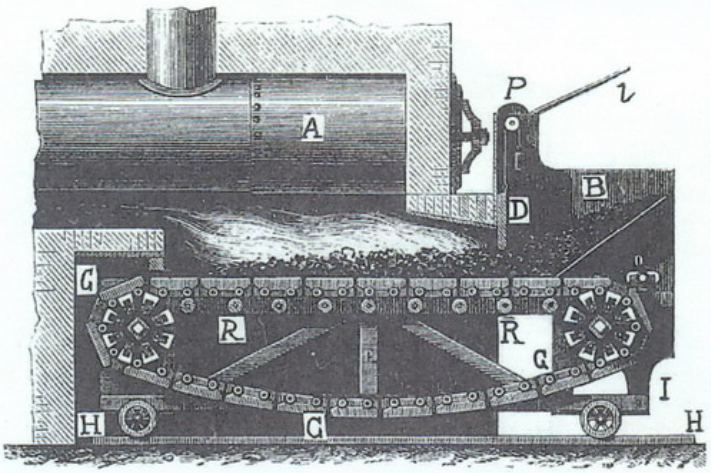
Wood was the most commonly used fuel until the Tudor period. Charcoal was also used, particularly in braziers, but the forests were being denuded of trees at an alarming rate at a time when timber was used for both ship and house building.

By the time of Henry III coal was being shipped by coastal barge from the Tyne to London. This was known as "sea-coal." It was not popular and in 1306 the use of coal in London was forbidden. However, wood continued to be in short supply and the widespread use of coal as a fuel proved to be inevitable. Fireplaces, grates and chimneys were developed accordingly. At the end of the 18th century both Benjamin Franklin and Count Rumford developed rules for fireplace and chimney construction, making the combustion of coal more efficient.

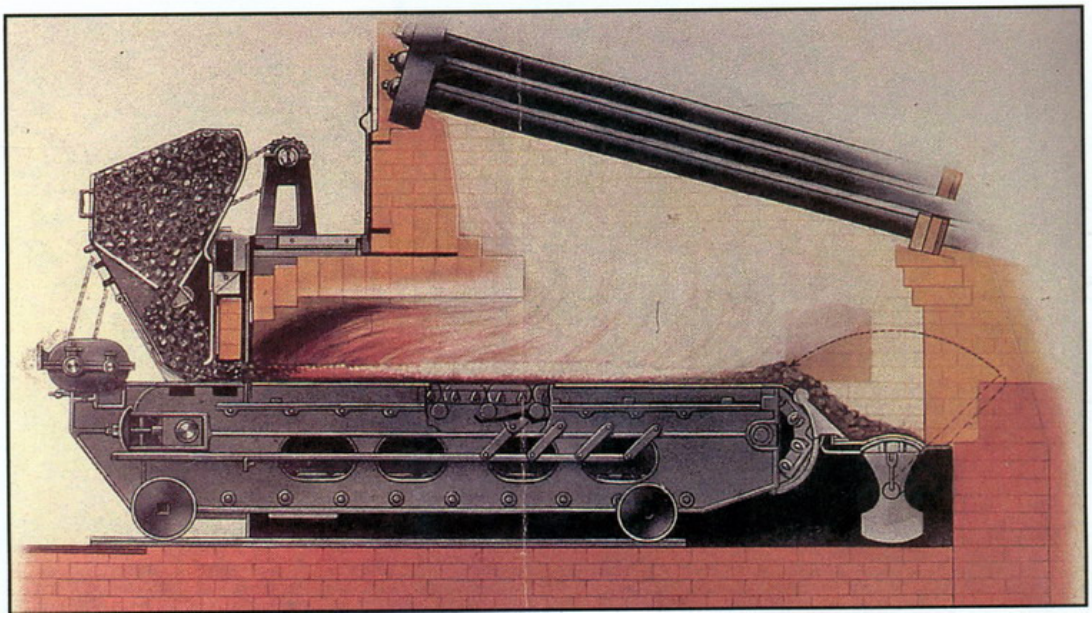
The early 19th century saw the development and use of solid fuel metal stoves and steam, then hot water, boilers. Both coal and coke were used but as boilers became larger their performance relied on the skill of the men who stoked them. The introduction of automatic draught regulators eased the work, but where shifts of stokers were required this was an expensive operation and automatic continuous methods were sought. Moving large quantities of coal or coke from storage areas to the boilerhouse could also be a problem. For the Great Stove (glasshouse) at Chatsworth and for the Palm House at Kew, hand-drawn trucks on an underground railway were employed. [The tunnel at Kew survives and houses modern pipes and services].

A type of mechanical stoker was used by Watt in 1785, but the principle of the underfeed stoker was invented by Hawkins & Downson of London in 1816. Brunton made a flat revolving stoker in 1819 and patented a travelling grate, the basis of many modern stokers, in 1822. Smaller boilers used gravity fed hoppers or magazines.

Early attempts to use mechanical draught fans and oil-firing were largely experimental until the Edwardian era.

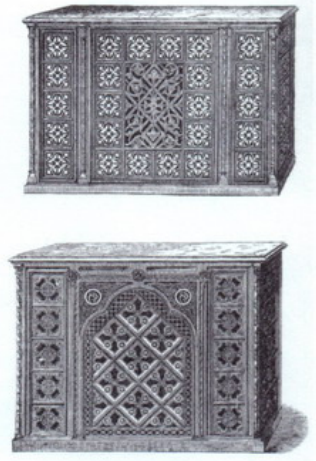


Juckes' patent chain grate (travelling grate) stoker, 1841

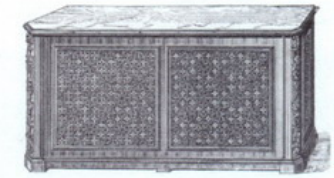


Babcock & Wilcox patent mechanical chain grate (travelling grate) stoker, Renfrew, c.1912

Decorative heating pedestal designed by William Burgess
The heating engineer was Wilson Weatherley Phipson
Cardiff Castle, c.1880



Two coil cases by the
Coalbrookdale Co, c.1870
with Maw's pierced tiles



Jones & Attwood, 1904

Decorative coil & radiator cases or pedestals

Box-end heating coil beneath Wm Burgess desk, Cardiff Castle.
Heating designed by Wilson W Phipson, c.1880

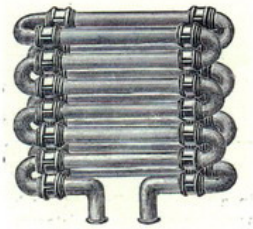
Heating Coils, Pedestals & Cases

The use of steam or hot water for heating required the development of a suitable heat exchanger to warm the air in the spaces being served. In 1784, James Watt used a tin-plate box filled with steam but the output was low because its bright metallic surface did not radiate heat efficiently. Thomas Tredgold, a pioneer of steam heating, suggested in 1824 that the exposed pipes then generally used as heating surface should be concealed or some alternative form of surface used. Earlier, Count Rumford had similar thoughts for his heating of the Royal Institution.

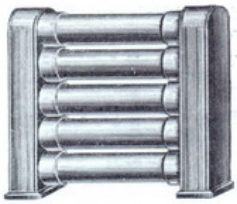
One early form of room heating consisted of cast-iron or wrought-iron pipes of 4 inch diameter as commonly used for heating greenhouses (one of the first applications of central heating). This method was so common that it was usual to rate a boiler as suitable for so many "feet of 4 inch pipe," a practice which continued well into the 20th century. The first alternative was the cast-iron pipe-coil made by connecting short lengths of pipe by means of 180-degree return bends. Both socket and flanged bends were used. Next came the "box-end" coil where the horizontal lengths of pipe, typically five or six in number, were connected at either end into vertical headers. Small diameter pipes, perhaps 2 inches or less, were used for steam coils while larger 3 and 4 inches size were employed for hot water heating. Heating coils could be either external or internal socket type.

In 1876 Walter Jones of Stourbridge patented a hot water heating coil that used rubber ring joints, compressed with nuts and bolts rather than flange or socket connections to the header. His first model was suitable for very low pressures, only 30 feet head of water. His later, improved model was suitable for 100 feet.

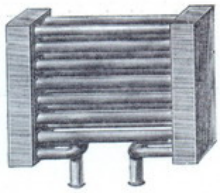
The unattractive nature of these coils led to the use of decorative cases, usually a mesh of patterned metal or pierced tiles, but some stately homes had expensive stone or marble pedestals which incorporated urns or even statues.



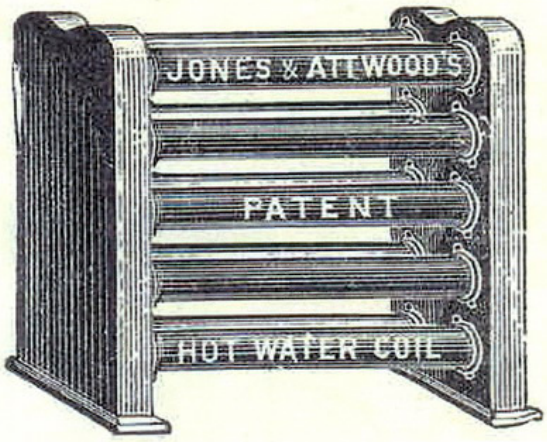
Cast-iron heating coil made using socket return bends



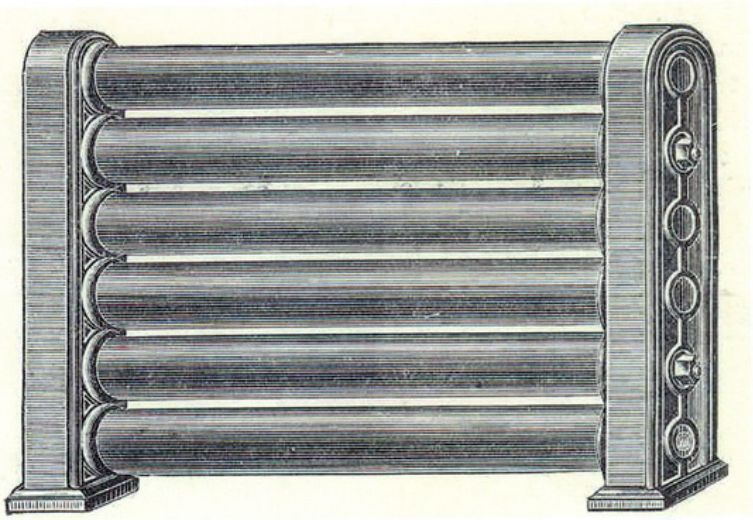
External socket heating coil



Internal socket heating coil



Patent hot water heating coil, 1876



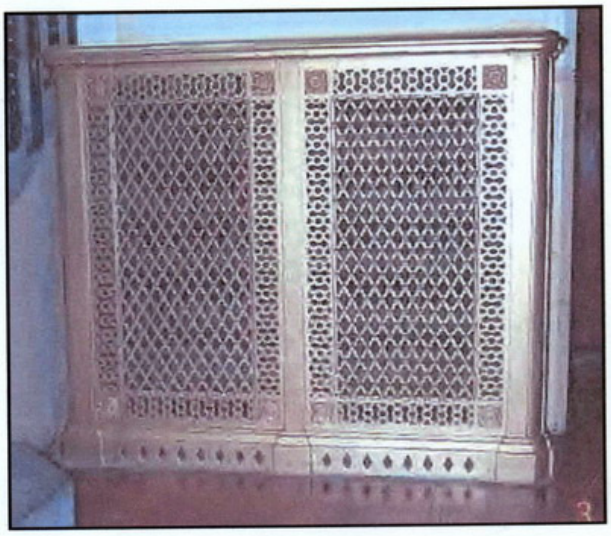
Hot water heating coil with rubber joints

A selection of heating pipe coils manufactured by Jones & Attwood, Stourbridge, c.1875-1905 before the widespread use of radiators

Box end heating coil,
Tyntesfield House, near Bristol

Box end heating coil, Church of St Swithin,
East Retford, Notts

Decorative heating case,
Montacute House, Yeovil, Somerset

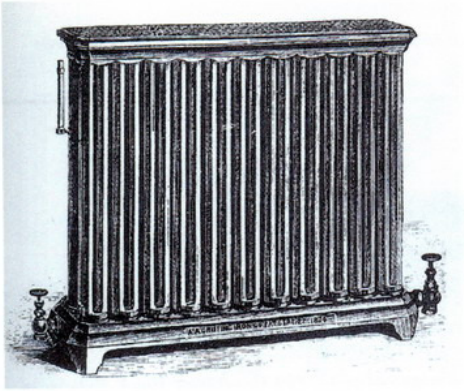


Decorative heating case, Congregational Church,
Trowbridge, Wilts

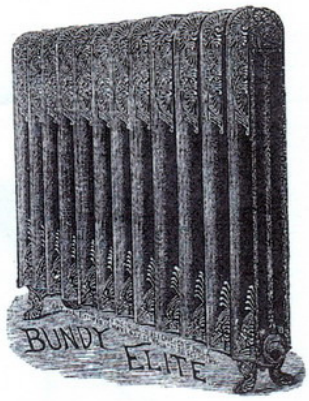
Vertical tubular radiator by Vincent Skinner, Bristol Church of St Andrew, Cheddar

Statue of Lady Bankes on a pedestal housing heating coil, Kingston Lacy

Italian marble radiator pedestal hiding double-bank pipe coil heater, Kingston Lacy, Dorset



Bundy radiator, A A Griffing Iron Co, Jersey City, 1874



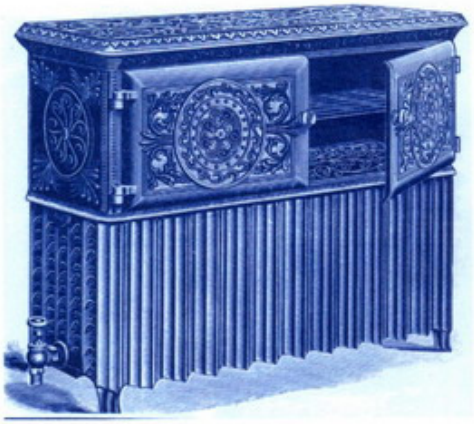
Bundy Elite radiator, 1877

Radiators

The term "radiator" is a misnomer since for column radiators some 70% of the heat output is by convection. The development and mass production of radiators was an American phenomenon, the first patents dating from around 1841. The first radiators were variously shaped "heat distributors," a mixture of pipes and metal plates. Next came vertical wrought-iron welded tubes fixed between horizontal top and bottom headers. These were followed by "looped tube" type, an inverted-U, fixed to a base plate. These were used for both steam and hot water.

One of the early radiators was the *Mattress* design of Stephen J Gold in 1854, a flat panel with rows of recessed dimples. His son, Samuel, developed the *Pin* radiator around 1863, the attached pins increasing the heat transfer area, allowing it to be used as a convector in a heating chamber or duct. Tasker in Philadelphia patented a primitive sectional radiator in 1858. It is the factory mass production of radiator sections that could be connected together that distinguishes them from pipe coils. Another pioneer was Joseph Nason who had spent time working in England with A M Perkins (the high-pressure hot water heating specialist). He collaborated with Robert Briggs to patent a steam radiator in 1862. Bundy patented a cast-iron radiator for steam, with loops screwed into a cast iron base, in 1874. This and the Bundy Elite were manufactured by the A A Griffing Iron Co.

Until 1892 numerous American manufacturers produced a variety of designs, many highly ornamental, but in that year the three principal manufacturers merged to form the American Radiator Company. This firm, trading as the National Radiator Company, opened a factory in Hull in the early 1900s where they manufactured *Ideal* radiators. During the 1890s, radiators of American manufacture were imported into Britain, but from the turn of the century the home radiator manufacturing industry became predominant.



American ornamental radiator, 1896
Complete with plate/food warming compartment

Detroit circular radiator, 1906

Early British patents for hot water radiators include those of James Keith (1882 & 1884), A Waters (1882), W G Cannon (1887) and T A Heap (1887). The *Universal* radiator of James Keith was probably unique being cast in one piece; he claimed it less liable to leakage.

At the end of the 19th century, one expert claimed that British radiator design had fallen behind the current American offerings. However, this opinion was based on external appearance and not on the technical performance. British designs were generally plain, though there were exceptions. American ones were ornate. Gradually, improvements in foundry technology enabled more elaborate castings to be made. Radiators having 1, 2 and then 3-columns became available. By 1917, radiators with 4-columns were being used.

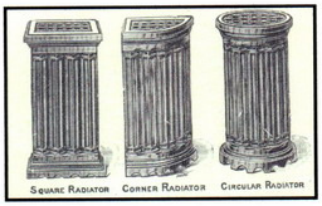
At the beginning of the 20th century, the *Ventilating* radiator was gaining acceptance in the USA. The idea was to remedy the lack of ventilation afforded by the ordinary "direct" radiator. Essentially, the lower part of the radiator was blanked off against the entry of room air, and fresh air was led to the base of the radiator by a channel in the wall behind it. These were sometimes termed "indirect" radiators when located outside the room being warmed. But it is believed this type was first introduced about 1850.

In 1904, claims and counterclaims relating to the introduction of radiators into Britain abounded. Acknowledging that steam radiators were of American origin the firm of Longden in Sheffield claimed to have played a major part in introducing hot water radiators to the British market.

Rosser & Russell of London claimed to be the original inventors of the ventilating radiator, but did not give a date. Other claimants include The Thames Bank Iron Company, and Weekes & Company. The case remains unproven, but one of the earliest is the ventilating radiator introduced by Walter Jones in 1881 and awarded a silver medal in the same year.

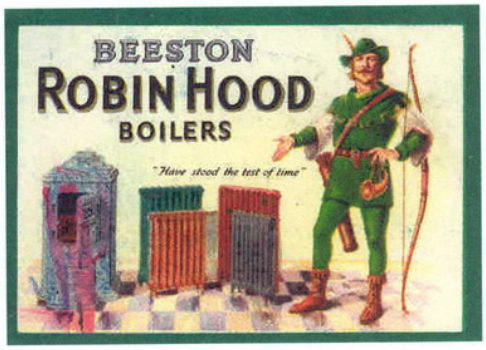
Unusual Bamboo pattern ventilating radiator, Meadow Foundry, c.1900

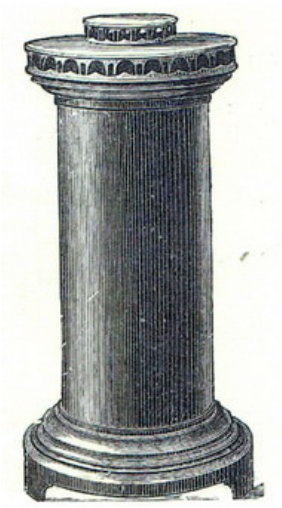
The number and variety of radiator styles and pattern names available as the Victorian era came to a close is overwhelming. In 1891, Keith was advertising both the *Universal* and the *Ornamental,* while the Coalbrookdale Co listed their *Hydro-Caloric* (Heap's Patent). By 1897, the American Radiator Co was promoting in London their *National Single Column* and *Rococo* designs. H Munzing in London was importing a variety of American radiators including *Royal Union, Coronet, Union*, and *Walworth Patent.* Longden of Sheffield featured the *Sunbeam (*Leed's Patent). Wontner-Smith Gray of London had the *Finsbury*, while the Meadow Foundry of Mansfield made the *Count* and the *Peer* Other British companies merely advertised their radiators as "ornamental" or "special," including firms like Haden of Trowbridge, Williams of Reading, and Thames Bank Iron and W G Cannon, both in London.



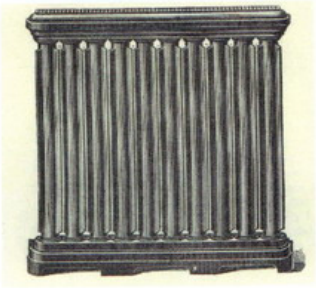
Beeston special radiators, 1904

In 1906, the London catalogue for the American Radiator Company listed: *Astro Hospital Swinging, Circular, Colonial Wall, Corner, Curved, Detroit, Excelsior, Italian, National, Peerless, Perfection, Primus, Rococo*, and *Sanitary Pin;* many of these came in a choice of heights, widths, number of columns and arrangement, and in so-called flue, ventilating and non-ventilating designs.

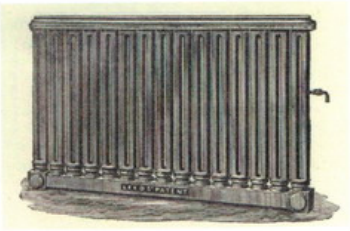




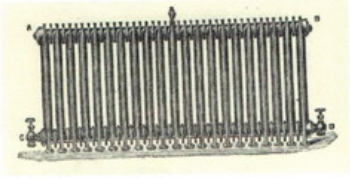
Jones, Stourbridge
Ventilating radiator



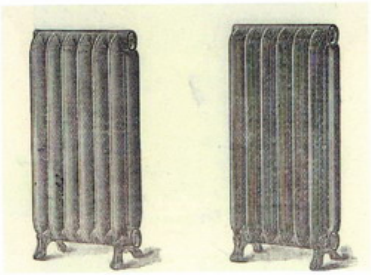
C & F Sanderson, Mansfield



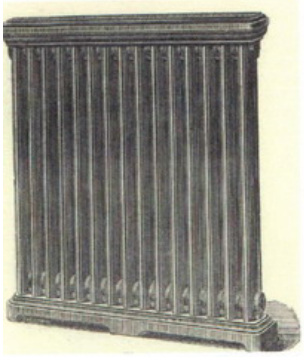
Longden, Sheffield, Leeds' Patent



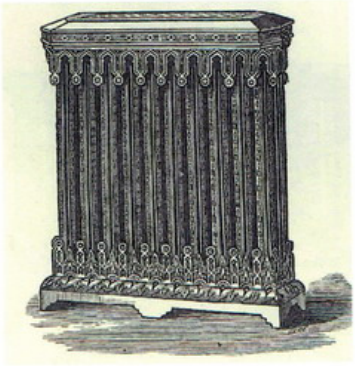
James Keith, London, Universal



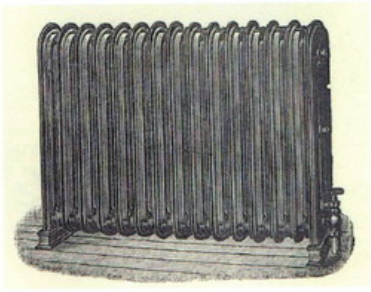
Meadow Foundry, Mansfield
Peer (left, plain) & Count (fluted)



'he General Iron Foundry Co, London

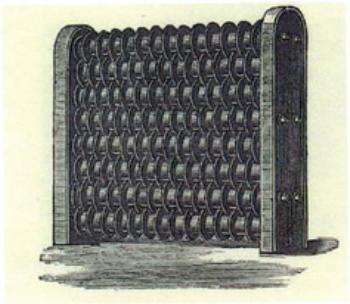


James Keith, London

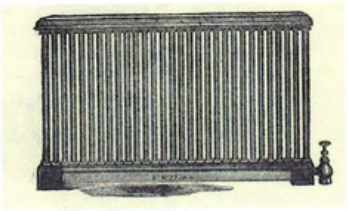


Messenger, Loughborough

Late Victorian radiators

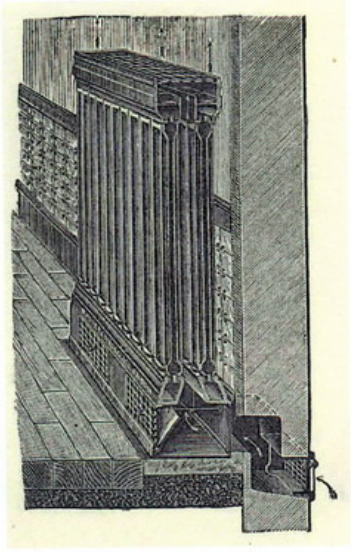


The General Iron Foundry Co
London

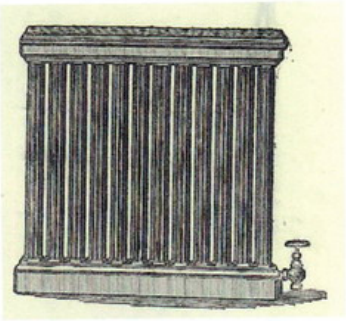


Coalbrookdale Co, Shropshire
(similar to T A Heap, Huddersfield)

W G Cannon, London
Ventilating radiator

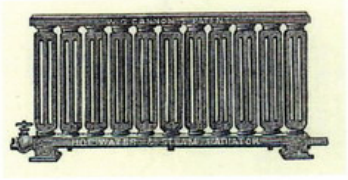


C & F Sanderson, Mansfield

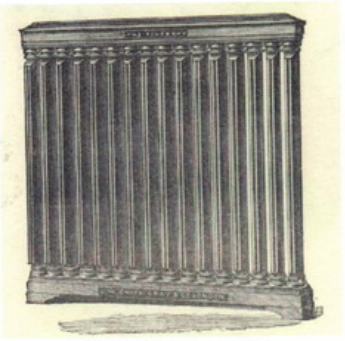


T C Williams, Reading

William Graham & Sons, London
Ventilating radiator



W G Cannon, London



Wontner, Smith, Gray, London
The Finsbury

Late Victorian radiators