About 1900 many examples of hot houses and heating boilers, radiators, pipework & gratings
Houses of Glass

A Nineteenth-Century Building Type

Georg Kohlmaier and Barna von Sartory

1990 from the German with information and drawings on heating systems & equipment
1990 describes the original heating systems at Kew. Visited by the CIBSE Heritage Group.
1988 describes, with illustrations, early heating schemes and has advertisements by heating engineers.
Today's heating engineers owe a large debt to the early gardeners and their attempts, by artificial warming, to protect tropical plants from European winters.

When citrus trees and other delicate plants from the East reached the centre of the Roman Empire, primitive arrangements were made to protect them in winter. Roman gardeners employed the principle of forcing growth by making hotbeds, either in the ground or raised beds with a surrounding low brick wall, filled with manure.

Other heating techniques included pouring hot water into trenches around rose roots, covering plants with bell jars, lighting fires between rows on frosty nights and covering hot-beds with thin sheets of mira (a transparent form of rock used by Romans in windows).

Many of the formal gardens of the Italian and French nobility during the 13th and 16th centuries relied heavily on theatrically arranged rows of mounds of citrus plants for their decorative effect, notable orange trees in pots. It was often found easier to move plants into an orangery during winter, rather than to cope with protective wood in cases.

In England, the most famous orangery of the Elizabethan age was in the grounds of Sir Francis Carew's house at Beddington in Surrey. The trees were planted in the ground and a wooden shelter, most likely with windows, was erected around them each winter. Heating was provided by two iron stoves, possibly from Holland since the word stove has a Dutch origin.

The accounts of 1609 record that 55 shillings was paid for a stove, more than the 40 shillings advertised in Price of Merchandize of 1618. In 1657, the new tenant, the Earl of Warwick, 'paid £1 for repairs to the old stove in the orange house'. He also paid £1.10s. for the construction of a new stove but a note in the accounts refers, 'New stoves set up by Mr. W. (lord) but of little use'.

The removable shelf principle was also popular elsewhere. Olivier de Serres gives a detailed description of how to build a protective house in the first edition of Le Théâtre d'Agriculture of 1660. He stated that it should have large windows and be heated by pans of charcoal or dry wood; he gave his name to the French word for greenhouse – serre.

In 1684, John Watts, the keeper of the Chelsea Physic Garden, experimented with different methods of heating and used a Dutch design which 'conveys warmth through the whole house by tunsels'. Sir Christopher Wren added a greenhouse to Hampton Court in about 1681. The writer and traveller Celia Fiennes noted stove houses: 'So artificially contrived that all foreign plants are preserved in gradual heats, suitable to the climes of the respective countries wherein they are native'.

William Cavendish, 1st Duke of Devonshire, had a greenhouse at Apsley House (later Buckingham Palace) and in 1696 had one built at Chatsworth, a name later to be associated with its most famous gardener, Joseph Paxton, and the greatest of all glasshouses – the Crystal Palace. Around 1710, Ynysbragh built a greenhouse as part of Bletchingley Palace.

Dr Richard Bradley published a book in 1718 called The Gentleman and Gardener's Calendar with advice on greenhouse design. This included building the greenhouse as an outward-facing circle to catch every available ray of sunshine, providing an insulated roof storage area, and insulating floor to ceiling removable windows with insulated shutters. He advised against heating with underfloor flues because the mortar between the bricks often cracked in the heat, filling the conservatory with smoke.

At Camom, in Herstmonceux, Bradley collaborated with the Italian architect Galli to provide what he hoped was a better solution than pans of burnt charcoal. His idea was that at either end of the greenhouse there should be a small room with a fireplace in the greenhouse wall and the chimney should have a number of bends in it, so as to provide a heated wall.

Unfortunately, his arrangement provided an insufficient area of heating surface, but his ideas were later taken up and improved upon.
Undated (c.1990) the Alexandra Palace: The second “Ally Pally” incorporated a large conservatory, the first Palace having been destroyed by fire shortly after opening.
Visited by the CIBSE Heritage Group
1996 with chapter on heating
1907 shows heating methods & equipment at that time
2003 features the Palm House in Belfast which was provided with heating from mid-Victorian times. Visited by the CIBSE Heritage Group
1986 contemporary photographs of both the Hyde Park & Sydenham Crystal Palaces. The former being a temporary structure was unheated,
1973 His life and the Crystal Palaces
1961 includes description of the engineering services at the Sydenham Crystal Palace (the fountains, rainwater systems, Brunel’s water towers and the heating system with some 27 boilers and 50 miles of heating pipework)
THE CRYSTAL PALACE AT SYDENHAM
AND THE ARCHITECTURAL COURTS
1994 with detailed drawings of the louvred window shades and their operating mechanism
"The Crystal Palace is on fire!"
MEMORIES OF THE 30th NOVEMBER 1936.

THE CRYSTAL PALACE FOUNDATION

1986 The story of Crystal Palace’s destruction by fire
1994 with information on the “ponts roulants,” the travelling gantries for moving people