## *9.01a Heating*

**a. chimneys**
**b. fireplaces**
**c. heating stoves**
**d. hot water**
**e. incinerators**
**f. kerosene**
**g. heating systems**

### *a. chimneys*

There is very little in the field of services that can be regarded as specifically ethnic in origin, but it is true that Cornish round chimneys are widespread in Australia. They were brought by Cornish miners, and are found in Cornish houses in the mining areas of South Australia. They are also found in many other localities, and were used in the isolated settlement of Port Essington, on the Cobourg Peninsula, while E and D Baglin illustrate one in the Blue Mountains.[1] They likewise occur on a larger scale in Cornish operated mining works, and one of these round chimneys survives at the Duke of Cornwall Mine at Fryerstown, Victoria - a venture promoted by the Cornishman R L M Kitto.[2] Very distinctive round chimneys, better decribed as tubes, survive on an outbuilding at 'Marida Yallock, western Victoria,[3] which is undated but unlikely to be later than 1865, and there used to be similar chimneys on a cottage at Port Fairy.[4]

In 1835 J W Hiort of London published a description of an improved flue which, although it has become well-known, seems to have been rarely put into effect, especially in Australia. From Hiort's description – for he did not illustrate it – the flue was circular in plan and built from appropriately curved bricks, also invented by Hiort. This circular flue rose within an enclosed cavity which would warm up sufficiently to present condensation within the flue itself. Hiort claimed a number of other adantages.[5]

Another form of chimney that deserves comment, even if it is not fully explicable, is that which is an ordinary square in plan, but with brick courses progressively offset so that it is helical in form. This probably stems from the Dutch building tradition in South Africa, where Lewcock traces it to Baroque

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1 E & D Baglin, *Australian Chimneys and Cookhouses* (Sydney 1979), pp 19, 67.

2 Mark Whitmore, 'The Duke of Cornwall Mine, Fryerstown, Victoria', *Historic Environment,* II, 3 (1982), pp 5-21.

3 Inspected 2007.

4 There are photographs in the John Collins collection, State Library of Victoria.

5 J W Hiort. *Description of an Improved Chimney Flue or Tunnel invented by John William Hiort* (author, London 1835). passim.

influence.[6] In 1846 this type was recommended for use in Adelaide by a journalist who had seen it in Cape Town:[7]

> I do not remember to have noticed it elsewhere ... the upper end of the flue (which is here finished square, and in London with chimney pots) is at the Cape, carried up in the form of a spiral or Archimidean screw, by a particular mode of laying the bricks.

The intention was perhaps not merely ornamental, but to prevent smoke blowing back into the house. Although no examples are known to survive, this may be attributable to the relative instability of the form, and until quite recent years there was one such chimney on a house at the corner of Grattan and Swanston Streets, in the Melbourne suburb of Carlton.

The Preston brickmaker James Coe was producing chimney pots by 1858,[8] and in 1859 A Cheale was advertising chimney pots, chimney linings and air flues, all of which could be made to order at short notice.[9] Luke Nolan, of the Gillbrook Pottery, Brunswick, seems to have been the source of a large number of distinctively designed chimney pots. One bearing his brand, and decorated with heart-shaped openings around the collar, was found at a now-demolished South Yarra cottage,[10] and many others of the same form are found in buildings of the period 1859-72.[11] The South Australian Pottery, near Magill, was making chimney pots by 1869.[12] The English firm of Doulton and Company, which had a Melbourne agency imported from the parent company 'terra cotta chimney tops',[13] including, according to an advertisement of the time, 'Terra Cotta Chimney Tops of various and approved shapes for smokey chimneys'.[14] One type was the subject of a Victorian patent in the name of James Doulton, for improvements in chimneys whereby they were constructed with pyramidal tops and screens rising above them.[15] In England Doulton & Co were still making chimney partitions in the 1920s, in two styles, as well as chimney tops to go between them, though now in the form of a flat cone rather than a pyramid.

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6 R B Lewcock, *Early Nineteenth Century Architecture in South Africa* (Cape Town 1965), pp 203, 245.

7 *Builder,* IV, 161 (7 March 1846), p 110: notes taken from the *South Australian Register* and *Adelaide Observer.*

8 Victoria Industrial Society, *Catalogue of the Eighth Annual Exhibition* (Melbourne 1858), p 10.

9 *Australian Builder,* 18 June 1859, p 152.

10 Information 1999 from Peter Latreille, former owner of the cottage in Argo Street, South Yarra. Latreille has the pot, which is in a damaged state, and plans to restore it.

11 'Overnewton', Keilor, additions of 1859; 'Osborne House', 54 Osborne St, Williamstown, 1860; the first part of 'Blythvale' homestead, western Victoria, 1860s; 'Titanga' homestead, western Victoria, 1870-72.

12 Noris Ioannou, *Ceramics in South Australia 1836-1986: from Folk to Studio Pottery* (Netley [South Australia] 1986), p 78.

13 C B Mayes, *The Victorian Contractors' and Builders' Price-Book* (Melbourne 1859), p viii.

14 *Australian Builder,* 1860-61, advertisements, passim.

15 No 291 to James Doulton, 3 December 1859.

A minority of chimney pots were made of sheet metal, and the decorative metal chimney pots at 'Burswood', Portland, Victoria, of 1855, appear to be early and possibly original.[16] Benhams and Froud of London showed their 'octagon chimneyhead' at the International Exhibition, London, of 1862. It was an octagonal shaft of sheet metal with no opening at all at the top end: instead the smoke left sideways under a ring of baffles near the top.[17] There were also metal cowls of various sorts, both imported and locally made. At the Great Exhibition of 1851 wind guards for chimney tops were shown by Isaac Green and J Beeston, and the former was illustrated. Though the section is not shown, it appears that on top of the chimney shaft there is an inverted cone, which is presumably open at the top, for on top of this is a small disc, and it seems that there is access between the cone and the disc.[18] A little later Bailey's 'Smoke Guard' was a prominent device which was supposed to increase the drawing power of a chimney by doubling the area of the outlet, at the same time protecting it with a conical top and a circular ring or band, intended to prevent the wind from entering.[19] This was a simple design, but far more complicated ones were also on the market.

A rotating cowl called 'the Circulator' was being sold in about 1815 by the patentee, W Farlar of London, as a cure for smoky chimneys. Without an illustration it is difficult to assess it, but it was described as being of iron, fixed to the top of the chimney, having a rotary action, being noiseless, and preventing rain or hail from entering the chimney.[20] In 1836 a rotating chimney cowl made by one Dowson, a London ironmonger, was described by a correspondent of the *Architectural Magazine.* It took the form of a short cylinder across the top of the chimney flue, with a vane on top to keep it pointing in the same direction as the wind. A conical aperture on the windward side of the tube allowed the draught to pass through at an accelerated rate, presumably creating a Pitot tube effect and drawing the air out from the flue.[21] An odd type, Dupree & Co's ventilator, looks as though it rotates, though this is unclear. It is approximately cylindrical, with radially placed strips or fins, somewhat curved or s-shaped in profile: thenature of the apertures into the flue is not apparent.[22]

C B Allen described two ventilating systems, in one of which the top of the flue tapered and entered an outer tube so designed as to create suction,

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16 Viewed from ground level, 2007.

17 London, International Exhibition of 1862, *The International Exhibition of 1862. Illustrated Catalogue of the Industrial Department. British Division* (2 vols, Her Majesty's Commissioners, London 1862), class xxv, p 99.

18 London, Great Exhibition of the Works of Industry of all Nations, 1851, *Official Descriptive and Illustrated Catalogue* (3 vols, London 1851), I, p 329. Others included G Cooper's 'Venetian' chimney top, designed to create an upward draft and to prevent a downdraft, and Abraham Green's 'protective syphon chimney-pot' to cure smoky chimneys: ibid, II, pp 617, 597

19 *Builder,* XI, 530 (2 April 1853), p 222.

20 W Farlar, 'The Circulator for the cure of Smokey Chimnies' (London, no date [c 1815]), passim.

21 *Architectural Magazine,* July 1836, pp 315-6.

22 *Builder,* xiv, 674 (5 January 1855), advertisements.

while the other contained a moving screw and was similar in principle to rotating vents used today. In this latter system the top of the flue carried a finned wheel, like a paddle wheel placed on the flat, which would be rotated by any passing breeze. The vertical axis of this wheel continued down the shaft and served also as the axis for an archimidean screw in the shaft. Thus the turning of the wind vane automatically turned the screw, which then drew air up the shaft.[23] This device had already been used in chimney flues to help in extracting smoke. Charles Tomlinson, in his *Warming and Ventilation,* was doubtful of its efficacy, but discussed it in the context of other quasi-mechanical devices such as revolving bonnets and cowls, which were already well-known in Britain.[24] The appearance of the rotating chimney cowl in Australia cannot be accurately dated, but they were advertised for sale in Melbouurne in 1853,[25] and a sketch of 1860 shows one in position on the Manifolds' third homestead at 'Purrumbete', Victoria, built in the later 1850s.[26] By 1861 the Sydney metalworker Mark Berry was advertising fifty different models of chimney cowl, an almost over-profuse variety, and in many cases over-elaborate in design - many with offset shafts, double heads, rotating cowls, wind vanes and so on.[27]

The South Australian engineer Oswald Brown received a patent in 1879 for an 'improved chimney-top and ventilator',[28] which has yet to be investigated. In 1889 Barnett Brothers of Melbourne were agents for Cohen's Patent Deflector Flue Cap, and were so confident of its capacity to cure smoking chimneys that they offered a 'no-cure-no-pay' deal.[29] Another British type was the 'National', made by Wright, Sutcliffe & Son of the Globe Sanitary Works, Halifax.[30] In 1890 there was an interesting episode at Melbourne University, where the architects Reed & Smart installed a 'Torpedo' cowl to cure a smoky chimney at Professor Allen's house. Allen's wife, Julia, wrote that the chimney now smoked in two winds rather than only one. She wanted a 'Grey' or 'Gray' cowl, which was recommended by A K Henderson as curing none out of ten chimneys, but could press for this only discreetly because of the tensions then existing between Henderson and his erstwhile partners Reed and Smart.[31] This is probably a reference to the Standard Adelaide (Gray's) revolving exhaust cowl, which will be mentioned below.

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23 C B Allen, *Rudimentary Treatise on Cottage Building* (London 1854 [1853]), pp 50-51.

24 Charles Tomlinson, *Warming and Ventilation* (London 1860), pp 88-9; Thomas Tredgold, *Principles of Warming and Ventilating Public Buildings, Dwelling-Houses* (2nd ed, London 1824), pp 91-2.

25 *Argus,* 4 October 1853, p 8.

26 Reproduced in Heather Ronald, *Wool Past the Winning Post* (South Yarra [Victoria] 1978), p 136.

27 Sands's *Sydney Directory* for 1861, reproduced in Ian Evans, *Restoring Old Houses* (South Melbourne 1979), p 89.

28 D A Cumming & G C Moxham, *They Built South Australia: Engineers, Technicians, Manufacturers, Contractors and their Work* (Adelaide 1986), p 31, citing South Australian patent 94, August 1879.

29 *Australasian Builder & Contractor's News,* 7 September 1889, p 278.

30 *Building News,* 20 April 1888, p xxiii.

31 Julia M Allen to - James, 25 June 1890, 13 July 1890, University of Melbourne series 312, 1890/5 Buildings, by courtesy of George Tibbits.

### *b. fireplaces*

Cooking stoves were abnormal before the mid-nineteenth century, and a surprising amount of cooking was achieved in an open fireplace, while in the towns it was still common to carry one's roast to a baker's oven. As late as 1867 it was said that in England 'large open grates' were generally in use, though now being superseded by cooking ranges of one sort or another.[32] Stoves caught on even more slowly in Australia than in England for, for where wood was plentiful and the climate warmer there was less incentive to make the change. William Howitt, having looked around Melbourne and environs late in 1852, said 'One thing pleases me here - the old English dog in the fire-places of the country houses, instead of stoves.[33] But by 1862 it was being argued, even in Queensland, that it was 'very poor economy' not to install a kitchen stove.[34]

In rural dwellings cooking on the open fire remained common longer than in town, and one country dweller described the arrangements:

> From an iron bar up and across the chimney, trace (plough) chains are fixed; on these hang the large or smaller boiler, the 3 gallon water tea kettle, and when needed the frying pan, saucepan, or a camp oven, a pot hook with a "sort of a swirl" held the saucepan. The cooking utensils were made of cast iron. As the settler increased in riches and knowledge, an iron crane was introduced to the fire place. This was like a one bar (top) gate and held with simple gadgets the hanging cooking vessels, and did away with long chains and heavy lifting, the kettles and pots could be brought on and off the fire with little effort, a camp oven was used for baking - (bread, meat, potatoes + some kinds of puddings) placed in the fireplace, a fire under and above. The youngsters knew how to cook potatoes and onions, in the ashes ... [35]

The camp oven is not to be confused with the colonial oven, discussed below, for it is a utensil father than a fitting - a cooking pot with a removable lid, a handle to either side, and typically three short legs, which allowed the embers to be pushed right in beneath it. It was not an Australian invention, for while Robert Gouger reported in 1836 that 'Cast-iron three-legged pots are much used in out-of-doors cookery in these colonies', he seems to be recommending that emigrants should bring them from Britain, and 'they should be provided with a bale and cover'.[36]

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32 *Cassell's Household Guide to every Department of Practical Life* (4 vols, London, no date [c 1869-71]), I, p 5

33 William Howitt, *Land, Labour, and Gold; or, Two Years in Victoria, &c* (2 vols, London 1855), I, p 57.

34 Ian Evans et al, *The Queensland House: History and Conservation* (Mullumbimby [New South Wales] 2001), p 25, quoting William Coote, in *Transactions of the Philosophical Society of Queensland,* I, 1859-82, unpaginated [John Oxley Library].

35 J K Andrews, 'History of Merrigum' (manuscript, Merrigum [Victoria] 1954, copy provided by Anne Tyson, 1997), pp 61-2.

36 Robert Gouger, *South Australia in 1837; in a Series of Letters: with a Postscript as to 1838* (London 1838), quoted in Penelope Hope [ed], *The Voyage of the Africaine* (South

There is one minor characteristic of fireplace design which derives from British tradition, but in Australia seems to be associated with a particular region, that of the coastal limestone area from Port Fairy in Victoria to Robe in South Australia. In early cottages in these towns the back of the square chimney flue is set in plan slightly behind the back of the fire chamber. This is in itself common enough, but usually it angles forward to the fire back somewhere near the throat of the chimney, whereas in these houses it continues well down. Thus it descends as a sort of rectangular channel in the fireplace back for a short way before the base slopes forward to meet the main vertical face. Older English examples tend to have the 'sinking' or 'smoke check' proportionally wider, and descending almost to the level of the hearth. Percy Thomas wrote of it as one of the 'small refinements met with in old works [which] should be carefully observed in modern practice'.[37] This advice does not seem to have been heeded in Britain, much less in Australia, in or after his time.

Other forms of fireplace were transmitted by literary sources and by the middle classes. Benjamin Thompson (Count Rumford)'s *Chimney Fireplaces with Proposals for Improving Them* of 1795 was known in Australia in the early years of settlement,[38] and families as sophisticated as the McCraes in Victoria, were almost obsessively concerned that their fireplaces should be built on the Rumford plan.[39] The 'Rumford Stove' was an improved design of fireplace in which the area of the fire chamber was contracted, the sides sloped back at $45^0$ in plan, and the depth was equal to the width at the back. The throat of the chimney was reduced to a narrow slit (formed on one side by a flagstone which could be removed for the purpose of sweeping the chimney) and the breastwork leading in to it was rounded off so as to avoid any obstruction to the smoke.[40]

Somewhat analogous with this was the so-called 'Russel Stove' - not really a stove as we would understand it, but a sort of sheet metal fireplace and grate. It was the invention of John Russel, lecturer in natural philosophy [physics] at

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Yarra [Victoria] 1968), p 26. Gouger goes on to write of the 'camp-oven' in the same paragraph, but it appears that he does not intend this term to apply to the three-legged pot.

37 Percy Thomas [ed], *Modern Building Practice* (4 vols, London, no date [c 1935]), II, pp 435-6; III, pp 375-6..

38 Robert Irving, 'Georgian Australia' in Robert Irving [ed], *The History and Design of the Australian House* (Melbourne 1985), p 55, ref James Broadbent 'Early Sydney Houses ...' (where it is not found), and Joan Kerr & James Broadbent, *Gothick Taste in the Colony of New South Wales* (1980), p 35.

39 W G McCrae to Georgiana McCrae, March 1845 in G G McCrae [ed], *Letters to Georgiana from her Four Sons* (Arthur's Seat [Victoria] 1986), no page; also Hugh McCrae [ed], *Georgiana's Journal* (Sydney 1934), pp 142, 151, 161.

40 Charles Tomlinson, *A Rudimentary Treatise on Warming and Ventilation* (London 1850), pp 79-80. See also Lawrence Wright, *Home Fires Burning* (London 1964), pp 115-117; John Gwilt [ed Wyatt Papworth], *Encyclopædia of Architecture* (London 1888), p 747, for subsequent developments. The proportions are misrepresented in D J Eveleigh, *Firegrates and Kitchen Range*s (Shire Publications, Princes Risborough [Buckinghamshire] 2004 [1983]). p 7.

Edinburgh, and consisted of a vertical back with an attached grate, surrounded by iron plates coming forward at $45^0$ not only to the sides, like the Rumford fireplace, but above and below as well. The grate was simply a basket attached to the back surface, surmounted by a small canopy to help gather the smoke into a flue behind. It was made by J Sibbald & Sons of Edinburgh,[41] and though it may not have reached Australia it is necessary to refer to it, if only because of the confusing references to the 'Russell' cooking stove in the colonies.

Less radical was the hob grate, in which the grate proper was placed between cast iron boxes, as in a surviving example at 'Lindesay', Sydney, of 1834-6.[42] These are far rarer in Australia than in Britain, but a very handsome Aesthetic Movement version is found in the master bedroom of the 'Villa Alba', Melbourne, and another elegant one, probably of local manufacture, can be seen at 'Dundrennan', 2 Walker St, St Arnaud, Victoria, of 1884, branded:

ST ARNAUD FOUNDRY
ANA GRATE

In New Zealand Charlotte Godley recommended (for heating not for cooking), the Sussex grate as used her neighbours, 'which will burn either wood or coal, and in which you can make as small a fire as you please, and it always burns brightly.'[43]

A number of English patents and other improvements to fireplaces and flues, mostly of the 1840s and 1850s, are discussed in Richardson's *The Englishman's House,*[44] a work which was used in Australia, though their local impact is yet to be demonstrated. However one house of 1867 adopted something approaching the principles of Benjamin Franklin[45] and, so as to avoid draughts caused by the suction of the fire, provided for fresh air to be admitted through a grating in the hearth which could be regulated.[46] English heating stoves seem are not much heard of in Australia, but we can assume that the main ones were known. The 'Vesta' stove was self-contained, giving rise to no dust and, depending upon its size, requiring attention only at from

41 J C Loudon [ed], *Architectural Magazine,* I, pp 74-6.

42 Illustrated in Joan Kerr, '"So Elegant an Edifice": the Building of Lindesay', in Dinah Dysart & Joan Kerr [eds], *Lindesay: a Biography of the House* (Sydney 1984), p 22.

43 Charlotte Godley [ed J R Godley], *Letters from Early New Zealand by Charlotte Godley 1851-1853* (Whitcombe & Tombs, Christchurch 1951), p 185.

44 C J Richardson, *The Englishman's House from a Cottage to a Mansion* (London 1870), pp 406-414.

45 Benjamin Franklin's 'American' or 'Pennsylvanian' stove is not discussed here, because there is no evidence that it had any significant influence in Australia. However, a connection by way of London would not be out of the question. James Sharp patented certain improvements in the stove, and published his *An Account of the Principle and Effects of the Air-Stove Grates ... commonly known by the name of American Stoves; together with some Late Improvements made to them by James Sharp, for which His Majesty's Patent has been Obtained* (London, after 1781): Charles Wood, *Catalogue 108* (Cambridge [Massachusetts] 2001), pp 36-7, no 126. John Murray and Adam Anderson's patent for 'a stove or furnace to produce ventilation as well as warmth' seems also to relate to Franklin's principle: Great Britain no 3287, 14 December 1809.

46 King, *Price Book,* p 135.

eight to twenty-four hour intervals. The interior parts were easily replaced. The ‘patent chunk stove’ was similar, though made in only one size. The ‘Patent Pyridon stove’ had no doors, and could be used either as a closed stove or as an open fireplace.[47]

At the Great Exhibition of 1851 Jobson & Co of Shefffield showed a ‘patent bright steel light and heat reflecting stove-grate’, in which the grate basket was at the centre of a completely circular polished steel dish designed to reflect the maximum heat outwards.[48] Eveleigh sees this as the forerunner of the the more conventional arch-topped grate,[49] the sides of which are sometimes concave, but more often simply a canted flat surface. But this can scarcely be so. Firstly, it was not unique: D Doncaster of Sheffield showed a very similar circular steel grate,[50] and James Gray & Son of Edinbugh a ‘radiating and reflecting stove grate’ which was almost completely circular, but convoluted in the form of a scallop shell.[51] Secondly the arched grate was contemporary: both Jobson and Doncaster showed arched grates with canted sides, and W S Burton of London showed the ‘Nautilus register stove’, which was a more elegant version of the arched grate form.[52] By 1860, according to Eveleigh, the arched type had largely superseded the circular one.[53]

Much more widespread is an improved form of grate, the bivalve, in which the usual lunette-shaped opening into the flue has its own lid, but the annular surround to it can also be opened. There do not seem to have been any examples shown at the Great Exhibition of 1851 or the Dublin Exhibition of 1853, but an early version, not called a bivalve but the 'patent Vesta register grate', was sold by the London ironmongers Clark & Hunt in the early 1860s. They argued that by keeping the inner trap closed and the annular trap open, once the fire had 'burnt up', the excessive rush of air to the chimney was checked, and with it the tendency of the fire to 'burn black' on top. The remaining opening was still sufficient for the escape of the hot gases. In Clark & Hunt's model the surrounding arch reveal was concave rather than flat, so that the hollow part directly above the fire would project the radiation more or less horizontally across the room, on the principle of a parabolic

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47 This was 'Rajpootana', St Kilda: *Argus,* 15 March 1867, p 6.

48 Great Exhibition of the Works of Industry of all Nations, *Official Descriptive and Illustrated Catalogue* (3 vols, Spicer Brothers, London 1851), II, pp 603-4; Great Exhibition of the Works of Industry of all Nations 1851,*The Art Journal Illustrated Catalogue* (George Virtue, London 1851), p 294; *Illustrated Exhibitor,* 121 (23 August 1851), p 203.

49 D J Eveleigh, *Firegrates and Kitchen Range*s (Shire Publications, Princes Risborough [Buckinghamshire] 2004 [1983]).,p 7.

50 Great Exhibition of the Works of Industry of all Nations, *Official Descriptive and Illustrated Catalogue* (3 vols, Spicer Brothers, London 1851), II, p 613.

51 Great Exhibition of the Works of Industry of all Nations, *Official Descriptive and Illustrated Catalogue* (3 vols, Spicer Brothers, London 1851), II, p 643; *Illustrated Exhibitor,* 121 (23 August 1851), p 203.

52 Great Exhibition of the Works of Industry of all Nations, *Official Descriptive and Illustrated Catalogue* (3 vols, Spicer Brothers, London 1851), II, p 620.

53 D J Eveleigh, *Firegrates and Kitchen Range*s (Shire Publications, Princes Risborough [Buckinghamshire] 2004 [1983]), p 8.

reflector.[54] William Eassie wrore in 1874 as if everyone would be familiar with 'the improved registers of the present day both univalve and bivalve', of which the latter 'are now fitted up at an expense which is at first sight incomprehensible',[55] but rather oddly, he writes as late as late as 1879, as if the bivalve is a new development, and still a monopoly: 'Besides the univalve register grates, there are ... now the bivalve registers, sold by Messrs. Lowman, Taylor & Co., of London.'[56] It is also puzzling that such an apparently ubiquitous device as the bivalve grate is not mentioned in the later editions of Gwilt's *Encyclopædia of Architecture,* where other improved and patent types up to the 1880s are discussed.[57]

Dates have not been established for the bivalve in Australia, and this is not easy to do because grates were commonly replaced in the nineteenth century, and are still more commonly replaced by house renovators today, so the date of the building is not a reliable guide. One appears, without any specific reference to it, in an advertisement of 1875,[58] and it seems that they were still being sold as 'Wright's Patent Bi-valve' well into the 1880s, suggesting (as a normal patent ran for fourteen years) that this version was introduced no later than the early seventies. The catalogue of the Melbourne ironmonger James McEwan, apparently of about 1880, illustrates two models of patent bivalve grate, which look like Wright's but are not identified.[59] One house in Fitzroy, Victoria, has a 'Wright's Patent Bi-valve', but in other rooms an 'Improved Bivalve' and an 'Improved Registered Duplex'.[60] At 'Ferndale Manor', Castlemaine, of 1859-60, there are three bivalve grates, one of them branded:[61]

[upward arc
IMPROV'D PATENT
]
[valve lunette]
BIVALVE

A more enigmatic device is the 'plate-glass blower which effectually prevents smoking, that bane of houses in mountainous regions'.[62] This was fitted at Sir George Verdon's house 'Alton', Mount Macedon, late in the century. Apart

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54 F W Laxton, *Laxton's Builder's Price Book for 1863* (London 1863), advertisements, unpaginated.

55 William Eassie, *Sanitary Arrangements for Dwellings intended for the use of Officers of Health, Architects, Builders, and Householders* (Smith Elder, London 1874), p 116.

56 William Eassie, *Healthy Houses* (New York [?London] 1879), p 182.

57 Gwilt, *Encyclopædia of Architecture* (London 1888), pp 747-8, §2279d.

58 Advertisement by Whitney Chambers & Co of Melbourne, in Melbourne, Victorian Intercolonial Exhibition, *Official Catalogue* (Melbourne 1875), advertiser p 19.

59 *James M'Ewan & Co.'s Illustrated Catalogue of Furnishing and General Ironmongery* (Melbourne, no date [?c 1880]), p 66.

60 140 George St, Fitzroy, undated, inspected 1997.

61 Inspected 2004.

62 'Wanderer', 'Picturesque Macedon', *Gisborne Gazette,* 5 February 1895, reproduced in Nigel Lewis & Associates, 'Alton and Hascombe, Alton Road, Mount Macedon' (mimeographed report, South Yarra [Victoria]), p 93.

from the various bivalves, various branded or patented examples are found, such as a Crosthwaite's Patent No 2495, in a house of 1888-9, as yet uninvestigated.[63] Most of these grates must be assumed to be of British manufacture, or at least based upon British designs, but no research is available on the subject. Incandescent iron, asbestos fibre, and patent ball fires, the predecessors of the fake coal fires of the twentieth century, were available in Britain in the 1890s in a range of models,[64] but do not seem to be reported in Australia until much later.

Art Nouveau grates. 'Egremont', Launceston: Miles Lewis. William Sandover & Co. *Designers and Manufactures of Mantels* (Sandover, Perth, no date); Pryke & Palmer, *Illustrated Catalogue* (Pryke & Palmer, London, no date [c 1900]), pp 16-57

Only in the twentieth century is there a specifically local innovation, in the form of the 'Australian Open Fireplace' of the architect H D Annear. It was designed to draw well and to clean easily, and the base, which joined flush with the hearth rather stepping up from it, sloped backwards to obviate the tendency for collapsing fuel to roll out at the front. Fireplaces to this design are found in a number of Annear's own buildings, but he also published it in the *Real Property Annual* in 1921[65] and in *Every Man's Home* in 1922,[66] and it may be found anywhere. Another architect in Victoria who made use of it was Marcus Martin, for example in his renovations at 'Mooramong' homestead, and in 1947 the New South Wales architect Kenneth McConnel illustrated a very similar form in his book *Planning the Australian Homestead*.[67]

By 1933 the locally made 'Domus' fire was being sold by Edward Jenkins Pty Ltd of Melbourne, but whether it was an Australian invention or development is not clear. It was simple enough, consisting of a metal grate, with an ash pan beneath which could be pulled out, and a fireclay back which leaned forward well over the grate. This back plate incorporated vertical grooves or channels, which were claimed to have as beneficial effect.[68] At about this time McEwans offered a slow combustion fire grate with fire grating, ash pan, front fret and 'lift up' top roll.[69] In the 1940s the 'Wonder-Heat Air-Conditioning Fire' was on sale. This was a fire which burnt conventional fuels, such as wood, coal and coke, but was set behind a glass screen and was

63 Reported as 'Crossthwaite's', almost certainly erroneously: 'Yooralbyn', Erin Street, Richmond, reported by Tanya Hancock, Australian Architecture B, University of Melbourne, 1997.

64 T & W Farmiloe, *T. & W. Farmiloe's Miniature Catalogue* (London 1894), pp 631-8.

65 H D Annear, 'Built in Furniture: Savings in Cost and Labour', *Real Property Annual* (Melbourne 1921), pp 31-3, cited in Harriet Edquist, *Harold Desbrowe-Annear: a Life in Architecture* (Melbourne 2004), p 224.

66 *Every Man's Home,* 1 March 1922, p 48.

67 Kenneth McConnel, *Planning the Australian Homestead* (Sydney 1947), p 50.

68 D W Tulloch, *Details of Australian Building Construction* (Melbourne, no date [c 1933], p 90.

69 W L Richardson, *Ramsay's Architectural and Engineering Specifications [Volume 1]* (Melbourne, no date [1934]), p 49.

designed to circulate hot air effectively throughout the room, without sooty smells or draughts.[70] In 1954 A E Goodwin of Sydney introduced the Firemaster grate 'based upon a new American principle', which could be fitted into an ordinary fireplace. It was said to prevent smoking and to produce three times as much heat.[71]

### *c. heating stoves*

The American parlour stoves which will be discussed below were sought mainly as a means of cooking but also served as heaters. Heating stoves as such were relatively rare in Australia, where the open fireplace tended to be sufficient, but they were fairly often used in prefabricated houses. Manning, the London manufacturer, supplied as an optional extra a room heating stove which was made or wrought iron, rather than the more usual cast iron, so as to save weight.[72] However Samuel Vaughan, who came out with a Manning house, recorded that he had obtained from Farmer and Gorbell of London 'An emigrants Stove. 6 Feet piping + an Elbow with Set of Utensils fitted complete.'[73]

Atkinson & Marriott's Thermo-Regulating Stove: R S Mickleham, *The Theory and Practice of Warming and Ventilating Public Buildings, Dwelling-Houses, and Conservatories* (Thomas and George Underwood, London 1825), frontispiece.
Dr Neil Arnott's stove as manufactured by Fredeick Edwards of London [reformatted]: Great Exhibition of the Works of Industry of all Nations, *Official Descriptive and Illustrated Catalogue* (3 vols, Spicer Brothers, London 1851), II, p 641

In about 1825 Atkinson & Marriott obtained an English patent for an improved grate which they called the 'Thermo-Regulating Stove', features of which included a pipe to admit compressed air when required to start or to accelerate the fire, taking the place of bellows, and a way of making the combustion products pass back through the the burning coals so as to extract the most heat.[74] Dr Arnott, of ventilation fame, then invented a 'self-regulating' stove which by 1851 was being manufactured by Frederick Edwards of London, and which was claimed to be economical of fuel and to distribute an even heat. The stove was regulated either by Arnott's 'balanced valve' or his 'thermometer'. The balanced valve, as on the stove shown by Edwards at the Great Exhibition, was a second valve which tended to be closed by the air current towards the fire, but held open by a weight calculated so as to allow just enough air to still enter. His 'thermometer' was not just a temperature gauge but an auto-serve mechanism which closed a

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70 *Australian Home Beautiful,* January 1941, p 42.

71 *Cross-Section,* no 20 (1 June 1954), p 3.

72 J C Loudon, *Encyclopaedia of Cottage, Farm and Villa Architecture and Furniture* (London 1853 [1833]), p 252.

73 Journal of Samuel Vaughan, La Trobe Collection, State Library of Victoria.

74 R S Mickleham, *The Theory and Practice of Warming and Ventilating Public Buildings, Dwelling-Houses, and Conservatories* (Thomas and George Underwood, London 1825), frontispiece & pp 333-340.

throttle valve when the temperature reached the required point, restricting the entry of air and damping down the fire.[75]

At a larger scale the gill stove, patented by John Sylvester, seems to have been designed for heating large spaces or complete buildings. It was manufactured by Stuart & Smith of Sheffield in a functional form for installation in a basement, and an ornamental quasi-Gothic one to be installed within a room.[76] The principle was that flat plates of metal like fins (or the gills of a mushroom), projected from the sides of the fire chamber, doubtless intended to maximise the heated surface exposed to the air. In Stuart & Smith's version of this the plates were parallel, but a rival type, Gurney's, was round with radial fins Edmund Becket favoured Stuart &Smith's, which never overheated, whereas Gurney's stoves usually became red hot at the base at some time or other, or even without doing this, overheated and burnt the air, creating an unpleasant smell.[77] At 'Carranballac', Victoria, an 'Excelsior No 1' heating stove survives in the basement, the origin of which is unknown.

One of the most ubiquitous heating devices of the twentieth century was the 'Wonder-Heat Air-Conditioning Fire', which was simply an updated version of Benjamin Franklin's stove. Though console units were available, it was normally placed in a domestic fireplace. It contained a fire, which could burn any kind of fuel, behind an armour plate glass door. Fresh air was drawn in, typically from the sub-floor space, passed around the outside of the combustion chamber through ducts and across fins, to heat it up, and released into the room from the top of the unit. Thus the hot air entering the room had its full oxygen content, contained no combustion products, and had little propensity to cause draughts.[78]

### *d. hot water*

Domestic hot water was commonly provided by the more elaborate kitchen ranges, discussed above, but in the laundry a fire was set beneath the washing copper. Water for bathing was generally brought manually - or very occasionally piped - from the kitchen until late in the century, when the chip heater appeared. The 'instantaneous water heaters', which were being sold by Douglas & Sons of Melbourne by 1888[79] were probably of this sort. In 1892 the Melbourne ironfounder Angus McLean was advertising as the sole proprietor and manufacturer (presumably for Victoria) of Fischer's Patent Bath Heater, which could be heated with wood in three minutes at the cost of one farthing. Such heaters continued in use long after the introduction of more convenient gas hot water systems, and in the early twentieth century brands

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75 Neil Arnott, *On Warming and Ventilating, &c* (London 1838), pp 39-57.

76 *Builder,* XI, 547 (30 July 1853), p 495.

77 Edmund Beckett, *A Book on Building* (Crosby, Lockwood and Co, London 1876), p 198.

78 *Ramsay's Catalogue* [1949], § 39/11.

79 Melbourne, Centennial International Exhibition 1888-1889, *Official Record* (The Executive Commissioners, Melbourne 1890) p 893.

included the Royal, Little Hero, Silver Ace, Kangaroo, Empire and Little Wonder, though Douglasses seem by now to have gone over entirely to gas.[80]

The geyser was invented in Britain in 1868 by B W Maughan.[81] It was a gas fired bath heater which would heat a volume of water (from 2 to 19 litres) by about 22 to 28º Centigrade immediately and continuously. It might be of the sealed type in which the water passed through the heat in thin copper tubes, or of the unsealed type, in which the water flowed in a thin film from one shelf to another, in direct contact with the combustion products (which made it unsuitable for drinking).[82] In 1886 a geyser on Maughan's patent was shown at the Sydney Mechanical and Sientific Exhibition, and was reportedly able to heat three gallons [14 litres] of cold water to 100° in a minute[83] - the meaning of this is not entirely clear, but to heat the water to 100°C, or boiling point, was beyond the capacity of a typical geyser. Geysers were available in England during the 1880s in types including the Lightning, Calda, Maughan's Patent, Fletcher's and Hecla,[84] and in the 1890s in even more models - the 'Lightning', the 'Champion', Shanks's 'Tubal', 'Quick Hecla', Doulton's 'Paragon', 'New Rapids', 'Calda', 'Calda Dwarf', 'Liliputian', 'Wyman's Patent', 'Maughan's Patent', 'Fletcher's Patent High Power Instantaneous Water Heater,' 'Fletcher's Rapid Heater', and 'Fletcher's New Patent Wall Pattern Water Heater & Bath Heater'.[85] How many of these were available in Australia it is impossible to say, and those which were mayhave been rebranded, For example in 1913 James Moore & Sons of Melbourne were selling the 'Moor' chip heater,[86] previously unrecorded, and unlikely to be of local manufacture.

By 1914 J Tylor & Sons Ltd of Sydney were the sole Australian agents for Ewart's 'Califont' water heater, which was apparently gas fired, and designed to reticulate hot water to any part of a house.[87] This is one of the earliest local references to a multi-point water heater, of which the 'Ascot' was soon to emerge as the leading British type.[88] In 1941 Douglas & Co of Melbourne advertised the latest Douglas automatic gas hot water services of the streamline wall type, but the truly advanced form was the '"Brian" Gas-

80 Chandler, [catalogue], p 90.

81 Brian Roberts & Paul Yunnie, *The Magic of Hot Water* (Andrews Water Heaters, Wednesbury [West Midlands] 2001), p 90.

82 E L Oughton, 'Gas Heating', in A A Jones [ed], *Modern Heating and Ventilation* [3 vols, London, no date [c 1930]], II, p 156.

83 *Australasian Ironmonger,* 1 October 1886, p 163.

84 George Farmiloe & Sons, *General Catalogue* (revised ed, George Farmiloe & Sons, London 1885), pp 157-162B. For Fletcher's see Roberts & Yunnie, *Magic of Hot Water,* pp 44-6, and for the Calda, p 47.

85 T & W Farmiloe, *T. & W. Farmiloe's Miniature Catalogue* (Farmiloe, London 1894), pp 439-452.

86 James Moore & Sons Ppty. Ltd., *Price List 96 August 1913* (James Moore, Melbourne 1913), p 2.

87 C E Mayes, *The Australian Builders and Contractors' Price-Book* (8th ed, Sydney 1914), p 10. For Ewart's heaters see Brian Roberts & Paul Yunnie, *The Magic of Hot Water* (Andrews Water Heaters, Wednesbury [West Midlands] 2001), pp 60, 62, 63.

88 Oughton, 'Gas Heating', pp 137-140.

Automatic Water Heater', which supplied boiling water automatically as required, up to 47 gallons [260 l] a day. At the Napier Waller house in Ivanhoe, Melbourne, there survives a mains pressure electric hot water heater of unknown (but relatively early) date, made by Thomas Abbot & Co of Melbourne and Sydney, and branded 'T.H.M.' By 1954 there was a very large range of both mains pressure and storage systems on the local market. Solar heating arrived in the 1950s, and it was reported in 1955 that a CSIRO-designed solar hot water service was being tested in Alice Springs. £60 absorbers fed a seventy gallon [360 l] tank, and would provide hot water throughout the year, in a location where the same effect using electricity would cost £100.

### *e. incinerators*

Domestic incinerators have never played a great role in Australia, but in 1922 the Kernerator was being marketed by the American Wall Bed Co of Sydney,[89] and in 1935 by what was now the Kernerator and Wall Bed Co of Sydney, as well as by Norman Brook of South Melbourne, and by James Campbell & Sons of Brisbane. It was a built-in incinerator which presented a square hole in the wall surface.[90] By 1949 the company was Kernerator Incineration, of Alexandria, with representation in other states. The incinerator was claimed to be 'a product of the largest incineration company in the world', and it does not seem to have had any Australian content. Though the brand was registered with the Australian Patent Office there is no reference to any Australian factory, and even the literature is not geared to Australian conditions, as in 'Ordinarily, where there is a basement in the residence...'[91] Flat blocks were probably the major customers in Australia, one example being 'Maretimo', South Yarra, in 1939. Here there were chutes from the landing to take all the rubbish to the basement furnace (not necessarily a Kernerator).[92]

### *f. kerosene*

By 1851 a mineral oil obtained by distilling tar oils from a coal pit at Riddings, near Alfreton in England, had been given the name 'paraffine' [*sic*] from its lack of affinity for other substances, and had come into extensive use as a lubricant for machinery.[93] In 1853 a 'fluid called *Kerosene*' obtained from asphaltic rock in New Brunswick, USA, was used to generate gas, apparently

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89 *Building,* 12 October 1922, p 40.

90 J P Brogan, *101 Australian Homes* (Sydney, no date [c 1935]), p 122. A advertisement by the Kernerator and Wall Bed Co is reproduced in Eddie Butler-Bowden & Charles Pickett, 'The Fibro Frontier' (typescript, Sydney 1994), p 46.

91 F W Ware & W L Richardson [eds], *Ramsay's Architectural and Engineering Catalogue* (Melbourne 1949), § 51/4.

92 W Arthur, 'Melbourne's Latest Group of Modern Flats: Perpetuating the name of an Historic House', *Australian Home Beautiful,* VIII, 10 (1 October 1930), p 15.

93 Great Exhibition, 1851, *Catalogue,* I, p 187.

by firing pressurised air through it. By way of demonstration, the gas was used to light the Art Union Building, New York.[94] In 1854 the Canadian Abraham Gesner patented a process for distilling oil from coal, which he also called 'kerosene', but was otherwise known as 'coal oil'. After the discovery of oil at Titusville, Pennsylvania, in 1859, kerosene could more easily be refined from petroleum,[95] and this was exported as 'paraffin'.[96] Given the decline in the whaling industry and the consequent cost of whale oil, it is not surprising that kerosene quickly found a market for lighting purposes.

The first kerosene and kerosene lamps were imported to Melbourne by T W Stanford, arriving in the *Mary Bang*s on 13 March 1860.[97] By 1861 kerosene was being used at the Limestone Plains, near what is now Canberra,[98] and by 1863 the 'Kerosene Establishment' had been built on the south side of the Yarra in Melbourne.[99] W B Jones's Waverly Bond and kerosene stores were established in Maffra Street two years later, and some later structures survive on the site. In 1879 Young's Paraffin Light and Mineral Oil Company at Glasgow had agents in New South Wales, Mason Brothers, which suggests a substantial local business.[100]

Local production from shale began in 1865 at Mt Kembla and Hartley Vale. Mt Kembla produced more than a thousand tonnes in 1866, and up to three thousand tonnes a year during the next decade. At the Intercolonial Exhibition of 1866-7 John Graham of Sydney showed a block of kerosene shale from Wollongong and a case of 'Pioneer' brand kerosene oil. The Hartley Kerosene Oil and Paraffine Company (Limited) showed cannel coal or kerosene shale from the Hartley mine and tins of 'burning oil' or kerosene, and the Western Kerosene Oil Company also showed kerosene shale from Hartley. William Keene, the New South Wales Examiner of Coal Fields, showed (*inter alia*) kerosene shale from Colley Creek, Liverpool Plains, and Burragorang near Picton.[101] The industry expanded fairly continuously until the twentieth century, but virtually died out between the two world wars, and was then briefly revived during and immediately after World War II.[102]

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94 *Builder,* XI, 568 (24 December 1853), p 774.

95 Mimi Sherman, 'A Look at Nineteenth-Century Lighting: Lighting Devices from the Merchant's House Museum', *APT Bulletin,* XXXI, 1 (2000), p 41.

96 Lane & Serle, *Australians at Home,* p 387, ref R Field, *Irons in the Fire* (Wiltshire 1984), pp 131-4. Lane and Serle date the first extraction of kerosene to 1850, and its production from petroleum to 1858.

97 Winston Burchett, *East Melbourne 1837-1977* (Melbourne 1978), p 119. See also *Illustrated Australian News,* 2 January 1871), cited in Michael Cannon, *Life in the Cities* (West Melbourne 1975), p 102. See also Victorian patent no 1097 to Thomas Welton Stanford, 9 March 1868, for improvements in the construction of lamps.

98 Lane & Serle, *Australians at Home,* p 387, ref D Dolan, 'Around the Auctions: Queanbeyan in the 1860s', *Australiana,* VII, 1, pp 22-3.

99 Lane & Serle, *Australians at Home,* p 387, ref R Chirnside to T Chirnside, 24 December 1863, Chirnside papers, MS 11127, La Trobe Collection, SLV.

100 Sydney Exhibition 1879, *Catalogue of British Section,* p 90.

101 Intercolonial Exhibition, *Official Record,* pp 60-61.

102 Ian Jack, 'Oil and Shale' in Judy Birmingham et al, *Australian Pioneer Technology* (Richmond [Victoria] 1979), pp 120-122.

Lighting by oil had already been greatly improved by the introduction of the Argand lamp, in which the wick was a hollow cylinder and the oil was wholly consumed, with little or no smoke or smell.[103] At the 1875 Victorian exhibition Douglas and Cameron showed as 'kerolier' amongst their other fittings, James Riddell showed reflecting lamps and reflectors for both gas and kerosene, John Danks also showed reflectors for both fuels, and James Prince of Melbourne showed Sibley's patent kerosene lamp and 'cooking apparatus'.[104] Kerosene was far less popular as a fuel for cooking purposes, but kerosene stoves were portable, and Rippingille's model, mentioned above, was being advertised in Australia in the 1880s. Others by local makers such as Simpson of Adelaide, also mentioned above, were shown at the Centennial Exhibition. In 1923 the Vacuum Oil Company was advertising the 'New Perfection' oil cooking stove.[105] By 1929 one could buy the possibly cognate Perfection Oil Cook [*sic*] stove, which had been 'built by men, but designed by a woman to meet the needs of women'.[106] This was the main type marketed by D & W Chandler of Melbourne, but there were also others such as the Queen of Scots and the Handy Outdoor Stove.[107]

Oil heating was being promoted in the 1920s by companies like William's Oil-O-Matic of Melbourne,[108] and after World War II individual oil-fuelled room heaters became common. The Vulcan claimed to have a 'revolutionary world patented stainless steel blue flame smokeless burner' as well as electric ignition and other convenient features.[109]

### *g. heating systems*

The engineer John Watt had apparently used steam to heat his own apartment in 1784-5, though not very successfully, and patents for heating by steam were granted to John Hoyle in 1791 and John Green in 1793. In 1794 Watt's partner Matthew Boulton, assisted the Marquess of Lansdowne in improving an apparatus which Green had installed in Landsdowne's library, but it was abandoned because of defects in the pipes and joints. Twelve months later Boulton installed an apparatus in the library of his friend Dr Withering. Despite its initial success, it gave off a disagreeable smell, apparently from the soldering of the joints, and was removed with the intention of relocating it to Boulton's own house, though this never

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103 *Cassell's Household Guide to every Department of Practical Life* (4 vols, London, no date [1869-71]), III, p 2.

104 *Official Catalogue of Exhibits, Victorian Intercolonial Exhibition, Melbourne, 1875* (Melbourne 1875), pp 145, 147.

105 V C Marshall, *The 'Herald' Ideal Homes Exhibition, Wirth's Park, Melbourne* [catalogue] ([Herald, Melbourne] 1923), p 74.

106 Alex Smith, *The Australian Home Carpenter* (Melbourne 1929), p 125.

107 Chandler, [catalogue], p 86.

108 *Australian Homes* (Melbourne 1927), pp 141-5. See also *Ramsay's Catalogue* [1949], § 40/2

109 *Australian House and Garden,* December 1965, p 105.

eventuated. In about 1798 Watt suceeded in heating his bath by steam, and from 1789 onwards Boulton and Watt installed steam heating in a number of mills.[110]

The first 'perfect' steam heating was installed in Lee's cotton mill at Manchester in 1799. In 1807 Robertson Buchanan published a pamphlet, *Essay on the Warming of Mills and other Edfices through the Medium of Steam,*[111] followed in 1815 by a more substantial work.[112] Meanwhile William Strutt used hot air to heat the Derby Mill in 1792-3, and probably helped his friend Charles Sylvester in the design of the system used at the Derby General Infirmary in about 1810.[113] In 1822 Thomas Tredgold published *On the Principles of Warming Public Buildings and Hot-Houses by Steam.* But neither steam nor hot weater heating had much impact in Australia before the end of the nineteenth century.

The use of hot water in radiators, as opposed to steam, was pioneered by the Marquis de Chabannes early in the nineteenth century, but was generally a development of much later date in Australia, However the principle was applied as early as 1856 in the Houses of Parliament, Melbourne. Here the Legislative Assembly Chamber was heated in winter by means of hot water circulating in pipes supplied from a large underground tank.[114] Hot water was used to heat greenhouses and conservatories, before it was used for central heating generally. In 1883 the glass houses of 'Rippon Lea', Melbourne, were reported to be heated by means of hot water piped from a 'Deard's Patent Boiler'.[115] This was a form of coil boiler in which the coil was not of wrought iron, as was the norm, but of cast iron, and in which the rings of the coil were set together with no space in between, so that the flame was kept entirely within. This increased the surface in contact with the heat, and was claimed to produce better results.[116] The 1889 catalogue of Boulton & Paul of Norwich reports that B W Chandler and the Hon H Miller of Melbourne had each bought the company's no 4 boiler[117] (Miller's was probably for his house 'Findon').

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110 George Cottam, 'An Account of the Origin and Progress of heating Hot-houses and other Buildings by the Application of Hot Water, instead of by Fuel or Steam', *Architecural Magazine,* June 1834, pp 172-3.

111 George Cottam, 'An Account of the Origin and Progress of heating Hot-houses and other Buildings by the Application of Hot Water, instead of by Fuel or Steam', *Architecural Magazine,* June 1834, p 175.

112 Robertson Buchanan, *Practical and Descriptive Essays on the Œconomy of Fuel, and Management of Heat* (author, Glasgow 1815). Cottam dates this to 1810, but I can find no reference to an edition earlier that this one, from the catalogue of the British Library.

113 Charles Sylvester, *The Philosophy of Domestic Economy* (Nottingham c 1810), cited in Elton Engineering Books, *Catalogue Number 13* (London 1998), pp 57-8.

114 *Argus,* 17 April 1856.

115 *Leader,* 1 December 1883, quoted in John Foster, *Victorian Picturesque* (Melbourne 1989), p 64.

116 John Hood, *A Practical Treatise upon Warming Buildings by Hot Water* (3rd ed, London 1897), pp 257-8.

117 Information from Tracey Avery, June 2003, citing Boulton & Paul's catalogue no 45 of May 1889, no 11 in the Boulton & Paul Archives, Norwich Record Office, 5/10/1998.

Some of the examples would have been conventional shell boilers, but others relied upon tubes carrying the water through a furnace, an idea even older than Strutt's reticulation of hot air. In 1866 William Blakey, of Britain, made an apparatus in which tubes passed through a furnace, alternately at opposite angles, and were connected by smaller pipes at the ends. The first successful tubular boiler, however, was not Blakey's, but that of the American James Ramsay, who in 1788 received a British patent covering boilers of various forms, one of them a coiled tube within a cylindrical fire box, linked with an annular water jacket surrounding the cylinder. This was the first of the coil boilers, while another of Ramsay's designs was what was to become known as the vertical tube boiler.

There were various other developments. The first water tube boiler with fire tubes inside the water tubes was that of Summers & Ogle in 1830, and the first with inclined water tubes connecting with spaces at the front and back was Stephen Wilcox's, of 1856. It was from the latter that the boilers of Babcock & Wilcox developed, the canonical model dating from 1867.[118] At the Centennial Exhibition in Melbourne, in 1888-9, a number of British boilers were shown, notably those of Babcock & Wilcox of Glasgow, who were soon to become prominent on the local scene. Their 'patent water-tube steam boilers' were awarded a gold medal,[119] and by 1894 they had their own branch in Sydney.[120] By now they had supplied industrial boilers to a number of major enterprises in Melbourne and elsewhere in Australia,[121] and we can assume that there many more commercial residential and greenhouse installations.

A major improvement in Britain was Thomas Potterton's boiler, patented in 1894. It was a rectangular boiler, the sides and top of which were hollow and contained water. Instead of the hot gases passing straight into the flue, they were made to step down through the water jacket before rising again, in the process of which much more of their heat was captured.[122] The Potterton boiler has not so far been documented in Australia. By contrast, 'Ideal' products are ubiquitous, this being the brand of the National Radiator

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118 Babcock & Wilcox Co, *Steam its Generation and Use, &c* (New York 1891 [1879]), p 29, apparently based upon a discussion by George H Babcock of a paper by Sterling on 'Water-Tube and Shell Boilers', VI, p 601.

119 Centennial International Exhibition, *Official Record,* pp 891, 975.

120 Babcock & Wilcox, *Steam,* frontispiece.

121 The Electric Light and Power Company and the Fitzroy and Richmond lines of the Melbourne Tramways [Babcock & Wilcox, *Steam,* p 123], the Australasian Sugar Refining Company [p 127], the Austral Otis Elevator & Engineering Co [p 132], the Dight's Falls Waterworks, the Crown Street Station Waterworks, Sydney, the Hydraulic Station, Newcastle [p 133], the Queensport Brick & Tile Co, Brisbane, John Sharpe & Sons, wood works [p 138], Cunliffe & Paterson, fruit preservers [pp 138, 144], James Miller & Co rope works [p 142], the W M Foster Brewery, and the tobacco factories of Moss, White & Co, Wm Cameron Brothers & Co and Dudgeon & Arnell [p 144], the Giant's Den Mining Company, Sydney, and the Pioneer Gold Mining Company of Yalwil, NSW [p 145], and Lewis Samuel, merchants, Sydney [p 148] (all Melbourne where not otherwise stated) .

122 British patent no 5182 of 13 March 1894, reproduced in Roberts, *The Quest for Comfort,* pp 18-19.

Company of Hull, England. At 'Holey Plain', Victoria, the 'Ideal' boiler of the conservatory survives, possibly from the early twentieth century. An Ideal no 525 boiler survives in the basement of 'Purrumbete', Victoria, where it served to heat the house, using solid fuel. John Danks & Son, of Melbourne and Sydney, illustrate three 'Ideal' boilers in their catalogue of 1906,[123] but state that 'All the Boilers and Radiators are made in Special Cast Iron by the American Radiator Co, for whom we are sole agents in Australia'. It is possible that this was merely an ill-expressed reference to the extensive range of boilers which they advertised in a separate catalogue, and not to 'Ideal' range - certainly later Danks literature on Ideal boilers makes no mention of an American or any other overseas connection.[124] They were still selling Ideal boilers in the early the 1940s,[125] but by 1949 Ideal boilers and radiators were distributed by Shanks & Co of Melbourne, and Swans Ltd of Sydney.[126] A competing product, apparently of local origin, was the Hammel gas steam radiator of Hammel Heating Pty Ltd, Melbourne, which by 1936 had been installed in a number of prominent Victorian buildings.[127] Pacific Heating also made gas steam radiators, together with a number of other appliances.[128]

John Danks referred to 'the tremendous strides that have taken place in heating buildings by hot water':

> The fact that a building, no matter how large, can be efficiently and thoroughly heated by one fire, that expensive chimneys, mantel-pieces, grates, &c., can be omitted, and that all the dirt, dust, ashes, and cleaning caused by the fires is done away with, are facts now well known. In cities, where building space is so valuable, the extra room gained by leaving out chimney flues and fireplaces, is an item that alone demands serious consideration, and the inducement to intending tenants that rooms are well warmed, will always bias them to rooms heated in this manner. Another advantage is that ventilators can be placed at the back of or under Radiators to admit fresh air, which is warmed before being diffused through the room, without having the oxygen burnt out of it, as is the case in Gas or Kerosene Stoves.[129]

At a sophisticated engineering level, George Vincent, of Melbourne and Sydney, dealt in both low pressure gravity systems and 'Reck' accelerated heating systems. He claimed over sixty installations in Melbourne, Sydney, Adelaide, Perth. Launceston, the Australian Capital Territory and

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123 John Danks & Son, *'Daspyl' Plumbers' and Engineers' Supplies* (Melbourne 1906), pp 181-4.

124 John Danks & Son Pty. Ltd., *Ideal Hot Water Supply* (Melbourne, no date), passim.

125 *Australian Home Beautiful,* January 1941, p 42.

126 *Ramsay's Catalogue* [1949], § 38/1.

127 *Journal of the Royal Victorian Institute of Architects,* xxxiv, 4 (September 1936), p iii.

128 *Journal of the Royal Victorian Institute of Architects,* xxxiv, 4 (September 1936), p xxiii.

129 Danks, *'Daspyl' Plumbers' Supplies,* p 180.

Christchurch.[130] Hot water radiators came in the various tubular forms which are well-known, but were always recognised as being intrusive and more or less ugly, as well as prone to collect dust and rubbish. Various forms of cases, guards or screens were developed, but between the wars there appeared the panel type, in which no discrete pipes were visible, but only a flat rectangular surface with a waffle pattern of recessed planes, as in the Ideal 'Classic'.[131] There was even a type, the Ideal 'Rayrad' which had a completely plane face set within a moulded frame.[132] In Australia Gardner & Naylor Pty Ltd of Melbourne appear to have developed their own 'Garnay' panel and convection systems, designed to be flush mounted in a wall surface.[133] The baseboard heater, which originated in the United States and had reached Britain by the early 1950s, must have appeared in Australia not long afterwards. This was a metal skirting with a heating element behind, which heated by both radiation and convection, for the metal surface radiated heat and air was warm was warmed by entering the base of the skirting and passing out the top. A more specialised development of the panel heater, which may or may not have reached Australia, was the Frenger ceiling panel, in which perforated metal plates were clipped onto a grid of overhead pipes.[134]

Chilson & Co.'s air-warming furnace: Great Exhibition of the Works of Industry of all Nations, *Official Descriptive and Illustrated Catalogue* (3 vols, Spicer Brothers, London 1851), III, p 1463.

Hot air heating attracted local interest at a surprisingly early date, though it canot have been much used. In 1859 the architect R A Love proposed to heat the second and third floors of the Bendigo Benevolent Asylum with a hot air installation 'after the ideas of Mr Chilton, of Boston, U.S.A.'. There was to be a furnace surrounded by a large air chamber, and the furnace was to be fired to a moderate temperature so that the air drawn in from outside was 'only heated rather than being burnt or decomposed.' It was admitted to any given room using a turnable valve, in combination with cold air controlled by another valve, so as to guarantee 'a very healthy, agreeable temperature'.[135] This is a reference is to the ‘air warming furnace’ of Chilson, not Chilton, shown at the Great Exhibition of 1851 by Chilson & Richardson of Boston.[136]

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130 *The Architectural Students Annual* (Melbourne 1913), p xxvii,

131 A A Jones, *Modern Heating and Ventilation* (3 vols, London, no date [c 1930]), I, p 102.

132 Jones, *Modern Heating and Ventilation,* I, facing p 103.

133 *Journal of the Royal Victorian Institute of Architects,* XXXIV, 4 (September 1936), p 1v; Robin Boyd, *Victorian Modern* (Melbourne 1947), advertisements, no page.

134 J R Kell, 'Heating of Larger Buildings', in Eric De Maré, *New Ways of Servicing Buildings* (London 1954), p 79.

135 Frank Cusack, *Candles in the Dark: a History of the Bendigo Home and Hospital for the Aged* (Carlton [Victoria] 1984), pp 30-31, quoting 'Architect's Report' in the *Second Annual Report of the Benevolent Asylum,* 1859. Cusack, p 37, confirms that the Chilton heating was in fact connected to all rooms.

136 Great Exhibition of the Works of Industry of all Nations, *Official Descriptive and Illustrated Catalogue* (3 vols, Spicer Brothers, London 1851), III, pp 1462-3.

Love had been in the United States, and probably drew on his own experience, but the Chilson stove was also illustrated in A J Downing's *Architecture of Country Houses,* a book which was well-known in Australia. It is shown as consisting of a firebrick lined grate, an iron container above the fire in which the air was heated, and air pipes leading off from it.[137] The idea that rooms should be heated by introducing large quantities of moderately warmed air, rather than small quantities of hot air, was also one of the two main propositions advanced by Henry Ruttan of Canada in his patent and in his book of 1862.[138] Ruttan's patent rights in the United States were bought by a group of Illinois businessmen in 1866, and the company they established, William A Pennell & Co, was to evolve into that of Isaac Smead, who by 1889 was the largest manufacturer of warming and ventilating systems in the United States.[139]

Modern ducted heating arrived only in 1960. The Melbourne engineer Frank O'Brien began importing ducted heating systems from both Britain and America after seeing the system used in England in 1959. He worked with Craig & Seeley Pty Ltd, after two years obtained a licence to manufacture ducted units locally, and ultimately established Brivis Ltd, one of Australia's largest makers. By 1969 ducted heating was common in industrial and commercial projects and was beginning to make inroads into the domestic market.

At the outset the ducting was made of galvanized iron, rectangular in section and welded at the joints, but subsequently cylindrical tubing was preferred, commonly insulated with asbestos. When the danger of asbestos was realised it was replaced with fibreglass blanket, which was found to cause problems after ten or fifteen years, when particles of fibreglass began to enter the ducting and be distributed with the air. Meanwhile in 1969 the Vulcan company had introduced 'Sidewinder' aluminium ducting, which could easily be bent around corners, and in 1970 they began to perforate it so as to absorb noise from the fan. This type was first used at Tullamarine Airport in 1970. By the early 1980s metal was being entirely replaced with durable polycarbonate components which were joined by 'snaplocking' rather than soldering or welding. Then Vulcan introduced 'Flexiwinder' ducting consisting of a spiral coil of nylon wound through flexible aluminium fabric and encased in a plastic sleeve. This had the merits that it would concertina together for transport, and could be taken through difficult spaces in the installation process.[140]

The 1955 experimental solar hot water heater at Alice Springs has been referred to. In about 1956-7 an Engish architect, E J W Curtis, designed a

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137 A J Downing, *The Architecture of Country Houses* (New York 1850), pp 477-8.

138 Henry Ruttan, *Ventilating and Warming of Buildings* (New York 1862), cited in Charles Wood, *Catalogue 129* (Cambridge [Massahcusetts] 2006), no 170. Ruttan was Vice-President of the Board of Agrulture of Upper Canada..

139 I D Smead, *Ventilation and Warming of Buildings* (Toledo [Ohio] 1889), pp 7-8.

140 Brett Howlett, 'The Historical Development of Ducted Heating' (BBldg essay, University of Melbourne 1992), pp 4-7.

solar house at Rickmansworth with double glazed façades to the north and south, and with a heat pump designed by an Australian, A S Miller. The pump was similar to that developed much earlier in Australia by the CSIRO and sold as a packaged domestic air conditioining unit by a number of American makers. Miller's design was produced commercially in England by Denco Miller Ltd of Hereford, who aimed to develop a model for Australia, and were seeking an Australian company to make it under licence.[141]

In 1957 the Association for Applied Solar Energy, of Phoenix, Arizona, conducted an international competition for the design of a solar house, and attracted about 1600 entries. Sixty were selected for publication, including three by Australians: R G Fitzhardinge of Sydney, Neville D Quarry, then of London, but otherwise of Melbourne, and Lynton W Reynolds & Alan Hough of Melbourne.[142] Solar heating now became a live topic in Australia. In 1961 it was reported that R Sheridan and M Juppenlatz, senior lecturers in mechanical engineering at the University of Queensland, had designed a prefabricated solar house. The sun's heat would be collected in water tubes on the roof and stored in a tank at 450º F, or used to drive a refrigerator. This would provide air conditioning, hot water and cooling. A model house was being built for testing on the roof of the Biological Sciences Building at the St Lucia campus. The rights were owned by the University, and private firms would be licensed to build the house, which was estimated to cost only 10 to 15% more than conventional timber houses.[143]

141 *Australian Home Beautiful,* December 1957, pp 28-31.

142 Association for Applied Solar Energy, *Living with the Sun, Volume 1, Sixty Plans Selected from the Entries in the 1957 International Architectural Competition to Design a Solar-Heated Residence* (Phoenix [Arizona] 1958), *passim.*

143 *Cross-Section,* no 104 (1 June 1961), p 3.