

## 6.02 *Brick Burning*

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### *hacking*

Traditionally, hand moulded bricks were turned out gently onto the ground and left to dry until they were hard enough to be built into low stacks or 'hacks' for continued drying. This initial drying period was an anxious time because rain could ruin the bricks, but once they were in hack a degree of protection could be provided, even where an actual shed was not available. A variety of bagging and sheet materials were used in Britain, as was thatch. The same is true in Australia. A Melbourne suburban brickyard offered for sale in 1878 included grass and hurdles,<sup>1</sup> and 'thatched covers' were used Robert Selkirk's brickworks at Allendale, Victoria, in the 1880s.<sup>2</sup> Sawyer's yard at Horsham, further to the west, presents some puzzles. The bricks were borne off either directly to the hacks, which does not explain how the initial drying was achieved, or - even more mysteriously - onto 'bowling stools' which were moved forward as the hacks advanced. The hacks were in the open air, protected only by grass gathered from the commons, and by paling hurdles on the windward side. The drying time was typically three months.<sup>3</sup>

### *clamps*

When the bricks were dry enough they would be put into a kiln or clamp, but 'steamed' before being actually burnt - that is, heated at a relatively low temperature to drive the moisture off, usually for a matter of days, before the full heat was applied. In earlier years bricks would have been burnt in clamps, and we may view with some scepticism the claim that a chimney, which appears in a 1791 view of Parramatta,<sup>4</sup> is that of a brick kiln. The clamp was a stack of bricks, encircled with a skin of old or reject bricks and plastered with clay. Spaces, or 'liveholes', were left at the bottom for fuel, and it was fired gently until steam ceased to rise from the bricks, then the top

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<sup>1</sup> Hazard's Brick Yard, Glass St, Essendon, *Argus*, 21 September 1878, p 27.

<sup>2</sup> Norman Houghton, *A Century of Country Clay* (Ballarat 1983), p 2.

<sup>3</sup> James Cowell, 'Pioneers of Brickmaking: History of Horsham Works', typed extract from the *Horsham Times*, 23 June 1936 (held by the Horsham Historical Society), p 2.

<sup>4</sup> Tim McCormick et al, *First Views of Australia 1788-1825* (Chippendale, NSW, 1987), p 46.

was covered over and the fires increased. When the bricks were white hot the liveholes were bricked up and plastered over, and the whole thing left to complete the burning, and the cooling, without interference.

So far, this describes the Dutch clamp, which is prone to produce clinkers, or overburnt bricks, near the fires, and doughboys, or underburnt ones, elsewhere. The common English clamp differs principally in three ways: the lower courses have layers of ashes or breeze between them, a proportion of the firing material is dispersed throughout the stack, and the liveholes are continuous from one side to the other. This gives more uniform burning but less possibility of control by adjusting the fires at the liveholes. The Scotch clamp has the discontinuous liveholes of the Dutch one, but some of the fuel is mixed into the clay itself, so that the fire spreads more uniformly through the stack, but at the expense of creating some irregularities in the bricks as the fuel burns out. Sawyer's yard at Horsham used 'open kilns', probably meaning clamps, in which 50,000 bricks were burnt at a time. They were given three days of steaming and seven of burning, using twenty cord of timber for each kiln.<sup>5</sup>

No good illustration survives of a local clamp, but Salmond reproduces an excellent view of one in New Zealand, with four liveholes along the side, and there is a detailed description of the process as used by the Cox Brothers of Adelaide in 1867:<sup>6</sup>

The material in the first place is mixed with a due proportion of wood or coal ashes, and the mixture, having been saturated with water is shovelled into the 'pug-mill', a machine worked by a horse, and the effect of whose action is to thoroughly knead the soil and ashes together, and turn them out from an aperture near the ground in the form of a thick moist paste. When this is done, the first step in the making of a brick is accomplished, and this step is a very important one; for by the process of burning bricks adopted as this yard unless the same proportion of ashes is always mixed with the earth, the bricks are liable to be over-burnt and injured ... the mixing operation belongs to this, the first stage of the work, and so great is the care exercised in the process that every brick made is said to have as nearly as possible the same quantity of ash in it. To show this, a brick or two not yet dried, were broken, and the black ashes were seen scattered equally through each, like plums in a well regulated Christmas pudding.

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 Instead of there being a kiln with a large wood fire kept blazing in it, whilst the bricks are drying, they are simply made into a great stack, there being a small hole about the size of an ordinary fireplace left at some part of the stack near the ground. In this hole a fire is lit, and is allowed to burn one day, when the opening is closed up and the bricks are left to carry on their own burning. This, on account of the ashes contained in them, they do by conveying the fire from one to another, and in a very short time the whole stack becomes too hot to be touched. Of course the self-burning process thus followed would not answer with bricks made without ashes; but with that ingredient in them, so readily do they burn that a fresh stack piled by the side of the one first heated, would

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<sup>5</sup> Cowell, 'Pioneers of Brickmaking', p 2.

<sup>6</sup> Jack Diamond Collection, reproduced in Jeremy Salmond, *Old New Zealand Houses 1800-1940* (Auckland 1986), p 47.

gradually receive sufficient warmth to become thoroughly dried without the assistance of any additional fire.<sup>7</sup>

Clamp burning remained the norm in Australia for most of the nineteenth century. In Sydney the common bricks in the Macleay Museum at the University, as late as 1884-7, appear to be handmade and clamp burnt, with cinders in the mixture and crude heart-shaped frogs. In 1860 there were still no kilns in Victoria, where the industry was probably most advanced, and this is not necessarily a sign of backwardness, for the majority of bricks in London and the home counties were still clamp burnt even in the late 1880s.<sup>8</sup> In Canada the 'scove kiln', as the clamp is called there, was in use into the second half of the twentieth century.<sup>9</sup> Adelaide was exceptional, for by 1868 William Shearing had a total of five kilns in his three yards in the Hindmarsh area.<sup>10</sup> Morphett & Scown's brickyard advertised in 1878 that their bricks were burnt in a 'close kiln'<sup>11</sup> and George Shearing was using a kiln by the end of 1879.<sup>12</sup> Even so, kilns were exceptional in the city even in 1889.<sup>13</sup>

### *simple kilns*

The most basic sort of kiln may operate in exactly the same way as the clamp, but that the stack is surrounded by three or four permanent walls, still provided with openings or liveholes for feeding the fires. In such a kiln the heat distribution is as uneven as in a clamp, and there will be a high proportion of clinkers and doughboys. This was essentially the state of the art in mid-nineteenth century Britain. The standard text was Dobson's *Rudimentary Treatise on Bricks and Tiles*, of 1850, and it shows kilns of this sort: a rectangular brick kiln<sup>14</sup> and a circular tile kiln with a domed roof.<sup>15</sup>

At Dover, to the south of Hobart, are the remains of what is described as a mud-built kiln, seeming possibly too date from the 1840s or 1850s, or more certainly from before 1878.<sup>16</sup> A Melbourne brickyard advertised for sale in that year, included only 'kiln walls'.<sup>17</sup> The precise form of these kilns is not known, but others appear in illustrations. A kiln at Merrigum, in the Goulburn Valley of Victoria, was a simple unroofed rectangle of very thick brick walls, reducing somewhat with height, and with so wide an aperture at one end that it was virtually a U-shape. Such kilns were

<sup>7</sup> Noris Ioannou, *Ceramics in South Australia 1836-1986: from Folk to Studio Pottery* (Netley [South Australia] 1986), p 113, quoting *Observer*, 9 November 1867.

<sup>8</sup> Henry Ward, *Brickmaking* [offprint from Institution of Civil Engineers, *Minutes of Proceedings*, LXXVI, iv (1885-6)], (London 1886), pp 2-6.

<sup>9</sup> T Ritchie, 'A History of the Tunnel Kiln', *APT Bulletin*, XII, 3 (1980), pp 47-8.

<sup>10</sup> Ioannou, *Ceramics in South Australia*, p 106.

<sup>11</sup> Ioannou, *Ceramics in South Australia*, p 104.

<sup>12</sup> Ioannou, *Ceramics in South Australia*, p 105.

<sup>13</sup> Ioannou, *Ceramics in South Australia*, p 111, quoting the *Observer*, 4 August 1889.

<sup>14</sup> Edward Dobson, *A Rudimentary Treatise on the Manufacture of Bricks and Tiles* (London 1850), Part I, pp 60, 75-7, 79.

<sup>15</sup> Dobson, *Bricks and Tiles*, pp 104-5.

<sup>16</sup> Information from Mr Beechey of Dover, 1986, including a copy of a lease plan of 1878 in the name of David Chapman, who is believed to have operated a sawmill as well as manufacturing clay products.

<sup>17</sup> *Argus*, 12 October 1878, p 16.

also found in the various brickworks of F Baker & Sons in the East Maitland area of New South Wales. At Metford in 1888 Baker was burning in clamps, but in 1894 in an open updraught kiln.<sup>18</sup>

A kiln which survives at 'Holey Plains', Victoria, appears to have been used to burn common bricks for extensions to the house in about 1900. It is a rectangle with internal dimensions about 6.3 x 4.5 metres, and walls about seven bricks thick at the base, reducing to five above. The opening to give access to the interior is in the long side, which may indeed have been largely open in the first instance, though it was later built in to create a narrow doorway. There are three liveholes in each of the end walls.

### *continuous kilns*

A brick kiln of this character takes a long time to heat up and a long time to cool down, and during the latter phase a great deal of heat goes to total waste. This problem was partly or wholly obviated by James Gibbs and Thomas Ainslie's invention of the continuous kiln.<sup>19</sup> This is worth mentioning here because it was devised and brought into use long before the development of the Hoffman kiln, which is regarded by most writers as the effectively the first continuous model. Ainslie's kiln was described in the English *Builder* in 1846 as:

composed of various compartments, by which the heat from the first passes into the second, from thence to the third, and so on - thus economising on fuel; and, when the tiles in the first are burnt, the second are half-burnt, to which the greatest heat is then applied, and the chambers are taken in succession - the thorough drying of the bricks being completed by using the heat after burning. This new apparatus has been proved on a very large scale; and unlike the common method, by which, frequently one quarter of the article is spoiled, in this every brick and tile is said to be as perfect in shape as it entered, and ... thoroughly burned.<sup>20</sup>

It is not entirely clear whether the Ainslie kiln was linear or circular, which it would need to be to be truly continuous.<sup>21</sup>

Even in the 1880s there were semi-continuous linear kilns in Britain, and Henry Ward described one of Bull's type which he himself installed at Pluckley. It consisted simply of two side walls, similar to a Scotch kiln, with side fires, but was about sixty metres long, and the fires were started at one end, only gradually extending towards the other. The top was sealed with 150 mm of clay, within which were placed cast iron feed holes, through which coal dust could be inserted. Two portable iron chimneys were used to obtain a draught, and the Kiln was divided at intervals with sheet iron dampers to prevent back draughts, and to keep the heat towards the bottom

<sup>18</sup> D S Baker, *Yeomen to Brickmasters* (no place, 1986), pp 101-2.

<sup>19</sup> James Gibbs and Thomas Ainslie are said to have patented multi-chamber kilns in 1841 and 1843: Martin Hammond, *Bricks and Brickmakers* (Aylesbury [Buckinghamshire] 1981), p 23.

<sup>20</sup> *Builder*, IV, 200 (5 December 1846), p 585.

<sup>21</sup> One of the few writers to refer to Ainslie is Alan Cox, *Survey of Bedfordshire. Brickmaking: a History and Gazetteer* (Bedford 1977), p 43. Presumably Woodforde's reference to a tunnel kiln in 1845 is also to Ainslie's: John Woodforde, *Bricks to Build a House* (London 1976), p 120.

(this was achieved by opening them only partially in the first instance). The kiln was in this instance a more or less temporary one, used to burn the bricks from which the works themselves were built, and it was superseded by a Hoffman kiln. However it was said that kilns of this sort had been successful in India.<sup>22</sup>

Those kilns discussed so far (presumably including Ainslie's) are known as updraught kilns because the heat rises through them, by contrast with the next type. Such a kiln may give better spread of heat and more uniformity in the product if the heat is introduced through a perforated floor, rather than from the sides. This form was known from Roman times, but seems to have been little used in the nineteenth century, and the perforated floor becomes common only with the appearance of the downdraught kiln. In this the heat is introduced at the sides, usually behind a baffle, known as a flash wall or bag, to keep it from direct contact with the adjoining contents. The hot gases rise to the vaulted or domed top of the kiln, and are then sucked down through the stack to a perforated floor with a flue leading to a nearby stack.

### *downdraught kilns*

Later editions of Dobson's text illustrate and describe the Hoffman kiln,<sup>23</sup> but even now he does not illustrate the simple downdraught kiln. This suggests that British practice jumped straight from the primitive updraught kiln to the sophisticated Hoffman, which seems also to be the case in Canada<sup>24</sup> and in Australia. It is unlikely that the process was quite as simple as that in Britain, but it is probably true to say, firstly that brick kilns were far from standardised prior to the sweeping success of the Hoffman patents, and secondly that downdraught kilns were not in general use for brick burning. Potteries were slightly more advanced, and Gilbert Redgrave, writing perhaps in about 1880, put it:<sup>25</sup>

We may state briefly that the two chief methods are respectively known as the up-draught and the down-draught ... The ordinary up-draught is the old-fashioned plan, and the down-draught principle, which, when properly managed, saves a considerable amount of fuel, is of more recent introduction.

It would seem that intermediate kiln designs were perhaps more advanced on the Continent and in the United States than they were in Britain, though the actual illustrations that can be cited here all post-date the invention of the Hoffman. An American text of 1884 illustrates a rectangular kiln, invented by W N Graves, which could be made to operate upon either the updraught or the downdraught principle,<sup>26</sup> but of a form basically similar to the downdraught kilns subsequently found in

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<sup>22</sup> Ward, *Brickmaking* pp 20-21.

<sup>23</sup> Edward Dobson, *A Rudimentary Treatise on the Manufacture of Bricks and Tiles* (8th ed, London 1886), p 238.

<sup>24</sup> Where the downdraught kiln was in use 'by 1872': Ritchie, 'History the Tunnel Kiln', p 49.

<sup>25</sup> G R Redgrave, 'Brick and Tile-Making - II. Terra-Cotta, Bricks and Tiles', *The Technical Educator* (London, no date [published in parts, ?c 1880]), pp 205-6.

<sup>26</sup> C T Davis, *A Practical Treatise on the Manufacture of Bricks, Tiles, Terra Cotta, Etc* (Philadelphia 1884), pp 151-6.

Australia. Here, however, more primitive forms continued in use until well into the twentieth century.

In about 1910, or at any rate not long before the yard was abandoned in 1913, Bakers built a small four-hole downdraught kiln as their first experiment with the type. Some time later an eight hole downdraught was built at the new yard at Raworth.<sup>27</sup> In Victoria Robert Selkirk moved his yard from Allandale to Ballarat in 1900, and apparently built updraught kilns, but immediately began accumulating bricks for the construction of two more sophisticated coal-fired downdraughts. By 1905 Selkirk decided to install a Hoffman kiln.<sup>28</sup> In South Australia Job Hallet began converting to downdraught kilns in 1907.<sup>29</sup> In Tasmania long downdraught kilns were used at the Dulverton Brickworks in 1914, but whether they were common before that is unclear.<sup>30</sup> The history of two or three companies does not in itself prove anything, but the relative *absence* of reference to earlier downdraught kilns is certainly significant, for it is usually the newer and more advanced technology which receives the publicity.

A French text, Lefèvre's *Architectural Pottery*, published in an English translation in 1900, illustrates a square, open-topped kiln with a perforated floor,<sup>31</sup> an improved version of the updraught principle, and then discusses vaulted kilns, both updraught and downdraught (referred to as 'direct flame' and 'reversed flame'), and both square and round.<sup>32</sup> A round downdraught kiln is illustrated, but it is very unlike the pottery kilns found in Australia. A second French text, Bourry's *Treatise on Ceramic Industries*, was published in an English translation in 1901. It illustrates both a rectangular and a round downdraught kiln,<sup>33</sup> but again very different from Australian examples. The rectangular kiln as illustrated has a series of flues rising in a row of stacks along one side, though it is conceded in the text that a single stack may be used if the kiln is not too long. In the round kiln the heat enters not only by way of six very small pockets or bags around the circumference, but also from a central aperture. In both kilns the apertures in the floor are discrete and relatively few in number, compared with the continuous grid arrangements common in Australia.

### *round kilns*

The American situation seems closest to Australian developments. In 1905 the Wilson Kiln & Dryer Co of Pittsburgh advertised improved kilns, square, round and continuous, end and side fire; hot air and steam tunnel driers; steam or hot air dry floors; and test kilns of any size. They illustrated a rectangular downdraught kiln with a row of seven flues along each flank.<sup>34</sup> At the same time an existing brick and tile works which was offered for sale included two circular kilns tied with steel bands,

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<sup>27</sup> Baker, *Yeomen to Brickmasters*, p 134.

<sup>28</sup> Houghton, *A Century of Country Clay*, pp 3-6.

<sup>29</sup> Ioannou, *Ceramics in South Australia*, p 210.

<sup>30</sup> Frank Bolt, *Vanishing Tasmania* (Kingston [Tasmania] 1992), pp 82-3.

<sup>31</sup> Leon Lefèvre, *Architectural Pottery* (London 1900), p 198.

<sup>32</sup> Lefèvre, *Architectural Pottery*, pp 201-8.

<sup>33</sup> Emile Bourry, *Treatise on Ceramic Industries* (3rd ed, London 1919 [1901]), pp 213-4.

<sup>34</sup> *Clay Record* (Chicago), XXVI, 1 (16 January 1905), p 54.

very similar to later examples in Australia.<sup>35</sup> Gurcke illustrates a surviving American example which also seems to resemble the Australian circular type.<sup>36</sup>

The next major English text was by Alfred B Searle (who had been the translator of Bourry), and it is as much the twentieth century classic on brickmaking as Dobson is the nineteenth century one. Searle's *Modern Brickmaking* appeared first in 1911, and finally in 1953, and Searle himself was consulted even by brickmakers in Australia, such as Goodlet & Smith of Sydney.<sup>37</sup> He illustrates a round downdraught kiln no different in principle from those used in Australia, but once again different in form.<sup>38</sup>

According to Searle there are usually ten or twelve fireholes in a round kiln, and these are shown as entering relatively small semicircular pockets, though the alternative of a continuous 'flash-wall' or screen is mentioned. The flue for extracting the hot gases is at the centre of the floor, and though he illustrates a floor with some perforations, he explains that in most examples the floor is solid apart from this central flue. The chamber is roofed with a shallow dome, but this is set in a solid mass of masonry with a flat roof on top. The walls are required to be of a considerable thickness and, according to Searle, must usually be surrounded by iron bands to prevent damage by expansion.

The form of the beehive or round kiln today seems fairly standardised from one place to another within Australia. That is probably a phenomenon of recent date, as the efficiency of the presently canonical type has enabled it gradually to prevail over the varying forms which formerly merged into the spectrum of the double chamber and bottle kilns. At the Bristle site itself the earlier and now demolished kilns were considerably smaller, and possibly quite different in design. There are still some surprising variations to be seen, as in the five kilns at Cessnock, New South Wales, in which the stack rises directly out of the crown of the dome. Normally one would take this to indicate an updraught kiln, but the stack in fact continues down to floor level and the hot gases are extracted through the floor in the normal way. Here the floor is solid in a ring immediately surrounding the stack, but is perforated elsewhere. Similar kilns at an American hollow tile works were illustrated in 1913 by Frederick Squires, and his text confirms that they were of the downdraught type.

At the Thornleigh Brickworks, near Sydney, a series of domed kilns were built from 1912 onwards, but photographs seem to show a quite distinctive design with the dome rising from a square base.<sup>39</sup> In other examples there are variations in the form and pattern of the perforation, which is sometimes of specially formed bricks and sometimes of standard ones, and is in some cases radial in design and in others a uniform rectilinear grid. There are also variations in the flash wall, which may be continuous, or may take the form of a separate bag at each fire hole. The stack is

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<sup>35</sup> *Clay Record*, XXVI, 1 (16 January 1905), p 53.

<sup>36</sup> Karl Gurcke, *Bricks and Brickmaking: a handbook for Historical Archaeology* (Moscow [Idaho] 1987), p 33, fig 11(c).

<sup>37</sup> A W Johnson, 'Goodlet and Smith Ltd. Brickworks, Roofing Tile Manufacturers, Cement Works & "Benedict Stone" Manufacturers. Granville, N.S.W. (1886-1982)' (3 vols, major project for Historical Archaeology II, University of Sydney, 1982), p 7.

<sup>38</sup> A B Searle, *Modern Brickmaking* (London 1911), pp 248-9.

<sup>39</sup> I Austin, 'Thornleigh Brickworks' (3 vols, Project for Historical Archaeology, University of Sydney, no date, unpaginated).

(except at Cessnock) detached from the kiln and usually (but not at the Bristle site) serves one kiln exclusively. An illustration of the Brick and Drainpipe Works at Lithgow, New South Wales, in 1913, shows two types of circular kiln. One is large, with vertical sides bound by straps, and with a domed top: all quite standard except that the flue, which is only partly visible, seems to emerge above ground level and slant even further upwards before entering a square vertical stack. The other kilns are smaller and more distinctive, with battered sides contained by raking stanchions (probably rails) bound around only at the top. The roofs are much flatter, perhaps in the form of flat cone rather than a dome, and there are square chimneystacks either adjoining or attached to each kiln.<sup>40</sup> An illustration of the Marrickville works of R Fowler Ltd in 1935 shows (in addition to a number of bottle kilns), five circular kilns which are apparently of the canonical type, served by common flue.<sup>41</sup>

Searle's rectangular kiln might have a single separate chimneystack, two smaller ones at either end, or a row of very small chimneys, one to each fire, rather like that described by Bourry. Although he illustrated the last type,<sup>42</sup> he described the first, with a single stack, as being the best. His illustrations, apart from the number of stacks, come very close to the design found in Australia. The roof is a barrel vault, expressed externally as well as internally, and iron stanchions are shown along either side, linked in pairs by tie rods passing over the crown of the vault.

### *rectangular kilns*

Rectangular kilns in Australia never seem to have the rows of separate stacks shown in overseas texts, but some do have two stacks per kiln, either on the same side or diagonally.<sup>43</sup> Many are constructed with iron stanchions joined across the top with tie rods, and these stanchions are made of tram track not only at the Bristle site but also at the former James Brickworks, Woodville, Adelaide; at the Waterloo (Four Mile) Brickworks near Maitland; and at Mashman's Pottery, Kingsgrove, Sydney. At Mashman's the present proprietor was able to name the source as the old Rockdale Tramline. Despite these similarities, there are many variations between Australian examples, not only in size and number of fire holes (up to 26), but in the shape of the vault, which in some cases is a flatter segment; in the use of heavily battered walls; in the size and form of the wicket or access door; in the floor perforations;<sup>44</sup> and in other details. Peter Freeman illustrates one example in which timber posts rather than iron stanchions are used for the surrounding armature.<sup>45</sup>

Nevertheless it is true that Searle illustrated in 1911 a rectangular kiln similar to the common Australian form, though his circular kiln is different. According to Searle the circular type had been for many years the most popular single draught kiln,

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<sup>40</sup> E J Brady, *Australia Unlimited* (Melbourne, no date [c 1915]), p 103.

<sup>41</sup> R Fowler Ltd, *Catalogue of Fowler Enamelled Fireclay Ware* (Marrickville [New South Wales] 1935), pp 10-11.

<sup>42</sup> Searle, *Modern Brickmaking* (1911), pp 252-3.

<sup>43</sup> The F Baker & Sons brickyard at Raworth, East Maitland, included kilns of both types. See D S Baker, *Yeomen to Brickmasters* (no place, 1986), pp 109, 110.

<sup>44</sup> At the Waterloo kilns only the central band of the floor is perforated.

<sup>45</sup> Referred to as Dixon's brickworks, but not located: Peter Freeman *The Homestead: a Riverina Anthology* (Melbourne 1982), p 77.

but for bricks the rectangular pattern had obvious advantages, and was also cheaper to construct.<sup>46</sup> In Australia the rectangular kiln seems to have been commoner than the circular one, but the same distinction applies, the former being used for bricks, and the latter for other ware such as pipes and tiles. At the Bristle site the round kilns were used for pipes and the rectangular for tiles.

Notwithstanding Warwick Gemmell's claim to the contrary,<sup>47</sup> there is no evidence of the use of downdraught kilns in Australia before the appearance of the Hoffman kiln in 1870. In other words, the construction of single intermittent downdraught kilns is probably attributable to the small scale of operations, or to limitations of capital, rather than to a primitive level of technology. Some of the best recently surviving examples of rectangular downdraught kilns were at the brickworks established by Francis Gulson at Goulburn in 1884,<sup>48</sup> but the dates of the kilns themselves are not known. The oldest surviving examples are not claimed to be older than about 1910, and there are no clear photographs of an earlier date that show either of the standard designs here discussed. On the contrary, in fact, the evidence suggests that kiln designs were far from standard before World War I.

### *the Hoffman kiln*

The Hoffman kiln, was an annular downdraught kiln around which the fire moved continuously. Whether Ainslie's kiln had been annular is unclear, but by taking this form the kiln could operate unceasingly, and it is therefore known as a 'continuous' as opposed to an 'intermittent' type. In the Hoffman kiln, as in Ainslie's, the exhaust gases are drawn over the bricks yet to be burnt, thus drying and pre-heating them, and the air to feed the fires is drawn over the already burnt bricks, thus pre-heating it while cooling them. This, which is the principle of the heat exchanger, saves a very large proportion of the fuel.

Frederick (or Friedrich) Hoffman is said to have designed his kiln in 1856,<sup>49</sup> but the first example was built at Schleswig-Stettin in Germany in 1858.<sup>50</sup> The Hoffman patent dates from 1858<sup>51</sup> or 1859.<sup>52</sup> The first English example was built in 1862<sup>53</sup> at the Roundwood Brickworks, Wakefield, the founder and manager of which was John Craven,<sup>54</sup> the partner in Bradley & Craven, the prominent manufacturers of brickmaking machinery. In about 1863-4 a Hoffman kiln of twenty-four chambers

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<sup>46</sup> Searle, *Modern Brickmaking* (1911), p 248.

<sup>47</sup> Warwick Gemmell, *And So we Graft from Six to Six* [North Ryde, NSW, 1986], p 20, claims that downdraughts begin to replace clamps and Scotch kilns in about 1860.

<sup>48</sup> Alfred Barbara, 'Terra Cotta in Sydney Architecture 1788-1914' [2 vols, BArch, University of New South Wales, no date (1978)], II, p 24.

<sup>49</sup> Martin Hammond, *Bricks and Brickmaking* (Aylesbury [Buckinghamshire] 1981), p 23.

<sup>50</sup> Iain Stuart, 'The History and Archaeology of the Hoffman Brick and Tile Company, Melbourne, Australia,' *Industrial Archaeology Review*, XVIII, 2 (Spring 1995), p 130, citing the *Clay Products Journal of Australia*, October 1958, pp 809, apparently derived in turn from an unidentified periodical, *Claycraft*.

<sup>51</sup> Hammond, *Bricks and Brickmaking*, p 23.

<sup>52</sup> A B Searle, *Modern Brickmaking* (London 1911), p 264.

<sup>53</sup> Hammond, *Bricks and Brickmaking*, p 23.

<sup>54</sup> Stuart, 'Hoffman Brick and Tile Company', p 130, citing *Clay Products Journal of Australia*, October 1958, pp 8-9.

was built at Moore's Hayfield Park brickworks, near Belfast.<sup>55</sup> By this time there were reportedly about fifty of them in operation in Britain and on the Continent.<sup>56</sup> An English visitor to the United States in 1890 reported that the Hoffman kiln did not appear to have been introduced there so far,<sup>57</sup> but by now were proliferating in Australia.

In 1867 Hoffman & Licht of Berlin showed the kiln at the Exposition Universelle at Paris, where it was awarded a grand prize.<sup>58</sup> It seems still to have been in the original circular form, and R S Burn reports it as the 'annular kiln', without naming the inventor.<sup>59</sup> This was to be followed an oblong version with curved ends, but in 1870 Hoffman devised the rectangular version of it.<sup>60</sup> The English patentee was H Chamberlain, who devised his own improvements,<sup>61</sup> so that it is difficult to know to what extent the later forms of the kiln derive from him rather than from Hoffman. In 1886 Henry Ward described a Hoffman kiln which he had installed at Pluckley in England, explaining that it was now of the oval rather than the round form, and had fourteen rather than twelve chambers, to allow more time for drying the bricks. Each compartment had a damper, usually of sheet iron, to prevent the draught blowing backwards.<sup>62</sup>

The Hoffman patent was extended in Victoria in 1865,<sup>63</sup> and two years later William Addis, of Glenelg, applied for a South Australian patent for what must also have been the Hoffman kiln, described as a series of chambers in a circular arrangement, sharing a common flue, in which the heat from one oven was utilised in drying out and partially firing the contents of the next.<sup>64</sup> In Sydney J H Goodlet appears to have held the Hoffman patents, but sold or licensed them in 1878 to the Junction Brick and Pottery Company, which was later taken over by his own company, Goodlet and Smith.<sup>65</sup>

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<sup>55</sup> Dobson, *Bricks and Tiles* (1886), pp 241-2, quoting a paper by Professor James Thomson of Belfast of 5 January 1864.

<sup>56</sup> Akira Satoh [ed Ralph Morton], *Building in Britain, the Origins of a Modern Industry* (Aldershot [Hampshire] 1995 [1986]), p 185, citing the 1868 edition of Dobson, *Bricks and Tiles*, which apparently relies upon same paper by Thomson, the detail from which was reduced in later editions of Dobson. Even in 1886 there were said to be only sixty Hoffman kilns operating in Britain and on the Continent, but that must have been an out-of-date estimate: Edward Dobson, *A Rudimentary Treatise on the Manufacture of Bricks and Tiles* (8th ed, London 1886), p 238

<sup>57</sup> C D Elliott, *Technics and Architecture* (Cambridge [Massachusetts] 1992), p 43, quoting W Johnson, 'Brickmaking in America', *American Architect and Building News*, 28 (7 June 1890), p 147, reprinted from *Architect*.

<sup>58</sup> Pierre Chabat, *La Brique et la Terre Cuite* (Paris 1886), p 253; reported as 'Hoffmann'.

<sup>59</sup> Burn, *Modern Building and Architecture*, p 99.

<sup>60</sup> Hammond, *Bricks and Brickmaking*, p 24.

<sup>61</sup> Dobson, *Bricks and Tiles* (1886), pp 238, 244.

<sup>62</sup> Ward, *Brickmaking*, pp 21-2, figs 15-17.

<sup>63</sup> No 870 to Friedrich [sic] Hoffman (by Alfred Vincent Newton), 25 November 1865. Newton appears to have been a British patent agent.

<sup>64</sup> Ioannou, *Ceramics in South Australia*, p 112.

<sup>65</sup> Information from Iain Stuart, 1995.

The kiln reached Australia when the Hoffman Patent Brick & Tile Company<sup>66</sup> began operations at Dawson Street, Brunswick, in 1870, with a circular Hoffman kiln. The company added an oblong one in 1871-2 and a third, apparently also oblong, in 1875.<sup>67</sup> Despite a number of difficulties with the new technology the company produced 120 million bricks in its first nine years.<sup>68</sup> In Sydney Goodlet & Smith established a new yard at Waterloo in 1876 with an annular kiln<sup>69</sup> - presumably the original round Hoffman type, which was by now rather old-fashioned. The first Hoffman kiln in South Australia was built by the City and Suburban Steam Brickbuilding Company at Blackwood, in about 1882.<sup>70</sup>

The South Brunswick Company, which began operations in 1886 on a site between those of the Hoffman Company and the Brunswick Company, had a Hoffman patent kiln 'with the latest improvements.'<sup>71</sup> Similarly, the prospectus of the Houghton Park Brick Company (soon to become the Box Hill Brick Company) in 1885 promised to have the most up-to-date Hoffman kilns.<sup>72</sup> In 1912 a Hoffman kiln was built by the Glen Iris Brick and Tile Co.<sup>73</sup> In Sydney the North Sydney Brick and Tile Company at Gore Hill apparently had two Hoffman kilns at the outset in 1889.<sup>74</sup> By late 1887 a rectangular kiln, Queensland's first of the Hoffman type, was being built at James Campbell & Sons' Albion Terra Cotta Works,<sup>75</sup> under the superintendence of C H Meyer, manager of the Brick Department.<sup>76</sup>

In Western Australia Hoffman kilns were rather later than in the east, and during the 1890s Melbourne bricks were extensively used for prestige buildings:<sup>77</sup> the Hoffman Patent Steam Brick Co of Melbourne advertised both its bricks and its drainpipes for local use. The Union Stores in Fremantle were built using imported bricks in 1896,<sup>78</sup> and so was the Bank of Australasia in Perth, because 'the directors do not consider the WA article of sufficient class for the work required to be done.'<sup>79</sup> J H Moir's building

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<sup>66</sup> Directories are always a little behind, but it is surprising - if the company was really in operation in 1870 - that it is not listed in that year, and in 1871 appears only in the name of its agent, George Cakebread, at an address in Queen Street in the city. Only in 1872 is it listed in Brunswick. The firm is given as Collier Barry & Co, with Abraham Collings as manager, and in fact the partners were Jenkin Collier, David McKenzie, Barry Owen and William Owen.

<sup>67</sup> Stuart, 'Hoffman Brick and Tile Company', p 131. Stuart reports that the 1871-2 kiln was 'to the modified design patented in 1870 by Friedrich Hoffman', which would represent a very rapid adoption of the new technology. However if Hammond is correct in identifying the 1870 patent as being the rectangular version, Stuart must be incorrect, for the round-ended form of the 1871-2 kiln must have been developed by Hoffman earlier.

<sup>68</sup> Gemmell, *And So we Graft*, p 67.

<sup>69</sup> E Dianiska et al, 'Backgrounds of Melbourne Brick' (BArch, University of Melbourne, 1959), p 11.

<sup>70</sup> Ioannou, *Ceramics in South Australia*, p 220.

<sup>71</sup> *Argus*, 8 March 1886, p 7.

<sup>72</sup> Andrew Lemon, *Box Hill* (Melbourne 1978), pp 80, 86.

<sup>73</sup> Bates, Smart & McCutcheon letter book, Melbourne University Archives, item 54/1.

<sup>74</sup> Gemmell, *And So we Graft*, p 67 p 64.

<sup>75</sup> *Australasian Builder & Contractor's News*, 22 October 1887, p 387.

<sup>76</sup> Alfred Barbara, 'Terra Cotta in Sydney Architecture 1788-1914' [2 vols, BArch, University of New South Wales, no date (1978)], II, p 75.

<sup>77</sup> *West Australian*, 27 May 1895, quoted by Ingrid Van Bremen, 'The New Architecture of the Gold Boom' (PhD, University of Western Australia, 1990), p 130.

<sup>78</sup> *West Australian*, 19 September 1896, quoted by Van Bremen, p 130.

<sup>79</sup> *West Australian*, 26 September 1896, quoted by Van Bremen, p 130.

in Perth, of 1896-7, was faced in 'cherry red' Northcote bricks<sup>80</sup> (from another Melbourne company). In Solomon's Stores at Fremantle, however, a mixture of imported and local bricks was used.<sup>81</sup> However, John Millard opened the Cardup Steam Pressed Brick Company in about 1903, and added a Hoffman two years later.<sup>82</sup> In 1910 a Hoffman kiln was built to supplement the existing downdraught kilns at Helena Vale, making this one of the largest brickworks in the state, then in 1919 another was added and the works were converted to electricity, the first in the state to do this.<sup>83</sup>

### *the Centennial kiln*

In 1888 a patent for an improved kiln was taken out by Isaac Button, Edward Peters and John Wesley Goodsell of Sydney,<sup>84</sup> and they built this, which they called the 'Centennial Kiln' at the Croydon Brickworks. As the *Australasian Builder & Contractor's News* remarked, 'When the Hoffman Kiln was first introduced it seemed as if perfection in brick burning had been attained', but 'Everything now is being improved.' Button appears to have been the actual inventor. He had devoted his life to the construction of kilns, and had studied them in New South Wales, Victoria, England and Germany. Compared with the Hoffman kiln, his was rectangular in plan, and consisted of two rows of chambers in parallel, none of them sweeping around at either end. The chambers were separately barrel vaulted, running in at right angles to the length of the kiln as opposed to the continuous vault of the Hoffman, and they were large enough for a dray or truck to be driven right into them for loading and unloading. Fuel was fed through holes in the top. The chambers at either end continued right across the kiln, with provision to divide them, but the rest were separated by a relatively long and narrow 'smoke chamber' along the spine, which connected with flues from either end of each chamber, and discharged to a stack. The kiln as built at Croydon had eighteen chambers, held 35,000 bricks, and was reckoned to turn out 200,000 bricks in a fortnight.<sup>85</sup>

### *the tunnel kiln*

The only major development after the Hoffman kiln has been the tunnel kiln, introduced in various forms by Colas in France in 1854, then Curot in France, Otto Bock in Germany, William Cliff in England in 1869, and most importantly by J & C J Foster of Normanton, Yorkshire.<sup>86</sup> Foster's kiln achieves the same thing as the Hoffman but keeps the fire stationary while the bricks move slowly through it on trolleys, rather in the character of an assembly line.<sup>87</sup> It was also known as the

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<sup>80</sup> *West Australian*, 28 July 1897, quoted by Van Bremen, p 124.

<sup>81</sup> *West Australian*, 18 September 1896, quoted by Van Bremen, pp 130-1.

<sup>82</sup> Bryce Moore, *From the Ground Up* (Nedlands [WA] 1987), p 43.

<sup>83</sup> Bryce Moore, *From the Ground Up* (Nedlands [WA] 1987), pp 50, 52.

<sup>84</sup> *Australasian Builder & Contractor's News*, 24 November 1888, p 475.

<sup>85</sup> *Australasian Builder & Contractor's News*, 9 February 1889, p 127.

<sup>86</sup> Ritchie, 'History of the Tunnel Kiln', p 57.

<sup>87</sup> Chabat, *La Brique et la Terre Cuite*, p 267. Chabat gives the name as 'Forster', but other sources seem agreed that it is Foster, notably Ritchie, 'History of the Tunnel Kiln', pp 51, 55.

'railway brick kiln' and reportedly (in 1879) burnt 20,000 bricks a day on trucks carrying 5,000 bricks each.<sup>88</sup>

A Foster kiln was put into operation by the Hoffman company at Brunswick in 1885, but it was apparently unsuccessful, and was replaced by another Hoffman kiln in 1907-8.<sup>89</sup> By 1888 two tunnel kilns were in operation at the Box Hill Brick Works, where the trucks were drawn to the mouth of each kiln and then forced in by a powerful hydraulic ram, which pushed all the earlier trucks forward.<sup>90</sup> How successful these kilns were, and how long they lasted, is not clear, but it is interesting to note that these tunnel kilns predated the first in the United States, built at Chicago by J C Anderson in 1889. Anderson's and others were also failures, and the first successful tunnel kiln was constructed at New Jersey in 1910.

The Oaks Steam Brick Company at Neutral Bay is reported to have been the first in New South Wales to use a tunnel kiln, but the date is not apparent.<sup>91</sup> A later American tunnel kiln, the Dressler, was installed by Goodlet & Smith of Sydney on the advice of the British expert A B Searle, after fire destroyed their tile plant in 1924. It performed badly, and the American company had to send out experts to get it working, so the kiln and tile plant were not commissioned until August 1929. Later the kiln was used for textured bricks.<sup>92</sup> After World War II the Building Research Division of the CSIRO became strong advocates of the tunnel kiln,<sup>93</sup> but met some equally strong opposition, most of all from John Beacham Kiddle, then managing director of the Hoffman company, who recalled the earlier failure at Brunswick,<sup>94</sup> and doubtless knew of the troubles at Sydney.

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<sup>88</sup> Ritchie, 'History of the Tunnel Kiln', pp 51, 56, ref *Scientific American Supplement*, no 186, 26 July 1879. Ritchie incorrectly identifies it as 'tramway kiln'.

<sup>89</sup> Stuart, 'Hoffman Brick and Tile Company', p 141.

<sup>90</sup> *Australasian Builder & Contractor's News*, 15 December 1888, p 541.

<sup>91</sup> Gemmell, *And So we Graft*, p 65.

<sup>92</sup> Information from Ian Stuart, 1995.

<sup>93</sup> This probably originates with D V Isaacs & J W Drysdale, *Building Technique and Building Research* (Sydney 1949), p 37 and fig 1. The latter is an illustration of the tunnel kiln at the works of the Metropolitan Paving Brick Co, Minerva, Ohio, apparently visited by one or both authors.

<sup>94</sup> Stuart, 'Hoffman Brick and Tile Company', p 136, citing the *Clay Products Journal of Australia*, November 1908, p 15; and XVII, 2 (1952), p 13.