## *6.03 The Cavity Wall*

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### *a. recent studies*

In 1968 J M Freeland claimed the brick cavity wall as an Australian invention of about 1885,[1] which is totally incorrect. He claimed that it had become standard practice in Australia by 1895, 'when all buildings were of brick', and then spread to the rest of the world, 'a genuine Australian contribution to world building practice'. These misconceptions have been relayed by subsequent writers,[2] and though they are not excusable, they are partly understandable in view of the dearth of overseas material on the subject. In my own treatment of the topic in 1972 I discussed the proto-cavity wall forms (some of which were known to Freeland), and demonstrated that the true cavity wall was being used in parts of Britain and United States by the 1850s. In 1973 Thomas Ritchie published a paper on the history of cavity wall construction in the United States and Canada.[3]

In 1977 Brunskill and Clifton-Taylor discussed the cavity wall from an English perspective,[4] and cited the earliest reference to date, William Atkinson's *Views of Picturesque Cottages with Plans,* of 1805. This proposed the use of bonding bricks spanning the cavity, and to that extent it fell short of the true cavity wall as it ultimately evolved. In other respects Brunskill and Clifton-Taylor were fairly lightweight. They did not mention J B Papworth's designs for an ice house and a dairy in 1818, which may be one of the first proposals for true cavity walls.[5]

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1 J M Freeland, *Architecture in Australia - a history* (Melbourne 1968), pp 188-190.

2 For example, Hugh Fraser, *The Federation House* (Sydney 1986), p 60.

3 Thomas Ritchie, 'Notes on the History of Hollow Masonry Walls', *Association for Preservation Technology Bulletin,* V, 4 (1973), pp 40-49.

4 Ronald Brunskill & Alec Clifton-Taylor, *Brickwork* (New York 1982 (formerly *English Brickwork* [London 1977]), pp 143-8.

5 J B Papworth, *Rural Residences, &c* (London 1818). Papworth's proposal for a dairy, pl 22 and pp 89-92 allows for the possibility of 'double walls' to assist in maintaining a 'free circulation of air' but does not illustrate them. His ice house, however, pl 24 and pp 97-100, has a 'double wall for drainage of surrounding water or damps', which is shown in plan and section, with no indication of any bonding bricks.

Although they mentioned Thomas Dearn's[6] *Hints on an Improved Method of Building* of 1821, they did not refer to the original publication of his method in the *Repertory of Arts* in 1814. Nor did they refer to the first documented built example, which was a house at Rochester built before 1826, using occasional bonding bricks, or to other examples of that period at Portsmouth, Cranbrook and Shorncliffe. Nor did they refer to the appearance of true cavity walls, using only iron ties, on the Isle of Wight in the 1840s.[7]

My own purpose here is to summarise and update my previous conclusions about the development of the cavity wall in Australia, which have so far been published only in part, and in a venue so obscure as to be beyond the ken of most potential readers.[8] I will discuss them mainly using notional imperial brick dimensions (9 x 4½ x 3 inches, two leaves of which, with a 2 inch cavity, give an 11 inch wall).

It is necessary to state at the outset that the first hollow or cavity walls were not designed for the purpose of keeping out moisture, which is seen today as their principal or only function. In Britain some were designed to drain water, such as that from melting ice in an ice-house; some were designed for heat insulation, especially in ice-houses and dairies; some were designed to save bricks (upon which very high duty was charged until 1850); and some were designed as a ducting system for hot air. At times it seems that the different types evolve quite independently of each other, and that each version, except that designed to save bricks, reaches Australia.

### *b. hollow walls*

A distinction has to be made between walls which are bridged by brickwork at more or less frequent intervals, and what may be regarded as the true cavity wall, with only iron ties, or perhaps with patent or other bricks at only very spare intervals. In the nineteenth century all types are referred to indiscriminately as 'hollow' walls, but I shall distinguish the true cavity wall from what I will call the hollow or proto-cavity wall. The latter may be laid in one of the special bonding patterns invented for the purpose, which tend to leave as much as 25% of the wall area solid. It is the English tradition which is relevant to Australia, but it is interesting to note that this was preceded by an eighteenth century French proposal to use hollow walls in tropical areas such as the West Indies, apparently as a means of reducing heat rather than keeping out moisture. The writer d'Albaret proposed schemes for the Antilles and neighbouring areas, including a large building whose interior and exterior walls

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6 Not 'Dearne', as they spell him.

7 Wyatt Papworth [ed], *The Dictionary of Architecture* (London 1853-1892), sv 'Hollow Brick'.

8 Miles Lewis, 'From Hollow Brick to Brick Veneer', in T McNeilly & J C Scrivener [eds], *Proceedings of the 7th International Brick Masonry Conference* (2 vols, Melbourne 1985), I, pp 123-136.

appear to be of two leaves of brickwork spaced apart, but tied at very close intervals, though it may be simply a timber frame clad with brick on either side.[9]

In a similar vein the architect Nathaniel Billing in 1851 (prior to his emigration to Australia) proposed to the Rev J F Bourne of Guyana, the use in the tropics of double brick or stone walls, with an air-filled cavity between the leaves. Billing may have been familiar with the use of hollow walls to insulate ice houses, cool stores and dairies, but he had no experience of the tropics nor, one imagines, of the use of cavities to insulate conventional buildings. Bourne himself did have tropical experience, and he suggested that it would be better to fill the cavity with light material, such as the ash from sugar works.[10]

The first English hollow wall is said to have been that invented by Silverlock of Chichester, and by the 1860s was in frequent use in the southern counties of England. This is the form colloquially known - for obvious reasons - as 'rat-trap walling', in which the bricks are laid as if in Flemish bond, but on edge. This means that a nominally nine inch wall has a cavity of three inches between the stretchers, and is bridged by headers over 25% of its area. The better known method was that which Dearn proposed in 1814, in which the wall was laid in English bond but with the stretchers on edge, creating a continuous three inch cavity between them. Both these types of wall are found in Australia. Neither was really a new invention of the nineteenth century, for they were traditional in Zhejiang province of China, under the name of *kongdou qiang.* Because the bricks there are much flatter in proportion, the Chinese wall ends up being more like a series of thin-walled boxes than like a solid mass with gaps in it. The Chinese version of Dearn's walling differs in that there are headers on edge, as well as stretchers, in a pattern of two headers, then one stretcher. The Chinese version of Silverlock's walling differs also in that there is a course of headers on the flat at intervals, typically between three courses of stretchers.[11] It is therefore interesting that Brunskill and Clifton-Taylor give 'Chinese bond' as a synonym for Silverlock's, though it is not apparent when this usage occurred.[12]

Almost incredibly, the Common Brick Manufacturers' Association of America in the 1920s promoted what was in fact Silverlock walling as the 'Ideal All-Rolok Wall'. There was nothing new about it unless it was the eight inch [400 mm] length of the brick. It was claimed, however, that 'this method of laying brick was developed by THE COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA' but, rather ambiguously, that there were numerous examples in America and Europe, some as many as fifty years old. It was just that it had not previously 'been worked out in all its details to fit varying conditions, nor has it been promoted until now.'[13]

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9 Librairie Léonce Laget, *Catalogue 114* (Paris 1997 [book catalogue]), pp 21-2, reproduces an illustration from d'Albaret, *Différents Projets Relatif au Climat et à la Manière la plus convenable de Bâtir dans les Pays Chauds et plus particulièrement dans les Indes Occidentales* (Paris 1776).

10 J F Bourne, 'On Tropical Architecture', *Ecclesiologist,* LXXX!V (1851), p 170.

11 R G Knapp, *China's Vernacular Architecture* (Honolulu 1989), pp 29, 83.

12 Brunskill & Clifton-Taylor, *Brickwork,* p 72.

13 *Sweet's Architectural Catalogue* (17th ed, New York 1922), p 109.

'Rowlock', 'Rollock' or 'Rolok' appears to be an American term for a brick laid on edge, though Sturgis mentions it only in the context of a rollock or rowlock arch, being one built up of concentric rings of small masonry units,[14] and Siegele uses it to refer to header bricks in arches and in horizontal courses, but does not specify that they should be on edge.[15] However R P Stoddard, in a book first published in 1920, defined three basic eight inch (equivalent to nine inch in Australian brick sizes) rolok wall types, in which the bricks are indeed laid on edge. One of these was the same as Silverlock's system, and one was essentially the same as Dearn's but with two courses of stretchers on edge to each course of headers on the flat. The third type was an interesting combination of six stretchers on the flat on one side of the wall to four stretchers on edge on the other side; then came a course of headers on the flat, then another 6/4 combination, and so on. Such a wall, which Stoddard called 'Rolok-Bak', would appear on one face to be entirely of bricks on the flat in English garden wall bond, and if plastered on the other face would reveal no indication of the cavity.[16] These types were reported in Australia in 1947 as if they were new developments. Silverlock's was referred to as 'British Rat-Trap Bond & American All Rolok wall'. Dearn's was also identified as 'American All-Rolok Wall', but with no British equivalent, and the American term makes little sense given that a significant proportion of the bricks were laid flat and were therefore not rollocks. The so-called 'American rolock-bak [*sic*] wall' is also illustrated.[17]

As a further refinement to his system Dearn had suggested that the stretchers be cut in half in the longwise direction, so that the cavity was bigger and even fewer bricks were used - or, better still, the brick could be cut part-way before burning, and afterwards split by striking it with a trowel. This and some other extraordinary suggestions of the period are purely a response to the high duty on bricks, and there is no indication that they are relevant to Australia. J C Loudon proposed another rather odd type of wall, of which only one example has been reported in Australia. It was a nine inch wall in Flemish bond, laid on the flat in the usual way, but with every stretcher on one face pulled forward two inches from the surface, thus leaving the headers on this face recessed and a cavity behind the stretchers. Loudon maintained that it kept the wall 'always dry, and less easily penetrated by the cold in winter, or the heat in summer. The inner surface being uneven, is peculiarly favourable for

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14 Russell Sturgis, *A Dictionary of Architecture and Building* (3 vols, New York 1901), I, p 119; III, pp 307, 383.

15 H H Siegele, *Building Trades Dictionary* (Chicago 1946), p 272.

16 R P Stoddard, *Brick Structures, How to Build Them* (11th ed, New York 1946 [1920]), illustrations reproduced in Thomas Ritchie, 'Notes on the History of Hollow Masonry Walls', *Association for Preservation Technology Bulletin*, V, 4 (1973), pp 40-49. In the use of six courses of stretchers this differs from English garden wall bond, which has three or five courses according to Brunskill & Clifton-Taylor, *Brickwork*, p 69.

17 Australia, Department of Works and Housing, Dierctorate of Housing, *Australian Housing, Bulletin 11* (Melbourne 1947), pp 229-231.

receiving and retaining the plaster'. A variation on this, together with some other hollow wall types, was described in the *Dictionary of Architecture.*[18]

In 1833 Loudon reproduced, from the *Bath Society's Papers,* designs for cottages by one Tugwell, who proposed a six inch [150 mm] cavity, the real purpose of which is not entirely clear. It was to be formed ingeniously with the aid of a flat deal box 900 mm long by 200 mm high by [puzzlingly] 75 mm thick, which was placed between the leaves during construction, raised when required by means of two rings in the top edge, and otherwise held in place by little pivoting wedges which engaged the brick surfaces on either side like ratchets. There was no reference to any form of wall tie across this cavity, but it was entirely closed at intervals by cross bonding, so that the cavity really comprised a series of discrete cells about 1200 mm or 1300 mm long.[19] One of the last proposals for hollow walling was the 'porous masonry' advocated by Major R E Medley for construction in India, which seems to have had voids comprising only one sixth of a thick brick wall.[20]

C B Allen's popular work on *Cottage Building* must undoubtedly have been used in Australia, and was to provide the basis for notes on the cavity wall in Mayes's *Australian Builders' Price-Book* of 1862.[21] Allen published Silverlock's, Dearn's and Loudon's methods, as well as some other ways of creating twelve and fourteen inch hollow walls, using only ordinary blocks on the flat.[22] Other methods were proposed by Henry Roberts.[23] Loudon had proposed the use of Silverlock bond for the construction of a dairy, and an example of exactly this occurs in a dairy at 'Ellerslie', Bacchus Marsh, discussed below.

All this had been entirely forgotten by 1947 when the Australian *Housing Bulletin* reported that brick on edge construction had first been used in Western Australia in 1936, though builders, being unfamiliar with it, were reluctant to tender, and it never came into general use. In South Australia, however, it was introduced in 1937 by H H Cowell, architect to the South Australian Housing Trust, with such success that it was used thenceforth throughout the Trust's work. The contractor involved in this work subsequently visited Western Australia, as a result of which the Workers' Houses Board built an experimental example, and henceforward used this construction in the majority of its houses. By 1947 about 250 houses of this sort had been built in South Australia and 500 on Western Australia. The method resembled

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18 J C Loudon, *Encyclopædia of Cottage, Farm and Villa Architecture* (London 1846 [1833]), § 25, p 14; §§ 336-8, pp 168-172, § 374, pp 186-8; Wyatt Papworth [ed], *Dictionary of Architecture* (published in parts by the Architectural Publication Society, 1853-92), sv Hollow Wall.

19 J C Loudon, *Encyclopædia of Cottage, Farm and Villa Architecture* (London 1853 [1833]), [§§ 1352-1360, pp 639-643.

20 Peter Scriver, 'Imperial Progress: on the Impracticality of Problem-Solving in Colonial Indian Building', *Fabrications,* XI (2001), p 20, citing *Professional Papers in Indian Engineering,* XI, 7 (1865).

21 C B Mayes, *The Australian Builders' Price-Book* (2nd ed, Melbourne 1862), p 19.

22 C B Allen, *Cottage Building* (2nd ed, London 1854 [?c 1845]), p 36.

23 Henry Roberts, *The Dwellings of the Labouring Classes* [London 1850], pp 24-5.

'rolok-bak' in that the outer leaf was a single thickness of normal bricks and the inner leaf of brick on edge, but there were no bricks bridging the cavity, and the two leaves were bonded with iron ties. In South Australia the top of the cavity was bridged with a course of headers on the flat, a detail also mentioned by overseas authorities.[24] It is probably significant that brick on edge was adopted in those states in which brick veneer had not achieved any currency, for that was also a method of conserving brick (albeit profligate of timber).

### *c. early cavity walls*

J B Papworth's design for a subterranean ice house, of 1818, proposed the cavity 'for drainage of surrounding water or damps',[25] and it may be the first proposal for a true cavity wall in that no system of bonding across the cavity is either described or illustrated. However, given the problems of supporting a sloping curved leaf of inner wall (for the structure is conical) it seems much more probable that considerable bonding was intended. In 1853 S C Brees refers to such conical ice houses, and to the use of hollow walls in them, but seems to derive the idea from Peter Nicholson's *Architectural Dictionary*.[26]

By 1826 a number of built examples of hollow walling were reported by Major-General C W Pasley. At Rochester, one Nicholson (?Peter Nicholson) had designed walls with two 4$^1$/$_2$ inch leaves and a four inch cavity, crossed only by 'occasional' bonding bricks. There were cavity walls in several ordnance buildings around Portsmouth, some houses at Cranbrook, in Kent, and a barracks at Shorncliffe. Pasley noted that in these barracks the damp came through at the bonding bricks, but instead of deducing that a true cavity would be better, he decided that the system was ineffective and that it was 'scarcely worth while to construct the external walls of any building of importance in the manner alluded to'.[27] These views may well have had some effect in Australia, given that Pasley's son became Colonial Engineer of Victoria.

In 1839 S H Brooks published the designs of two houses with cavity walls which were intended mainly for the purpose of distributing air to the rooms, as is clear from the fact that the cavity ran through internal partitions as well as external walls. Though it was bridged by occasional bonding blocks, these amounted only to something like 3% to 7% of the area, far less than in Dearn's or Silverlock's methods. In one of the buildings Brooks proposed:

> to erect the walls hollow by carrying up 4$^1$/$_2$-inch work externally and internally, leaving a cavity between them of 5 inches. The bond of the

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24 Australia, *Australian Housing, Bulletin 11*, pp 230-249.

25 J B Papworth, *Rural Residences, &c* (London 1818), pl 24 and pp 97-100

26 S C Brees, *The Illustrated Glossary of Practical Architecture and Civil Engineering* (London 1853), p 224.

27 C W Pasley, *Outline of a Course* (Chatham 1826), pp 252-4, cited by Papworth, loc cit.

> brickwork is to be made of bricks, 14 inches by 9 inches, which may be placed in every fifth or seventh stretcher horizontally, and in every third or fifth course vertically. In this way an excellent bond may be obtained, and if the sides of the openings be pargetted, in the same manner as fire-place flues, they may be made to convey rarefied air to all apartments; and, with suitable ventilators, the rooms may be kept at an equal temperature, which cannot be done with a common English fireplace.

External air was to be admitted by vents an to pass through heat boxes behind the fireplaces, or to the kitchen stove, before being allowed into the rooms.[28] The year after Brooks's book, J A Stewart of Philadelphia applied for a United States patent on the use of hollow walls for heating flues, stating that they had 'heretofore been constructed for the purpose of protecting the interior walls from the effects of moisture, and also with a view to obviate, in some degree, the effect of change in temperature.'[29] This is the first indication that cavity walls had been seen as a means of preventing damp, for in general the ducting of hot air, or at least fresh air, seems to be the earlier motive. At Titus Salt's 'Saltaire' of 1853, which was designed by Lockwood & Mawson with the engineer William Fairbairn, the two mill blocks had external cavity walls, through which the outside air was drawn to ventilate (but not apparently to heat) the interior.[30]

### *d. wall ties*

By the early 1840s cavity walls bonded only with iron ties had come into use on the Isle of Wight. The tie was a $^{5}/_{16}$ inch (8 mm) wrought iron rod, with the ends bent sideways to bond well between brick courses, and a depression at the middle to stop water from passing across.[31] As a correspondent of the London *Builder* wrote in 1854:

> The only method yet practised to prevent completely the percolation of water from the outer surface is by means of iron stays, the two ends built into the outer and inner walls respectively, and the middle part is bent downwards, so that water cannot follow the course of the iron, but must drop to the bottom of the cavity between the walls: these stays connect the two walls so that they form one firm wall.

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28 S H Brooks, *Designs for Cottage and Villa Architecture* (London, no date, c 1839), pls xlii-xlv, pp 59, 71.

29 J A Stewart, 'Mode of Warming buildings by Converting hollow Walls into Flues', U S patent application 1639, 1736/1840, quoted by Mike Butcher, draft monograph on R A Love, 1999.

30 William Fairbairn, *On the Application of Cast and Wrought Iron to Building Purposes* (London 1854), p 157 & Pl II.

31 Papworth, loc cit.

Even this writer, however, questioned the durability of iron ties, and mentioned a proposal for a house which was to have the walls bonded with 430 mm wide stones coated with pitch to stop them transmitting water.[32]

An article published in the *Dictionary of Architecture* early in the 1860s[33] described some types of cramp or tie thought to be better than those used on the Isle of Wight. Those used in Hampshire were of wrought iron, measuring 19 x 6 x 180 mm, with a central depression and forked ends, commonly coated in tar, and were built into every fourth course at three brick intervals [0.7 m] horizontally. At Southampton, where about 80% of the workers' housing had been built with cavity walls during the 1850s, there were cramps, rather resembling the Hampshire one, available in wrought, cast or hoop iron, as well as a more novel type in the form of an H. The sides were two bars measuring 76 x 25 x 6 mm, each intended to rest in the frog of a brick, and the crosspiece was a 10 or 13 mm diameter rod with a boss or moulding cast on it to prevent water from crossing. These were built into every fourth course at 0.9 m horizontal intervals, were available from every local ironmonger, and were also used in Devonshire.

In 1858 George Jennings received a patent for a form of bonding brick for hollow walls. It was an extruded brick, to be made in lengths to suit wall thicknesses:[34]

> Each brick is made with vertical passages through it, and has projections and grooves at its sides while its bedding faces have hollows sunk in them in order to prevent moisture flowing from one wall to the other, and 'the edges of each end of the brick are jagged so as to hold, when laid, the external and internal walls more firmly together'.

This is probably the type envisaged by John Blenkarn in a specification for a villa at East Cowes, prior to 1865: they were to be used in every second course vertically and at intervals of 460 mm (two stretchers) horizontally within walls of a single thickness inner leaf and either a single or a double outer leaf.[35]

After this Jennings patented an odd, but surely a more effective form of bonding brick: it appeared as a header in the outer face, then ramped upwards in the cavity to become a header one course higher in the inner leaf.[36] Where necessary to maintain the appearance of the outer face, a small false header might be placed over the

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32 *Builder*, XII, 583 (8 April 1854), p 190.

33 Papworth, loc cit.

34 Great Britain, Patent Office [?], *Abridgements of the Specifications relating to Bricks and Tiles* (London 1862), p 220. See also John Gwilt [revised Wyatt Papworth], *An Encyclopaedia of Architecture* (London 1899), p 564; *Notes on Building Construction. Part III Materials* (London 1879), p 135.

35 John Blenkarn, *Practical Specifications of Works* (London 1865), pp 101-2.

36 *Notes on Building Construction, loc* cit; also Part II (3rd ed, London 1887), pp 216-7, illustrating a range of types and sizes. One of these bricks is illustrated on the cover of Martin Hammond, *Bricks and Brickmaking* (Aylesbury [Buckinghamshire] 1981), and is described as being from Poole, Dorset.

Jennings brick. These bricks were to find a role in Australia, and in Britain they seem to have been used well into the twentieth century.[37] By the 1920s Doultons were producing a different type. It was an extruded section with a width of 4 3/4 inches [120 mm] built into one leaf and 2 1/2 inches [64 mm] into the other, all on the same level. the part within the cavity had the underside pointing downwards in a V shape.[38] The 4 3/4 inch section must have been designed to bond into a nine inch leaf and the 2 1/2 inch one into a 4 1/2 leaf, so that in either case the bonding brick would be concealed behind conventional bricks or batts.

From about 1869 John Taylor began building a somewhat innovative series of seaside bungalows at Birchington-on-Sea, later carried on by John Seddon, and it appears that some of these used cavity walls tied with flat metal straps with a considerable upward kink at the centre. Others were solid but with a complete division of slate slabs between the inner and outer leaves of brickwork (or inner brickwork and exterior rubblework), possibly using the same ties at the horizontal joints of the slabs.[39] By 1883 F W Braby of London was advertising no less than six different models of galvanised wrought iron tie, which must reflect a fairly widespread acceptance of cavity walling. All were either twisted or indented at the centre, and most were forked at the ends.[40]

### *e. acceptance of the cavity wall*

Despite the weight of all this evidence the use of the cavity wall in general building was still confined at the mid-century to a few areas in England, and fewer in the United States. However it was much more widely used for ice houses and dairies. S C Brees in 1853 describes it under the heading of 'hollow wall', as being a means of saving materials and of preventing damp, generally employed for icehouses and wine cellars, and gives no indication of any sort of bonding across the cavity. He discusses the design of an icehouse from Peter Nicholson's *Architectural Dictionary,* built in a conical form with hollow walls, very much like Papworth's.[41]

During the 1860s there are numbers of reports of more substantial houses in England using cavity walls: at an unspecified seaside location (where the cavity was bridged below the window sills, causing a line of damp which soon spread to drench the whole wall);[42] near Manchester;[43] in Derby;[44] and in Hertfordshire.[45] A

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37 Percy Thomas, *Modern Building Practice* (4 vols, London no date [c 1935]), IV, p 74.

38 Doulton & Co. Ltd., *Drainage and Sewerage Appliances, &c* (Lambeth [London] 1926), p 26-3.

39 *Building News,* 15 August 1873 and (for a plan showing the cavity) 4 August 1905, reproduced in A D King, *The Bungalow* (London 1984), pp 78, 79.

40 *Frederick Braby & Co. No. 9* ([catalogue] London 1883), p 39.

41 S C Brees, *The Illustrated Glossary of Practical Architecture and Civil Engineering, &c* (London 1853), pp 221, 224.

42 *Builder,* quoted Papworth, loc cit.

43 'Rosebank Villa' at Barlow Moor, by Speakman & Charles of Manchester: *Villa and Cottage Architecture* (London 1869), pp 109-111.

commission appointed in 1861 to recommend standards for the design of military barracks in England recommended the use of hollow walls to eliminate dampness,[46] but it is not clear whether a true cavity was intended. By 1873 John Birch, who was building labourers' cottages all over England in consequence of winning a competition held nine years earlier by the Royal Society of Arts, was specifying '11 1/4 inch hollow walls, bonded with iron ties about 2 feet 3 inches apart on the bed, and every alternate course in height, or with brick bonders ...'[47]

It is difficult, in the light of all this, to know what weight to attach to Brunskill & Clifton-Taylor's claim that J J Stevenson's house at 8 Palace Gate SW7, of 1880, was one of the earliest uses of cavity walling in London.[48] This seems unlikely, given the number of examples and the amount of published discussion elsewhere in England during the preceding three decades, but it is true that in 1876 Sir Edmund Beckett wrote that although hollow walls were 'now at last generally admitted to be expedient ... architects are wonderfully slow to propose them'.[49] This also suggests that the appearance of the true cavity in Australia in 1868-9 was not so very belated.

In some cases cavity construction was confined to the more exposed areas of the exterior walling, while the rest was left solid. In 1873 a widely used text, R R Rogers's *Specifications for Practical Architecture,* stated that

> In damp or exposed situations, as in basement-stories, or where from the climate during rains, water is liable to soak through the walls, double walling is necessary; the inner and outer wall being tied together in every course; thus in a wall two bricks thick the wall should be built with a 13 1/2 inch outside wall, 2 inch cavity, and 4 1/2 inch inside wall.[50]

### *f. the cavity wall overseas*

The cavity wall was reportedly introduced to America by the architect Ithiel Town of New Haven, where, according to A J Downing, in his *Architecture of Country Houses*

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44 A pair of semi-detached houses in Osmaston Road, by Hine & Evans of Nottingham; *Villa and Cottage Architecture* , pp 22-3.

45 A lodge by G A Dean: G A Dean, *Selected Designs for Country Residences* (London 1867), pl 13.

46 *General Report of the Commission Appointed for Improving the Sanitary Condition of Barracks, 1861,* cited in Allom Lovell Pty Ltd, *Victoria Barracks Melbourne* (Melbourne 1992), p 122.

47 John Birch, *Country Architecture* (Edinburgh 1874), p 16. Elsewhere, p 27, Birch specifies a three inch [75 mm] cavity. He also gives model specifications in which he provides for hollow walls 111/4 inches thick, tied with bonding bricks, and with quarter brick closers to make up the thickness. Another version is a nine inch wall with all of the bricks on edge and with one transverse brick for about every seven stretchers, somewhere intermediate between Dearn's and Silverlock's methods. As an alternative he illustrates cast iron ties. Birch stresses that these need to discharge the moisture at the base of the wall, and provides a complete run of drainpipe for the purpose.

48 Brunskill & Clifton-Taylor, op cit, p 145.

49 Edmund Beckett, *A Book on Building* (London 1876), pp 155-7.

50 R R Rogers, *Specifications for Practical Architecture* (London 1873), p 239.

in 1850, it was used for most of the best houses. Thus it appeared in the United States before 1844, when Town died. Downing illustrates both Dearn's and other methods, but all of them bonded by bricks rather than iron ties.[51] Stewart's patent application of 1840, referred to above, implies that the cavity it was well accepted before that date, but it is possible that Stewart was merely drawing upon English practice, by way of Brooks.

Samuel Sloan in 1852 proposes fourteen inch [355 mm] brick walls for an 'ornamental villa', with a 4¼ inch [110 mm] cavity and an 8½ inch [215 mm] outer leaf, but he does not illustrate this, and the specification makes no mention of bonding. On the other hand his 'Italian villa' has two single thicknesses of brick spaced apart 1½ inches [38 mm], and in one diagram there seem to be tie bricks at every fourth course.[52] Calvert Vaux, Downing's English-born partner, wasted no time on the half measures in his *Villas and Cottages* of 1857, but recommended two 'entirely and totally distinct' leaves of brick connected by painted or tarred strips of iron.[53] Both Downing's and Vaux's books were widely used in Australia, and likely to be influential, though Sloan's less so. Also in the United States, Robert Warry provided a four inch [100 mm] cavity in the Alexander Davis house at Stuyvesant, New York, but the nature of the bonding is not described.[54]

In the Custom House at Wheeling, Virginia, the specification in 1856 required all the partitions in the building to be '9 and 11-inch hollow brick walls.' The drawings show that the nine inch wall was a version of Silverlock's, consisting of brick on edge laid with two stretchers to each header. The eleven inch wall was laid mainly in stretcher bond with a two inch [50 mm] cavity. Every fourth course had a header for every two stretchers, and these headers tied the wall but, being only nine inches long, stopped an inch short of either surface.[55]

In 1867 a rather odd example of cavity walling appeared in France, in a model cottage which was shown at the Paris Exposition by the Paris Co-Operative Society. It was two storeyed and built of hollow bricks, which the architect, Ferrand, judged incapable of carrying the load. There were therefore structural iron columns, and on the long sides of the building the wall panels between these had full cavities (in addition to being of hollow brick).[56] By 1885 the cavity wall had been used in the new hospital at Le Havre, and this was reported by Professor H B Allen to a Melbourne readership which, ironically, was probably more familiar with the technique than were the French. The walls of the pavilion were 'double', with a thick outer leaf, a thin inner one, and a cavity of 2½ inch [65 mm] between.[57]

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51 A J Downing, *The Architecture of Country Houses* (New York 1850), pp 59-63

52 Samuel Sloan, *The Model Architect* (2 vols, Philadelphia 1852), p 42, p 13, & pl V.

53 Papworth, loc cit, ref Calvert Vaux, *Villas and Cottages* (New York 1858), pp 64-5.

54 John Bullock, *The American Cottage Builder* (New York 1854), p 191.

55 *Specifications for Building the Custom-House at Wheeling, Virginia* (Washington [DC] 1856), reproduced in *APT Bulletin*, V, 1 (1973), pp 80, 99.

56 R S Burn, *Modern Building and Architecture* (London, no date [c 1870]), pp 31-2.

57 H B Allen, *Final General Report on Hospital Construction and Management* (Melbourne 1891), p 14, citing *Notice sur le Nouvel Hôpital* (Le Havre 1885).

In Canada 'hollow' walls were used widely in the nineteenth century. Ritchie reports that near Ottawa and along the St Lawrence they were frequently two single leaves of brick with a four inch [100 mm] cavity. In the Halifax Academy, of 1878, there are two double brick [200 mm] walls and a 100 mm cavity, and heavy iron I-beam ties at the centre of each wall. In the Parliament buildings at Ottawa, as specified in 1861, the outer leaf is of stone and the inner one of nine inch [230 mm] brick, with a three inch [75 mm] cavity between, the two bonded 'by brick and flat bedded stones, and hoop iron bond where necessary.'[58] Other houses of the period 1878-1895 along the St Lawrence Seaway had ten inch walls with a two inch cavity bonded with header bricks at every eighth course, and where these bonding bricks stopped two inches short of the inside face, the gap was filled with mortar.[59]

In about 1920 'the most usual method' of building a hollow wall in the United States was one with 'withes or headers of brick extending across the airspace', and it appears from the context of the statement that this meant continuous vertical diaphragms dividing the cavity into separate cells, rather as in Tugwell's system.[60] But the cavity wall seems to have largely disappeared from view in the United States until it was revived after World War II. Thus an Australian report of 1949 found that cavity walls were 'a recent innovation' in the USA. The more usual construction was a solid wall with timber firring on the inner face, carrying plasterboard sheeting.[61]

### *g. proto-cavity walls in Australia*

As in Britain, the cavity wall seems to have been widely used for dairies and cool rooms long before it was accepted for general building purposes in Australia. Major T L Mitchell, Surveyor-General of New South Wales, wrote in about 1828 that:

> if the walls of a dairy be made hollow, [it] will be warmer in winter, and cooler in summer, than will a solid wall built of the same quantity of materials; the outside w[all] may be nine inches, the inside wall, brick on edge, tied to the nine inch work by head[ers] at about every five courses, the cavities betwe[en] the walls to be about two inches.[62]

This is the level of bonding proposed by S H Brooks at a later date, but if one seeks a specific source for Mitchell's knowledge of the cavity, it may well be found that he had attended General Pasley's lectures or was familiar with the published version. Mitchell also advocated hollow walls for the cesspools of privies, where they adjoined another building, as will be discussed below.

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58 Thomas Ritchie, *Canada Builds 1867-1967* (Toronto 1967), pp 21, 221.

59 Thomas Ritchie, 'Notes on the History of Hollow Masonry Walls', *Association for Preservation Technology Bulletin*, V, 4 (1973), p 46.

60 F T Hodgson et al, *Architecture, Building, and Carpentry* (5 vols, Chicago 1925-6 [1910]), II, p 138.

61 D V Isaacs & J W Drysdale, *Building Technique and Building Research* (Sydney 1949), p 45.

62 'Sir Thomas L. Mitchell, Memoranda Book, 1827-1829', ms ML C38 (reel CY 1992), Mitchell Library.

The cavity wall is not necessarily confined to brick construction, and we have already considered above the sod cavity wall of the extraordinary Longbeach Sod Cottage, New Zealand, thought to date from the 1860s. It is interesting that oldest known Australian example is to a dairy built with a cavity wall in stone, that of Andrew Lang, which still stands at Dunmore, near Paterson, New South Wales.[63] Whilst rubble stone walls can be deceptive, for the loose full of lime and rubble may sink to leave an unintended cavity, it seems likely that this one is authentic.[64] However Morton Herman refers to walls packed with mud and straw in the centre as a standard type,[65] and one can readily envisage how such a filling might sink down and leach out to leave a true cavity.

A distinction has already been made between proto-cavity walls like Mitchell's which are bridged by brickwork at more or less frequent intervals, and the true cavity wall, with only iron ties, or perhaps with patent or other bricks at only very spare intervals. Of the various proto-cavity wall types, Freeland has claimed that both Dearn's and Loudon's walls were known in Australia in 1854,[66] but does not explain the basis for this assertion. I know only of one example of Dearn's walling and one of Loudon's. Dearn's wall was used at the Mill Hotel at Howlong, in southern New South Wales, of some time before 1872.[67] Loudon's method, or something approaching it was used in a house of 1864 by the Bendigo architect R A Love, apparently with purpose-made 290 mm [11$^1$/$_2$ inch] headers.[68]

By contrast, Silverlock's (or 'rat-trap') walling was relatively common by the 1850s and 1860s in Victoria, and soon reached Queensland. It occurs in a dairy or meat house at the house 'Ellerslie', Bacchus Marsh, Victoria, of the 1850s, and it was probably used in the dairy of the Model Farm near Melbourne (possibly of 1860), which was reported to have hollow walls so as to save brick and to keep the building

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63 Rachel Roxburgh & Douglass Baglin, *Colonial Farm Buildings of New South Wales* (Adelaide 1978), p 12, and illustrations, pp 167-9. The text refers to a footnote which is missing, but is probably meant to be to the Colonial Secretary In-Letters, re Land, Lang, Archives Office of New South Wales.

64 The question is worth asking, given that stone walling of this sort, filled with loose rubble, is found in the same area at Berry House: R M Deamer, 'Houses erected on the original Land Grants in the Lower Hunter, Paterson and Williams River Valleys between 1800-1850' (MArch, University of Newcastle, 1971), pl 7.

65 Morton Herman, *The Early Australian Architects and Their Work* (Sydney 1954), p 132.

66 J M Freeland, *Architecture in Australia* (Melbourne 1968), p 134.

67 Joan Fairbridge, 'Historical Hotel to be Sold', *Border Morning Mail*, 11 February 1876, p 20, mentions 'a Royal Australian Historical Society publication' in which a visitor to Howlong in 1872 refers to the hotel. I originally learnt of this building from Allan Willingham, who was told of it by Mrs Shirley Trewin of Pearcefield, NSW. I have subsequently spoken to Mrs Trewin, and to the current owner, Mr Russell Cooper, who confirms that he can see bricks on edge and on the flat in the cellar, without being able to discern the bonding system, but that elsewhere the brickwork is concealed. He kindly sent me the Fairbridge article and other material.

68 Information from Mike Butcher, 1997. This appears to have been Love's house for Robert Lisle, mining investor, near the Sheepshead line of reef.

cool.[69] It occurs in at least three surviving buildings, probably of the 1860s, at Beechworth.[70] It is found in buildings of the 1860s and 1870s in Brisbane, such as a cottage at 355 Wickham Terrace, of 1864; Mooney's Cottage in Victoria Street, of about 1870; and a two storey shop in Leichardt Street beside the Alliance Hotel.[71]

In the *Australian Builder's Price-Book* of 1862 Charles Mayes makes mention of hollow walls in 9, 11, 12 and 14 inch thicknesses,[72] and it seems clear from the fact that he bases his remarks upon Allen's *Cottage Building* that he is referring to the proto-cavity types. A remarkable discovery in what was at the time my own house in Drummond Street Carlton, Victoria, of the 1870s, was what one might call a semi-Dearn wall or a version of the American Rolok-bak. This was a nine inch wall in English garden wall bond with three courses of stretchers to one of headers on the outside face. On the inner face the three courses of stretchers were replaced by two courses on edge, with a $1^1/_2$ inch cavity behind them. As the inner face was plastered and the outer one looked perfectly normal, the deceit was undetectable until the wall was part-demolished. A shop in Collingwood, probably of a similar date, has a full cavity wall to the street frontage with an inner leaf of brick on edge and an outer leaf of conventional stretcher bond brickwork, but how or if they are tied together has not been established.[73]

A wall with a more complete cavity was used in 1864 at St Monica's School, Eaglehawk, Victoria. When the building was demolished in 1992 it was reported to have a cavity bridged at intervals of about one metre either by individual bricks or by complete brick divisions.[74] This building was by the architects Vahland & Getzschmann, in the same year as the building by Love previously referred to, but it was Love - it seems - who was to introduce the true cavity wall to Victoria.

The true cavity wall seems to appear almost simultaneously just before 1870 in different forms, some with no apparent ties at all, and others with hoop iron ties, and

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69 *Farmer's Journal and Gardener's Chronicle* [Melbourne], 2 August 1862, p 408, courtesy of Deborah Kemp.

70 These are Dr E Collins's house, the old bakery and store near the lunatic asylum, and a building just out of Main Street towards Wangaratta. Information from George Tibbits, 1984.

71 All brought to my attention originally in 1991, by Richard Allom and Peter Marquis-Kyle.

72 C B Mayes, *The Australian Builders' Price-Book* (Melbourne 1862), p 19.

73 54 Gold Street, Collingwood, south-east corner of Peel Street, drawn to my attention by Andrew Muir, 1993. Directories show this to be the shop of Falcke & Owens, grocers. It appears to have been built integral with the adjoining terrace of single storey houses at 48-52 Gold Street, but the construction is not the same, for their walls are in Flemish bond and presumably are solid, reflecting the fact that they are protected from the weather by verandahs.

74 The individual brick version would under normal circumstances have to be preferred, as this was the description by Mike Butcher as published at the time, *Bendigo Advertiser,* 7 July 1992, and 11 July 1992, Saturday Magazine, p 3: the cavity is said to have been 75 to 100 mm wide. However, the building contractor, Ron Alexander, remembered [1997] the cavity as having complete divisions as in Tugwell's system, and Butcher has since described it in a manner more like this, as 'in metre long compartments which were bonded in overlapping header bricks from bottom to top': Butcher, draft monograph on R A Love. The building was designed by Vahland & Getzschmann, whose Rifle Brigade Orderly Room, Bendigo, of 1867, is also of hollow wall construction.

others with patent stepped up bonding bricks. In many cases it is simply impossible to tell. In Melbourne the South Yarra house 'Sunnydale', by the architects Smith & Watts in 1867, had 'hollow walls, to counteract the effects of both heat and damp',[75] and this is probably, though not definitely, the first local reference to true cavity walling. Otherwise the earliest examples are in the Victorian country towns of Stawell, Bendigo and Geelong, Port Adelaide, and possibly the Western Australian town of Guildford.

### *h. R A Love and the Bendigo connection*

Most of the Stawell and Bendigo examples appear to have been the work of a local architect, R A Love,[76] whose Loudon wall of 1864 has been mentioned. He had first practised in Ballymena, Co Antrim, Ireland,[77] and then spent some years in the United States, and may have brought the idea from there. St Matthew's Church, Scallan Street, Stawell,[78] and the Stawell Literary and Scientific Institute in Longfield St[79] are both of 1868 and have cavity walls. The church is known to be by Love and there must be a strong presumption that the Institute is also. The church has a wall of one double and one single leaf at the base, reducing at about 1.8 metres to two single leaves, with 22 x 3.5 mm iron strap ties at sparse intervals. The Institute is a two storey building in which the ground floor has a double leaf of brick on the outside and a single leaf inside, with a 75 mm cavity. The brickwork in an irregular bonding pattern, generally of two or three stretchers to each header. In some parts there protrude the bent-down ends of 3 x 19 mm iron straps, which must be the ties.

Similar ends are visible in the master's house at Stawell Grammar School, which was built to Love's design in 1869-70.[80] They are spaced apart six courses vertically and

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75 *Argus*, 11 February 1871, p 2. original tender in the *Argus*, 29 May 1867, p 3.

76 Robert Alexander Love (1814-c1876) was an interesting character. He was born in Ireland, where he seems to have trained as an engineer and architect, and immigrated to the United States, where he first lived in Philadelphia, then moved to Cincinatti in 1844. There he is said to have been associated with Charles Ellet, the innovative suspension bridge designer. In 1854-5 he moved to the Californian mining town of Vallejo, then in 1858 emigrated to Victoria and established himself as and architect at Bendigo. He made designs and models for suspension bridges, and in 1871 he inaugurated an architectural drawing class at the Sandhurst (ie Bendigo) School of Design. He left Bendigo in the 1870s because he was developing a perpetual motion machine, and he wished to perfect it and patent it in America. It had been intended to be a short trip, but as it turned out he contracted smallpox and died there. Frank Cusack, 'Robert Love, the Dreamer from Donegal', *Bendigo Advertiser*, 23 March 1985, p 14. Mike Butcher comments that the connection with Ellet is entirely speculative, and is improbable.

77 Information from Mike Butcher, 1997.

78 *Illustrated Australian News*, 4 October 1869, p 195, illustrates the church and reports that it was opened in May 1868.

79 Mike Butcher advises that tenders were called anonymously in the *Ararat Advertiser*, 12 May 1868, p 2. Love called tenders in the *Pleasant Creek News* in November 1868 for a house for Y J Wakeham in Seaby Street, Stawell (no 65), bit it is not clear whether this is of cavity wall construction.

80 Butcher advises that the tenders for Bradley's Grammar School were for the school and cottage. The 'cottage' is certainly the master's house, but the 'school' may be the two storey dormitory

2 1/2 bricks horizontally. The classroom at this school is a detached building which may be somewhat later, and has a very large cavity, about four inches [100 mm], and no apparent bonding at all. The Welsh Baptist Church at 17 Scallan Street, Stawell, was built to Love's design at the same date, with a cavity wall with a single leaf on both sides, which appears to be bonded with iron bars, the turned-down ends of which re visible externally. Love's church at North Lockwood is also of cavity construction,[81] and a house at 65 Seaby Street Stawell, not specifically linked to Love, has a cavity with no ties but bricked solid across the top. This is not accessible to inspection, but the outer walls are about 370 mm thick.

All of this leaves us with no absolute proof, but with a very strong suspicion, that it was Love who introduced the cavity wall in this region from 1868 onwards. He certainly built other cavity walled buildings in the next few years. Unfortunately for Love's reputation, however, another securely attributed cavity wall in the area is almost contemporary: that of the Strathfieldsaye Shire Hall, near Bendigo, built in 1869 to the design of the shire engineer George Steane.[82] Here the cavity is 4 1/2 inches wide and extends around the three outer walls only of the hall proper, not the offices in front. There is a row of circular vents in the interior cornice, and it appears from contemporary newspaper reports that they supplied air from the cavity, so that its role is not unlike that proposed in England by S H Brooks, though here doubtless for cooling rather than heating. There is no indication of any ties in the wall, so that it most resembles the classroom of Stawell Grammar School.

Hard on the heels of Love and Steane were the Bendigo houses 'Euroma', by Vahland & Getzschmann in 1870; 'Hillside', Kangaroo Flat, by Moffat & Brady in 1873; and the McGillivray house by J M Brady in 1875.[83] Later in Bendigo 'Lister House' at 37 Rowan Street, built in 1881 to the design of W C Vahland, is reported to have in at least the upper floor a complete cavity bridged only by bricks at the top and at window sill height.[84] 'Hillside' has ties cut from 18 x 3 mm wrought iron bar, roughly shaped at the ends, and curved downwards where it crosses the cavity. The bars are spaced at about one metre intervals horizontally and four to six courses vertically. The cavity itself is about 100 mm wide.[85]

### *t. the Jennings brick in Australia*

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building rather than the detached classroom, especially as the cavity construction of the latter is quite different.

81 Information from Mike Butcher, 1997.

82 I identified this example originally from external inspection, but it has since been investigated by Trevor Westmore of Maldon, who has kindly forwarded me a copy of the plans. They are signed quite unequivocally 'George Steane / Shire Surveyor &c. / 26th. January 1869.' An illustration of the building appears in the *Illustrated Australasian News,* 1 November 1869, p 10.

83 Mike Butcher, draft monograph on R A Love, 1999.

84 Information from Mike Butcher, 1999.

85 Illustrations supplied by Mike Butcher, 2002.

The cavity wall introduced at Geelong was of a different type. On 1 January 1870 the architects Alexander Davidson and George Henderson, while holidaying in Melbourne, looked at examples of the now fashionable polychrome or 'fancy brickwork' (as they called it), and in April they called tenders for Geelong College, their first major polychrome building.[86] This building has a brick cavity wall, as did the many other polychrome works of Davidson & Henderson to follow. The reason is probably that exposed face brickwork, which until now had been exceptional in major buildings, tended to admit moisture. How the wall was tied at Geelong College has not been established, but soon afterwards Davidson & Henderson were using a ramped-up brick of the form patented in England by George Jennings, and this was being manufactured locally, probably to the specific demand of the architects, by T H Widdicombe, of the nearby town of Portarlington.[87]

Widdicombe took out a Victorian patent in 1871 for a rather simplified version of the Jennings brick,[88] and his new product was reported in the *Australian Mechanic*[89] in November 1872. The same report illustrates another system of bonding which was allegedly English, though I have never seen any reference to it in England, Australia or elsewhere. This used flat iron plates on edge - which is to say that they slotted into header joints in both leaves - and there was notch cut out from the lower side to stop water passing across. This report identifies Widdicombe as the Victorian patentee of the Jennings bonding brick, and in the following month he was advertising the bonding bricks for sale in the Geelong area.[90] Widdicombe became insolvent in May 1872 and his patent, no 1559, was sold in June.[91] A later report refers to the brick as having been invented or developed by Davidson and Henderson (who may well have bought the patent), and it seems to say that the iron plate bond was also their invention.[92]

### *j. the cavity wall in Australia*

The brick cavity wall, therefore, appears fairly extensively in its various versions in rural Victoria in the period 1868-71, and in 1873 it appears in 'St Albans' homestead near Geelong, by the Melbourne architect J T Conlon. This suggests that Conlon's

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86 Allan Willingham, 'Two Scots in Victoria' (MArch, University of Melbourne, 1984), pp 108, 110.

87 Advertisement, *Geelong Advertiser*, from 3 February 1872, as advised by Virginia Maxwell, 1996. The *Geelong Advertiser* of 29 May and 7 September 1872 reports the use of a new type of brick made by Widdicombe in the Sydney Hotel, Mercer St, Geelong, designed by Davidson & Henderson. However this appears to be nothing to do with the bonding bricks, but a face brick in which a pattern was embossed before burning, so as to imitate cast cement or stone carving: information supplied by Allan Willingham and Virginia Maxwell.

88 Victorian patent no 1559 to Thomas Henry Widdicombe, 23 September 1871.

89 *Australian Mechanic*, 15 November 1872, p 134.

90 *Geelong Advertiser*, 14 December 1872, p 4.

91 Information from Virginia Maxwell, 1996.

92 *Geelong Advertiser*, 14 May 1873, p 4, cited by David Rowe, 'Architecture of Geelong 1860-1900' (2 vols, BArch, Deakin University, 1991), I, p 5, where the two inventions seem to become merged together.

buildings in Melbourne, of this date or earlier, may be of the same construction. The wall consists of a double outer leaf, a cavity, and a single inner leaf, with hoop iron strap ties kinked upwards at the centre. Closer to town, the dairy at 'Springfield', Berwick, was built for William Clarke junior in 1875 to the design of the architect George Browne. It has a 50 mm cavity between a double outer leaf and a single inner leaf, which are joined by what are described as galvanised iron ties,[93] probably meaning hoop iron or straps of some sort.

In 1877 a new house in Hawthorn was advertised as having all the main brick walls hollow,[94] and by now the cavity was sufficiently well-known in Melbourne for a barrister, H P Walker, to sue his architect for not using hollow walls in his house, which had leaked. The house had nine inch walls of Hawthorn brick, and water was penetrating the southern one. Walker contended that he should have been warned that the solid wall would be inadequate and that two 4½ walls connected by ties should be used, but the architect, William Ellis, insisted that he had been so warned. Some of the architects and builders who gave evidence were of the view that the two leaves would be as strong as a solid wall, whilst others thought they would be much weaker. It was further claimed, for Ellis, that the problem was largely attributable to the Hawthorn bricks, which were very porous.[95]

It was probably in 1878 that the architect Lloyd Tayler designed a house in Jolimont with a hollow wall,[96] which was probably a true cavity for (as will, appear) Tayler was using the true cavity three years later. Slightly earlier, in 1877-8 a building was put up at Trinity College, Melbourne University, with hollow walls. It was not by Tayler but by Frederick Wyatt, who had been Tayler's partner, or more accurately locum, while Tayler visited Europe. It was reported that the walls 'to insure at once coolness and dryness, are made hollow'.[97] At such a date, with an indirect link to Tayler, and where 'dryness' is a stated objective, it is likely that this is a true cavity wall. Finally, Tayler himself was responsible for the oldest authenticated surviving example of a cavity wall in Melbourne, which is a pair of houses in Club Lane, built in 1881,[98] in which the walls consist of two single leaves of brick and between them a large cavity, perhaps 75 mm, though the nature of the ties has not been established.

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93 Context Pty Ltd, *Heritage of the City of Berwick* (?Berwick [Victoria] 1993), p 230, quoting National Trust of Australia (Victoria), *Berwick Cheese Factory Classification Report*, p 3. I have been unable to see any such ties upon inspection.

94 *Argus*, 7 July 1877, p 2.

95 *Argus*, 28 February 1877, p 5.

96 Tayler called tenders for roofing and carpenter's work on a building in Jolimont Terrace (*Argus*, 30 October 1877), p 3). A building permit application was then made in 1878 for a house by Tayler in Jolimont Street, Jolimont, owner George Walstab, builder G T W Freeman (MCC application no 7696, 19 July 1878). It is unclear whether this is the 1877 building, delayed, or an additional house. However it seems to be referred to in a later auction notice for a house built in 1879 in Jolimont Terrace, designed by Lloyd Tayler, which has hollow walls (*Argus*, 12 June 1886, p 2).

97 *Argus*, 14 June 1878, p 7.

98 MCC building application no 8716, 11 March 1881.

Although we cannot identify existing examples, by 1880 the cavity was already fairly common in Melbourne,[99] and in 1883 Mayes stated that double walls connected only by iron cramps or ties had been used in public and private buildings at both Melbourne and Sydney.[100] Until at least the late 1880s some houses were built with cavity walls only on the side most exposed to the weather. For example, J L Leonard's drawings of 1885 for a house at 83 Walpole Street, Kew, show a solid front wall, protected by the verandah, but the wholly or partly exposed side walls of cavity construction. Similarly an auction notice in 1887, for a house designed by Twentyman & Askew six years earlier, refers to 'double walls' on the weather side only.[101]

In 1885 the cavity wall was being promoted in print by the prominent architect Percy Oakden, who advocated placing the thickest leaf on the outside, contrary to the opinion of Rivington, the recognised authority on building construction in the English technical schools.[102] This seems rather perverse as Rivington - actually the publisher, not the author - advances cogent arguments for this view: the construction advocated by Oakden exposes the bulk of the wall to damp and increases the span of joists and beams, which must of course bear upon the structural wall.[103] It may be added that it also exposes these timbers to direct contact with the damp masonry unless specific measures are taken to isolate them. Nevertheless, it was not new in Victoria, for it had occurred at the Berwick cheese factory and at St Albans, and it seems to have become the norm in the 1880s. The same inside-out construction later occurs (though not with the same ties) in the Melbourne mansions 'Villa Alba' of 1883, and 'Illawarra', of 1888-9, and in rural Victoria at 'The Ridge', Rosedale, of 1886. The drawings for the railway station at Maryborough, Victoria, of 1890, similarly show a wall of two bricks thickness on the outer face and one brick on the inner. It is bridged at every seventh course with a tie - probably a strap - notched upwards within the cavity, and, interestingly, the cavity is not continuous around the corners of the building.[104]

Despite all this, an architectural student in 1892 put the case for placing the structural wall on the inside, with great cogency:

> ... I would put the 4½-inch [75 mm] thickness on the outside, because the stronger portion of the wall would be inside to support the weight of the flooring and roof, &c. The damp or wet is intercepted more readily by the air

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99 'Haldon' at 426 St Kilda Rd, Melbourne, built in 1878-9 to the design of Conlon & Salway, had all the external walls 'hollow, by which heat and damp are entirely excluded' *(Australian Engineering and Building News*, 1 July 1880, p 7). A house of 1879 in St Vincent's Place, South Melbourne, designed by Edward Twentyman, has a cavity wall except for the rear or service wing (drawings in the Melbourne University Architectural Collection, SLV); and there were cavity walls in a villa in Kensington Road, South Yarra, designed by E G Ovey (*Argus*, 19 April 1884, p 2).

100 Charles Mayes, *The Australian Builders' Price-Book* (4th ed, Melbourne 1883), p 144.

101 *Argus*, 12 August 1887, p 144.

102 Terry & Oakden [architectural firm], *What to Build and how to Build It* (Melbourne 1885), p 6.

103 *Notes on Building Construction Part II* (3rd ed, London 1877), p 215.

104 Detail drawing supplied by Janet Beston, 2001.

> space, and is kept at a greater distance from the interior of the apartment than could be done with the thickness *vice versa.* The thicker wall being inside also forms a better bond for the interior transverse walls &c., than would the 4½-inch ... in that position.[105]

In 1899 Percy Oakden adjudicated a private competition for the design of J M V Smith's house 'Bundoora Park', north of Melbourne. This was won by Sydney Wilson, and carried out by him in conjunction with Oakden, using an inner leaf of two thicknesses and an outer of one thickness of brick - suggesting that Oakden had ultimately succumbed to Rivingtonian logic. In addition the cellar was flanked by spaces of the sort known in Britain as 'air drains', which were not so much cavities as tunnels about 450 mm wide, in the bottom of which were drains to lead the water away to a sump.[106]

The cavity wall may have appeared in South Australia as early as it did in Victoria. Bruce Harry asserts that there are examples of stone cavity walls - where the cavity is deliberate and not just the result of settlement in the rubble fill - and he cites as an example a church in St Mary's Road, Morphett Vale, of the 1860s.[107] The first appearance of the true brick cavity wall appears to be the Catholic Schoolroom in Dale Street, Port Adelaide, of 1869, designed by Wright, Woods and Hamilton. A report discovered by Carolyn Wigg states that:[108]

> A novelty has been introduced in the structure by means of hollow brick walls, and the advantages to be gained by this are lightness of building where the foundation rests upon soft ground, prevention of damp and heat, &c.

In 1881 the local *Building Act* included provisions for cavity walling, which indicates that it had now gained some currency.[109]

In Western Australia there is one cavity wall thought possibly to date from about 1870, the cottage at Guildford Grammar School known as the Armoury, originally identified by Margaret Morison, where there is a cavity only in the west wall, exposed to the weather.[110] Likewise G T Poole's unbuilt design for railway workers' housing at York, of 1885,[111] has a two inch (50 mm) cavity throughout the two storey height, and even through the rear wall where it was to be protected by a verandah. The cost

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105 Building and Engineering Journal, 9 April 1982. p 143.

106 Historical notes and drawings compiled by Terry Sawyer for the Department of Housing & Construction, c 1984: partial extract only sighted.

107 Information from Bruce Harry, 1991

108 *Southern Cross and Catholic Herald*, 25 October 1869, p 384.

109 Bruce Harry, 'Historic Building Method and its Relevance in Conservation Today', in Peter Freeman et al [eds], *Building Conservation in Australia* (Red Hill [ACT] 1985), p 51.

110 First drawn to my attention by Gerry McGill and Ralph Hoare.

111 'Eastern Railway Employés Cottages - York', drawing no 6 [498], signed by G T Poole, 29 October 1885, Battye Library. Reference copy kindly supplied by Ingrid van Bremen. See also Ingrid van Bremen, 'The New Architecture of the Gold Boom' (PhD, University of Western Australia, 1990), figs 3.2a, 8.14. The cavity ran through two storeys and even through the rear wall protected by the verandah.

of these buildings prevented them going ahead, and Ingrid van Bremen has suggested that this was due to the fact the local builders were unfamiliar with cavity construction.[112] It was not until about 1892 that the cavity wall appeared once more in designs by the Public Works Department. Given that the date of the Guildford Grammar building is not confirmed, it may have been Poole who introduced the idea of the cavity wall to Western Australia, and this seems feasible enough, for (as van Bremen has so perceptively noted[113]) he was a native of Southampton, which was the heart of cavity walling in Britain.

Subsequently the additions to the Katanning Court House of 1896 have a two inch [50 mm] cavity throughout,[114] and a cavity also appears in the new Museum building of 1896, in standard designs for one room country schools, and for bungalow hospitals on the North-West Goldfields, and in the East Wing extensions of the Government Offices in Perth.[115] In multi-storey work, van Bremen notes, the outer leaf was usually but not always the larger, but some government building continued in solid brick, and in some buildings the cavity was used only in walls exposed to the weather, as at Guildford. The same practice is said to be found in speculative housing built in the 1890s in Northbridge, North Perth,[116] but the only examples illustrated by Ian Kelly have the cavity around the full perimeter.[117] By now the cavity wall was widely accepted, and not only on grounds of damp-proofing, for in the case of the Christian Brothers Building in St George's Terrace, by Cavanagh & Cavanagh, it was reported that it 'helps greatly to keep the air cool in warm weather'.[118]

Dennis Jeans claims the first Sydney example to be the Sussex Street Public School,[119] but the building shows no sign of a cavity, and he does not cite his authority, so one must remain sceptical. However, the school was designed by G A Mansfield, who in 1872, while President of the New South Wales Institute of Architects, was publicly advocating 'hollow or double walls' with 'small wrought iron ties',[120] so there may be some basis for the claim. Although polychromy was not so

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112 Van Bremen, 'The New Architecture of the Gold Boom', p 134.

113 Van Bremen, 'The New Architecture of the Gold Boom', pp 133.

114 Information from Robin Campbell & Ingrid van Bremen.

115 Van Bremen, 'The New Architecture of the Gold Boom', p 134, figs 7.7, 7.11, & appendix B fig 4.2

116 Information from Robin Campbell & Ingrid van Bremen.

117 Ian Kelly, 'The Development of Housing in Perth (1890-1915)' (MArch, University of Western Australia, 1991), p 139, discusses the twenty-nine pairs of houses in Brookman Street, Northbridge, built in 1897 for the Colonial Finance Company (or Corporation). He illustrates numbers 13, 15 and 17 (p 140) and gives a plan and elevation of 25-7 (pp 141-2, the latter deriving from P Turner, 'Moir and Brookman Streets; an Architectural and Historical Record' (?BArch, Curtin University, no date cited).

118 *West Australian*, 14 January 1897, p 5, quoted by Van Bremen, 'The New Architecture of the Gold Boom', pp 133.

119 Dennis Jeans, 'The Building Industry: Materials and Styles', in Judy Birmingham, Dennis Jeans & Ian Jack, *Industrial Archaeology in Australia: Rural Industry* (Richmond [Victoria] 1983), p 104. The building was designed by G A Mansfield and is reported in the *Illustrated Sydney News*, XIII, 23 (15 September 1877), p 7, simply as being of 'brick, on stone foundations'.

120 G A Mansfield, 'Healthy Homes', 'Construction of Hollow Walls', *Town and Country Journal*, 24 August & 26 October 1872, quoted in Peter Freeman, *The Homestead - a Riverina Anthology*

influential in Sydney, exposed brickwork was widely used: not just in G A Mansfield's Gothic schools, but soon in a range of red brick Queen Anne and Free Style designs - hence James Barnet's disparaging comment in 1899 on the influence of Bedford Park in such matters as 'red brick hollow wallery'.[121] In 1884-7 the Macleay Museum at Sydney University was built with an outer leaf of double thickness [nine inch] brick in Flemish bond, a cavity, and an inner leaf of double brick in English bond. The ties were somewhat unusual, being bars almost square in section rather than straps, with s gentle concavity at the centre and a turn down at either end. The turn downs must have been designed to lock into the middle of each leaf of brickwork, as the length is about 290 mm [11½ ins].[122] In 1887 the *Australasian Builder & Contractor's News*, probably writing in terms of Sydney, argued that 'double brick walls', though effective, were too expensive for ordinary work.[123]

Cavity walls are found in the Riverina at least from 1879, when 'Czar Lodge' at Hay was built with hollow walls designed to allow the passage of air and to keep the building cool, rather than to control moisture.[124] The house was built by H L Lindsay, adjoining the Red Lion Brewery, and still stands as 'Claughton House' in Hay Street, together with an outbuilding which seems to have been a part of the brewery complex, and which has a similar cavity wall. This outbuilding may date from about 1882, when a prospectus was issued to float the brewery as a public company.[125] Other cavity walls, apparently later in date, are also found in the area.[126] In New Zealand, where brick buildings are less common, the cavity wall was in use at least by 1898.[127]

In Queensland brick is less common, but when the Tunbridge brothers set up in practice in Townsville in 1887, as Tunbridge & Tunbridge, they were said to be

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(Melbourne 1982), p 79. It is puzzling, therefore, to find St Mary's Parsonage, West Maitland, by George Browne in 1881, hailed as 'one of the first uses of the cavity wall': L J Dockrill, 'Developments in Architecture in New South Wales during the Victorian Period' (6 vols, PhD, University of New South Wales, 1983), I, p 100.

121 James Barnet, 'Architectural Work in Sydney, New South Wales, 1788-1899', *Journal of the Royal Institute of British Architects*, VI, 3rd series, 17 (29 July 1899), p 516.

122 These details are taken from the material on display at the museum, which is not accessible to direct measurement. The section of the ties might be, at a crude estimate, about 8 x 12 mm.

123 *Australasian Builder & Contractor's News*, 21 May 1887, p 35.

124 M L Gardam, *The Bishops Lodge* (Hay [New South Wales] 1993), p 10, quoting *Riverina Grazier*, 2 April 1879, p 2.

125 The house, with outbuildings in the right location, but more extensive, appears in a painting by William Tibbits: see George Tibbits, *William Tibbits 1837-1907* (Melbourne 1984), p 80. Here it is dated as 'c 1898' but apparently on no firmer basis than the thought that Tibbits was in New South Wales about that time. The illustration is more likely to have been commissioned in connection with the floating of the company in 1882. The prospectus of the company is reported then, but it describes the brewery building as of three storeys, to which additions are to be made (whereas the Tibbits illustration seems to show only a very small portion which may be two storeys high). *Argus*, 20 March 1882, p 3.

126 'New Female Prison, Boggo Road Contract &c. of 2 October 1901', specification held by the Historic Buildings Branch, Brisbane.

127 Martin Hill, *Restoring with Style* (Wellington 1985), p 30.

introducing 'a new class of residence ... viz., handsome brick villas with cavity walls'.[128] The design of the Medical Superintendent's dwelling at Toowoomba in 1889 shows a cavity wall on all exposed faces of the building, but not under the verandah. The cavity is not entirely continuous, being bridged at the corners by solid brickwork.[129] The specification for the Boggo Road Gaol, Brisbane, in 1900, describes the hollow walls which are to surround the exterior, and will be referred to below.

Just as the earlier cavity walls had appeared largely in the context of icehouses, dairies and cool stores, the cavity continued to be especially favoured for these purposes until well into the twentieth century. 'Anambah House' of 1888-9, in the Hunter Valley of New South Wales has a dairy/cool room which is part of the main body of the house, and has only one external wall. This wall alone has a cavity, which can be seen in the original architectural drawings by J F Pender,[130] and which seems to have been built in the form shown. The cavity in this length of wall is completely bridged by the brickwork at two points, so that there are in effect three distinct cells, each perhaps about 1.2 m long (in accordance with the Tugwell principle). There are large vents at the top and bottom of each cell exteriorly, and the top ones at least appear also on the inner face. Thermal insulation, in a rather different way, was also the motive for the cavity wall in the Turkish bath building at Mount Wilson designed and built be E A Bonney in 1893.[131] In the same tradition as Anambah is 'Innisfail', the R S Meares house at Forbes, New South Wales, which was designed in the 1940s by Kenneth McConnel with a cavity wall around the cool room only,[132] though McConnel writes of the cavity wall as being 'universally adopted'. It concerns him because it is necessarily built in stretcher bond brickwork, and he suggests improving the appearance by adding a snapped header brick at every third stretcher.[133]

### *k. hoop iron and wire ties*

The elaborate forms of cast and wrought iron tie illustrated in overseas texts (and in Australia by Nangle and Haddon) have yet to be found in any local example. Nearly all surviving ties are of hoop iron of various forms, and later of galvanised wire. Exceptions include the McGillivray house, 40 Forest Street, Bendigo, built in 1876 to the design of the local architect J M Brady, and reported to have wrought iron ties.[134] Another is the Macleay Museum, with its wrought iron bars, as discussed above, and a third seems to have been the Commercial Bank of Australia headquarters in Collins Street, Melbourne, of 1890. At the bank the cesspits were built in brickwork with a

128 Donald Watson & Judith McKay, *Queensland Architects of the 19th Century* (Brisbane 1994), p 198.
129 Specification held by the Historic Buildings Branch, Brisbane.
130 Reproduced in Barry Maitland, *The Pender Index* (Newcastle [NSW] 1999), p 25.
131 Hugh Fraser, *The Federation House* (Sydney 1986), p 60.
132 Kenneth McConnel, *Planning the Australian Homestead* (Sydney 1947), p 71.
133 McConnel, *Planning the Australian Homestead*, p 114.
134 Information from Mike Butcher, 1999.

1 1/2 inch [38 mm] cavity which was then filled with liquid asphalt. However, it was constructed in the proper fashion 'with galv wrot iron ties 1' 3" [225 mm] apart at every 4th course (7 to yd).'[135]

Cast iron ties were amongst the types used in the pioneering cavity wall experiments at Stawell, and such ties were used (or at least specified) in the Boggo Road Gaol, Brisbane, in 1901. The specification reads:

> All external walls above damp course level indicated on plans to be built hollow, built in English bond, with a two (2) inch cavity with cast iron ties nine (9) inches by two (2) ins. by quarter (1/4) inch formed as per sketch on margin: - [the sketch shows a flat strip with a downward kink at the centre, and with each end split into a pair of points curling decoratively to either side] with V drip in centre, placed every three (3) feet apart in every fourth course in height, dipped in hot pitch and sanded before being used. The bottom of the cavities to be finished with half (1/2) inch layer of well boiled tar and sand, finished with even falls to outlets as directed.[136]

There is also a requirement for a 'wood core' to catch falling mortar[137] - this is a narrow board suspended in the cavity to catch the drips, but it must be removed before each set of ties is laid, and replaced above them.

Hoop iron was already in wide use for bonding solid brickwork and other masonry, and it was the obvious material to adopt in cavity walling, as in the earliest examples at Stawell referred to above. At St Albans homestead outside Geelong, Victoria, there are hoop iron ties with an upward kick at the centre, but it is unclear whether these occur in the original house as designed by James Conlon in the 1873, or only in the extensions of 1875 and 1878. A house at 83 Walpole Street, Kew, of 1885, used 32 mm hoop iron riveted together ladder-wise, with the sides running in the two brick courses, and the rungs crossing the cavity. The whole assemblage was tarred and sanded to resist corrosion.[138] Similar ladder-like hoop iron ties have been found by Maree Hayes in the Alfred Isaacs house, 1 Goodall St, Hawthorn, of 1888, and by Mike Butcher at the undated, and now demolished, Durham Ox general store. An iron wall tie notched down at the centre is shown in Poole's 1885 drawings for railway workers' cottages at York (but of course not executed), but whether hoop, wrought or cast iron is intended is not clear.[139] By the turn of the century hoop iron seems to have been entirely superseded in Australia, by contrast with Canada, where 'Weese's patent wall brace or tie' continued in use. It was made by the Mac Machine Co of Belleville, and seems to have been nothing more than a plain strap with a slight

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135 G W Blackburn, 'The Commercial Bank of Australia Limited New Premises &c' ([bill of quantities] Melbourne 1890), p 6.

136 Held at the Heritage Branch, Brisbane: inspected 1901.

137 'New Female Prison, Boggo Road Contract &c. of 2 October 1901', specification held by the Historic Buildings Branch, Brisbane.

138 Miles Lewis, '83 Walpole Street, Kew' (mimeographed report, Melbourne 1981).

139 'Eastern Railway. Employés Cottages York. Drawing No.6', Battye Library, Perth: information from Robin Campbell & Ingrid van Bremen.

turn-up at either end,[140] so it is difficult to see the basis upon which a patent could have been granted.

By 1883 the American Morse tie,[141] of galvanised wire, appeared in Australia. It has been found at the 'Villa Alba', in the Melbourne suburb of Kew, and though the precise form cannot be seen, the wires are in pairs, indicating some sort of U or loop, and are not notched where they cross the cavity. Such ties also occur in the Alfred Isaacs house of 1888, in a wall on the opposite side from that with the hoop iron tie already mentioned. It occurs in at least one wall of the architect F R Barlow's 'Inverkelty', Kew, of 1888-9,[142] and has also been found by Ian & Ros Coleman in the Melbourne mansion 'Illawarra', of the same date, where the external leaf is two bricks thick, and thus able to be built in Flemish bond, the internal leaf is one brick, the cavity two inches, or 50 mm, and the ties are in every fourth course.[143] John Beswicke had been using cavity walls in houses such as 'Rotha' in Hawthorn, but we do not know the nature of any ties in these. For the Dandenong Shire Hall [later Town Hall] in February 1890, Beswicke & Hutchins specified:

> The walls below floor of stage in retiring rooms to be built 1'8" thick with a hollow space between two 9" walls which are to be tied together with strong gal iron wire cramps as per margin to be spaced 2 ft apart in every second course.

The sketch shows what was to become a standard form of tie, U-shaped, with the ends turning inward slightly.[144] A tie of this sort, but with the return ends actually touching, has been obtained from the wall of 16 Jolimont Terrace, East Melbourne, designed by Oakden, Addison & Kemp in 1890.[145] The same general type (with ends not touching) has also been found *in situ* in 'Creswick House', South Yarra, of the 1890s.[146]

In 1900, when Nangle's *Australian Building Practice* illustrates the stepped-up Jennings brick, two varieties of wrought iron tie and, in a separate diagram, a

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140 Thomas Ritchie, *Canada Builds 1867-1967* (Toronto 1967), pp 224, 227.

141 Although always spelled 'Morse' in Australia, it seems sometimes to have been 'Morss' in the United States, as in Waldo Bros. and Bond Company, *Building Materials and Construction Equipment* (Boston, no date [c 1920]), p 343. This is the exception, however, for it was spelled 'Morse' by the manufacturer, J B Prescott & Son of Massachusetts: *'Sweet's' Indexed Catalogue of Building Construction* (New York 1906), p 22. Likewise in standard texts such as *Elements of Brick Masonry* [International Correspondence Schools] (Scranton [Pennsylvania] c 1930 [1907]), p 12.

142 Later known as 'Kiora', 11 Redmond Street, Kew: the south wall has a cavity which can be inspected, and the north wall is probably the same.

143 Ian Coleman, Roslyn Coleman & Anne Neale, 'Illawarra Conservation Analysis Report' (draft typescript report, Melbourne 1990), p 51.

144 'Specifications of works to be done in the erection of Shire Hall Mechanics Institute + Court House Dandenong in Accordance with drawings prepared by Beswicke + Hutchins ...' [in the possession of Mr Ken Bethell, Doncaster, Victoria], pp 5-6.

145 Kindly supplied by Mark Hodson, 2001).

146 Romauld Andrew, 'Creswick House', Australian Architecture B, University of Melbourne 1996, pp 4-5.

primitive form of the Morse or galvanised wire tie,[147] and as the drawings are by author, one would expect them to have a real relationship to local practice. In 1908 Robert Haddon's *Australian Architecture*[148] shows three forms of cast or wrought ties, and two of galvanised wire. Also by 1908 Eastway Brothers of the Great Sydney Wire Works made a speciality of wall ties.[149] By 1930 standardised wall ties were being produced by the Titan Nail Co, which had become a subsidiary of BHP.[150]

147 James Nangle, *Australian Building Practice* [(2nd ed, Sydney 1900), pp 86, 89.

148 Robert Haddon, *Australian Architecture* (Melbourne [1908]), pp 235, 238.

149 C E Mayes, *The Australian Builders & Contractors' Price Book* (7th ed, Sydney 1908), advertisements p xi.

150 *Handbook for ... the Broken Hill Proprietary Company Limited* [BHP *Shapes and Sections*] (Melbourne 1930), p 502.