8.06 Nails & Ironmongery

a. the wrought nail
b. machine-made nails
c. cut brads
d. the Ewbank nail
e. the wire nail
f. roofing nails & screws
g. local nail manufacture
h. screws
i. anchorage
j. ironmongery
k. locks
l. safes

a. the wrought nail

The availability of cheap and reliable nails was an essential prerequisite for the development of a number aspects of Australian building practice, most notably the simplified modern stud frame. However, at the time of Australian settlement nails were expensive hand-wrought items, and were not used nearly as freely as in the later nineteenth century and the twentieth century. Much early building in Australia was done without any nails or metal fixings at all. In the novel *Ralph Rashleigh* James Tucker describes the construction of a slab hut on the Hawkesbury in the early 1820s, in which 'the whole framing of the roof was secured as it was needed by wooden pins in order to save the expense of nails, which were then both too scarce and too dear to be used by the lower order of settlers.'[1] Robert Gouger was pleased to report that the hut he built at Holdfast Bay [Glenelg], South Australia, at the end of 1836, used only six nails, as the other joints were tied with cord.[2] Timber dowels and trenails continued tro be widely used in rural buildings up to about 1860,[3] and as late as the 1880s a selector's house in Gippsland, Victoria, was said to be 'constructed altogether of logs, slabs and bark, no nails being used in its construction'.[4]

Both the Hawkesbury and Gippsland examples were bark-roofed, but shingles presented more of a problem. In Britain shingles were traditionally fixed with oak

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1 'Giacomo de Rosenberg' [James Tucker] [ed Colin Roderick], *Ralph Rashleigh, or the Life of an Exile* (Sydney 1952 [?c1845; 1929]), p 113.

2 Quoted in Penelope Hope [ed], *The Voyage of the Africaine* (South Yarra [Victoria] 1968), p126.

3 For example the fixing of the round timber ceiling joists to the wall plates at 'Moranghurk' homestead, Victoria, probably 1840s: A R J Billman, 'The Timber Vernacular: Building Techniques of Domestic Timber Architecture in Geelong and the Western District 1840-1870' (BArch, Deakin University, 1992), diagram 23; the foundation pads and round timber floor joists of the barn at 'Ballantyne', Cassilis, New South Wales, probably 1850s: inspected 2002; the kitchen wing, 'Gulf Station', Victoria, perhaps c 1860.

4 Caption to the photograph 'A selector's hut in Gippsland ...', No. 2 in the series *Gippsland Scenery*, by Nicholas Caire, c 1886, La Trobe Collection, SLV.

pegs, and in parts of Europe such as the Austrian Tyrol, low-pitched shingle roofs were laid without any fixing at all. In Sydney also, shingles were at first fixed with wooden pins, but this seems to have been found inadequate because of the warping of shingles made from local timbers. According to Robert Irving nails began to replace wooden pegs in about 1800, and by 1810 they seem to have been the normal fixing for shingles.[5] Samuel Marsden called tenders for shingling his church at Parramatta in 1812, requiring the successful tenderer to supply both the shingles and the nails.[6] In 1815 shingle nails were ordered for the roofing of Rouse Hill House, to the west of Sydney, and in 1818 the purchase of four thousand shingle nails was recorded.[7] Outside New South Wales and Tasmania wrought nails are rarely found: those which are reported by archaeologists and others usually prove to be the ubiquitous Ewbank patent pressed nail, or some cognate type.

Nails had traditionally been specified and sold according to length and weight, the latter in lbs per thousand nails.[8] But in the nineteenth century they were commonly sold on price per hundredweight, from which the approximate size could be inferred. Thus a Sydney advertisement of 1803 offered nails from 6-penny to 40-penny.[9] An excellent idea of the nails which would have been used in Australia at about the time of Macquarie can be gained from a list issued in 1812 by the British Office of Ordnance, in which 163 varieties of nail and spike are illustrated full size, and the weight of each is indicated. There are rose headed and clasp headed nails, countersunk clouts, slating nails, lathing nails, dog nails, spikes up to fourteen inches (356 mm) long, tacks, brads, rivets, and numbers of others including specialised types for boat building, cooperage and other purposes.[10] But from 1830 the hand-made nail trade in Britain declined due to the competition of machine-made nails, and in the nail making districts around Birmingham employment dropped from 50,000 to 20,000 by 1866.[11]

The mechanisation of nailmaking had begun with importation of the slitting mill from Liège to England toward the end of the sixteenth century.[12] This could be used to cut sheet iron into nail rods, or strips from which individual nails could then be cut. It spread to the United States within decades, and equipment for slitting nail rods, said to have been in use by 1645 at Saugus, Massachusetts, has been restored and

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5 Robert Irving, 'The First Australian Architecture' (MArch, University of New South Wales, 1975) p 191.

6 *Sydney Gazette*, 18 April 1812, quoted Irving, 'First Australian Architecture', p 191.

7 Account books in the possession of Gerald Terry, Rouse Hill House, cited by James Broadbent, 'Aspects of Domestic Architecture in New South Wales 1788-1843' (3 vols, PhD, Australian National University, 1985), I, pp 93-4.

8 See, for example, Royal Engineers Office Halifax, *List of Nails and Spikes required for the Service of the Office of Ordnance. Approved by the Honourable Board's Order of the 29 July 1812*, reproduced in *APT Bulletin*, VIII, 3 (1976), pp 91-118.

9 *Sydney Gazette*, 22 May 1803, p 4.

10 Royal Engineers, *List of Nails and Spikes*.

11 Ephraim Ball, 'The Hand-Made Nail Trade', in Samuel Timmins [ed], *The Resources, Products and Industrial History of the Birmingham and Midland Hardware District* (London 1866), p 111.

12 Hugh Bodey, *Nailmaking* (Princes Risborough [Buckinghamshire] [1983]), p 11. It was not an English invention as stated by J S Swank, *History of the Manufacture of Iron in all Ages, &c* (2nd ed, New York 1892 [1884]), p 48.

displayed in a museum. The smith now received the iron in the form of square rods, which were produced from flat plates by using 'slitting' rollers:

> The nailer should have the ends of three or four rods in the fire, and taking the one which has been in longest, after a pull or two at the bellows to bring it to a welding heat, he would taper down the point on his anvil, at the same time making a shoulder for the head. He would then hold it over a chisel or cutting-punch, stuck upright at the side of his anvil, and giving it one tap with his hammer, cut it halfway through; an iron stop in front of the punch giving him the exact gauge for the length. He would then turn down the point of the half-severed nail into a steel instrument called a *bose* (the top of which formed a mould for the head) and twist it off, and then, with a few smart blows, he would beat it down until the head was spread out sufficiently, and assumed the required shape, the nail just turning from red to black as he gave it the finishing tap.[13]

The most important distinction is that between the wrought nails and the later cut brads and nails. The quality of traditional wrought nails derived from the process of working by the smith, which gave them a fibrous texture and enabled them to be bent without snapping, something which would be totally impossible with a cast nail, and could not be achieved by cut brads or the earlier types of machine-made nail. Nails made from slit rod required forging only of the head and point, but because the original sheet had been rolled (or originally hammered) even the nail shank had some of this fibrous quality. However more demanding details of timber construction which were subject to changing stresses, such as ledged and braced doors, required a nail to be driven right through the wood and the point bent to one side, or *clenched* [or *clinched*].[14] In shingling it was said to be necessary to drive the nail right through the batten and clench it, which meant that the more expensive wrought nails should have been used, but in practice clenched nails are the exception rather than the rule in surviving shingle roofs. We have no evidence as to whether different or cheaper means of fixing were used for the imported shingles which were fairly widely used about the middle of the nineteenth century, but in general terms it can be said that shingling was not very common before the 1840s, and that the cost of suitable nails was probably the main reason for this.

Right through the nineteenth century much of the general framing of buildings, especially in urban centres and ports, was done in imported timbers which were much easier to work than the local species. But where local timber was used its hardness made wrought nails, or the later patented types, more or less essential even for general carpentry, and though their use could be avoided by the use of appropriate joints, pinned with timber dowels or trenails, this was labour-intensive and therefore more or less impracticable in economic conditions such as those of the 1850s in Victoria.

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13 Charles Hibbs, 'Great Manufactures of Little Things - IX', *Technical Educator* (4 vols, London, no date [? c 1870], IV, p 11: see also F E Martineau, 'Cut Nails', in Samuel Timmins [ed] *The Resources, Products and Industrial History of the Birmingham and Midland Hardware District*(London 1866), pp 612-613. For traditional nailmaking in France see Daniel Boucard [translated Alan Wharf], 'Nailmaking in France', *TATHS Newsletter*, 91 (Winter 2005), pp 22-9, reportedly from Boucard's *Craftsmen's Tools*.

14 C B Mayes, 'Manufactures for the Economical Development of the Resources of the Colony', in *Victorian Government Prize Essays 1860,* (Melbourne 1861), p 325.

b. machine-made nails

Historical references to machine-made nails are highly confusing. They may refer to a nail formed simply by chopping it from the end of a nail rod or strip - this is a cut brad of the type discussed below, which is cheap and of little use in structurally important location. They may refer to a true machine-formed nail, which has been produced by processes analogous with those of the blacksmith, and has acquired a similar fibrous quality, strength and resilience. Or they may refer to a hybrid - a nail formed initially by cutting, but subsequently worked upon to a greater or lesser extent to achieve at least some of the attributes of a true wrought nail. Many writers assume that the first machine-made nails were of cut brad type,[15] which is usually triangular and headless, but that is probably not the case, for most or all of the early patents specify means of separately forming a head.

In about 1776 an American, Jeremiah Wilkinson of Rhode Island, invented a process for cutting tacks with shears, then holding them in a vice while forming the heads.[16] In 1786 Ezekiel Reed of Bridgewater, Massachusetts, invented a machine for cutting both tacks and nails from plate.[17] A wedge-shaped block cut from a strip of hoop iron was placed point downwards in the jaws of the machine, gripped firmly, and then struck from above with a hammer so as to form the head. The machine was alleged to produce something like a thousand nails a day.[18] In 1798 Reed obtained a patent for cutting and heading in one operation,[19] and in 1815 his machine turned out 150,000,000 tacks.[20] In 1794 J Pierson of New York is claimed to have patent the first nail cutting machine in the US,[21] but this makes no sense, unless it can be argued that the earlier inventions did constitute true machines. In 1795 Jacob Perkins of Massachusetts patented a nail cutting machine, which he is thought to have invented about five years earlier.[22] Meanwhile in 1807 Ezekiel Reed's son, Jesse Reed, patented another machine, which produced 150,000 tacks per day.[23]

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15 Notably the pioneering paper by L H Nelson, 'Nail Chronology as an aid to Dating old Buildings', *History News*, XXIV, 11 (November 1968), unpaginated. H C Mercer, 'The Dating of Old Houses' (paper read at a meeting of the Bucks County Historical Society, 13 October 1923), unpaginated, is more realistic. Nelson also completely ignores the Ewbank nail and its equivalents.

16 F H Norton, *Illustrated Register of the Centennial Exhibition, Philadelphia, 1876, and of the Exposition Universelle, Paris, 1878* (New York 1879), p 43. Sickels, 'Nails and Nailmaking', p 67, dates this development to 1777. Swank, *Manufacture of Iron*, p 448, quoting Knight's *Mechanical Dictionary*, dates it to about 1775.

17 Norton, *Illustrated Register*, p 45; Swank, *Manufacture of Iron*, p 448, quoting Knight. M K Phillips, '"Mechanic Geniuses and Duckies" a revision of New England's Cut-Nail Chronology', *APT Bulletin*, XXV, 3-4 (1994), p 5, dates the invention to 1779.

18 Phillips, 'Mechanic Geniuses', p 5.

19 Swank, *Manufacture of Iron*, p 448, quoting Knight.

20 Norton, *Illustrated Register*, p 45.

21 J R Rempel, *Building with Wood and other aspects of Nineteenth-Century Building in Central Canada* (Toronto 1980 [1967]), p 101.

22 Norton, *Illustrated Register*, p 45. Rempel, *Building with Wood*, p 101, identifies the son as Jesse Reed of Boston, and refers to his patent as being for a machine which cut and headed nails in the one operation, the first time this had been done successfully.

23 Swank, *Manufacture of Iron*, p 133.

By 1788 Adam Rogers of Marshfield had developed a machine which 'cut nails from hoops or plates', but the first successful devices for cutting and heading nails were 'two operation' machines, which in effect comprised two distinct machines, one for cutting and one for heading.[24] In 1790 W Finch of Wimboorne, Staffordshire, patented a system of manufacture in which water or steam power turned an axle, working a series of tilt or lift hammers, under which a number of nails could be forged at once. But whether this was put into practical effect is not known, and more significance is generally attached to two patents taken out in the same year by Thomas Clifford of Bristol. In the first of these, of 17 July 1790, a steel die was made and the nail iron, pre-formed in an appropriate size, was forced into the die by means of rollers. Typically this produced a sheet of nails requiring only to be snipped apart, but they must have been more like brads than nails in the true sense, and would have been incapable of bending without snapping.[25] In the second of Clifford's patents the nail plate was rolled in a wedge-shaped cross-section, and the nails cut or punched out of it, and then placed in a bed to hold the shank while a head was formed by striking or pressing it.[26] 'Prince's metal nails', which were on sale in Sydney in 1804,[27] seem likely to be the result of further English development. Guppy's patent of 1796 was for cutting nails by passing iron plates under a roller with two cutters fixed at opposite points on its circumference.[28] Thirty or forty other patents followed, but the Americans led the field because of their much greater use of timber in construction.[29]

Machines for cutting and heading nails were further developed in America by Jacob Perkins, Jonathan Ellis and others, between 1790 and 1810. Perkins had nail cutting and heading machines in operation at Byfield, on the northern skirts of Boston, in 1794. The cutting was done by what Perkins called an 'ostrich', a 'roller' with two cutters fixed to it in such a way that, when a strip of metal was fed up to it, the right amount was chopped off. The heading was done by fixing the nail blank in a vice, where it was given three successive blows with hammers, lifted by means of a turning tappet wheel. Perkins received a United States patent in 1799, and then in about 1810 applied for a British one.[30] His machine could produce ten thousand nails a day.[31] According to C D Elliott, in the years following Perkins's patent (which Elliott dates to 1795) the price per pound of nails dropped from twenty-five to eight cents by 1828, and three cents by 1842.[32] Meanwhile twenty-three US patents for nail making machinery had been issued up to 1800.[33]

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24 Norton, *Illustrated Register*, p 43.

25 Abraham Rees, *The Cyclopædia, or Universal Dictionary of Arts, Sciences and Literature* (42 vols, London 1819), sv 'Nails;' Charles Tomlinson [ed], *Cyclopaedia of the Useful Arts* (published in parts, London c 1851-3), sv 'Nails'.

26 Rees, 'Nails'.

27 *Sydney Gazette*, 15 July 1804, p 3.

28 Hibbs, 'Great Manufactures', p 12; Tomlinson, *Cyclopaedia*, sv 'Nails'.

29 Tomlinson, 'Nails'.

30 Phillips, 'Mechanic Geniuses and Duckies', pp 6-7. Phillips gives the date of the patent as 1799, but both Norton and Elliott (*infra*), give 1795. Norton, p 45, refers also to a patent for a nail making machine granted tom Thomas Perkins of Philadelphia in February 1797.

31 Norton, *Illustrated Register*, p 43.

32 C D Elliott, *Technics and Architecture* (Cambridge [Massachusetts] 1992), p 18.

33 Nathan Rosenberg, 'America's Rise to Woodworking Leadership', in Brook Hindle [ed], *America's Wooden Age: Aspects of its Early Technology* (Tarrytown [New York] 1975), p 43.

Nathan Reed received a US patent in 1798 for a machine intended to cut and head a nail in one operation, but it seems to have been used only a short time before it was abandoned, possibly due to problems with jamming. In 1807 Jesse Reed patented an effective single operation machine, which was of great importance, but there had been forty patents registered in the intervening years, and a definitive assessment is impossible. Reed's patents were bought by Thomas Odiorne and his brothers, who set up the Malden Nail Factory in 1807, and two further factories in the following year,[34] and it must be the Reed/Odiorne machine which, it was later reported, was by 1810 able to cut and head a nail in one operation, at the rate of one hundred a minute.[35] By this time American machines, like those of Odiorne and Ellis, were said to produce nails better than wrought ones at about a third the price.[36] However this claim can hardly have been true, given the method of manufacture, and the continuing preference for wrought nails over the next half century gives it the lie.

c. cut brads

The two types of nail machine later used in Britain both derived from America. In the earlier of the two a flat strip of iron was pushed firmly against a steel plate as cutters descended upon it. The simplest form of nail produced was the 'bill' (or 'cut bill', as there had been cast bills at an earlier date), a long triangle or wedge shape, produced by cutters which began at a slight angle and were then turned slightly to reverse the angle before the next blow, and then continuing to alternate so that a series of bills were cut, alternating head to toe, and no waste was generated. The continual change of angle of the cutters caused great wear and tear on the machine, and an improved machine was therefore developed in which the cutters always descended in the same place, but the nail strip rested on a frame which presented it at alternating angles, so as to achieve the same effect.[37]

The bill was produced mainly for boot heels rather than for building purposes, but a small size (or 'sprig') was sometimes used in glazing, to hold the pane of glass before it was puttied in. This simple triangular shape was all in one plane, and if a true head was to be formed it required a separate operation and an allowance of extra iron for the purpose. Thus a $1^1/_4$ inch [32 mm] wide nail strip was used to produce one inch [25 mm] headed nails.[38] However it was also possible to for a head of sorts within the one plane, most easily in the form of a projection in one direction, so that the nail was like an elongated L with a tapering stem. This could still be arranged so that nails (or brads, as they in fact were) were cut alternately head to toe, leaving no waste, but it required appropriately shaped cutters rather than simple straight ones. In this process the end of the nail strip was fed to a fly press, which chopped off a nail from it; then the strip was turned over, and another nail chopped off, and so on. The process of turning meant that heads and points came from opposite sides of the strip

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34 Phillips, 'Mechanic Geniuses and Duckies', pp 7-10; however Rosenberg, 'America's Rise', p 43, dates Perkins's patent to 16 January 1795.

35 Tomlinson, 'Nails'.

36 Andrew Ure, *A Dictionary of Arts, Manufactures and Mines* (London 1839), s v Nails.

37 F E Martineau, 'Cut Nails', in Samuel Timmins [ed], *The Resources, Products and Industrial History of the Birmingham and Midland Hardware District* (London 1866), pp 613-4.

38 Martineau, 'Cut Nails', p 613.

in the usual way, and it was possible to devise various nail profiles which could be cut in this way without any waste. Whatever the profile, however, the widening of the head and the narrowing of the point were in one dimension only: in the other dimension the nail retained the thickness of the strip from which it was cut.[39] A description of 'cut nails' as produced at the Crown Nail Works, Birmingham, in 1851, indicates that they were no more than cut brads to which further work was done to create a three dimensional head.[40]

The process for cutting brads as shown at the Workmen's International Exhibition of 1870 was essentially unchanged:

> A girl sits in front of a press worked by steam, holding a strip of iron in a pair of long pliers, the handles of which are tightened up to retain it firmly; and turning it over rapidly at each stroke, a continuous stream of well-shaped nails falls from the machine, the head of one being formed from the point of the next, and vice versa. The formation of the die and punch is somewhat peculiar. In the bed of the press is cut a square oblong hole, in which a punch of the same shape works, filling it exactly, and forming a solid block of steel, rising and falling with the motion of the press. The punch never rises entirely out of the hole, but on its underside is cut a step, the shape of the nail to be produced, and the girl inserts the strip of sheet-iron under this step as it clears itself from the hole, pressing the end of the strip against the solid part, and the sharp edges of the press cut off the nail.[41]

By now a more advanced machine was in existence. In 1866 R C Robinson of England was reported to have developed a new nail making machine which was self-feeding and much faster than the old ones, cutting off four nails at a time, and producing good points and heads. Moreover these nails were not hardened by the cutting process, and therefore did not require annealing, as had the earlier cut nails.[42] These sound like cut brads. In 1873 the Birmingham maker John Cornforth and one T Ashford almost simultaneously patented devices for turning over the nail strip between each cut,[43] presumably to eliminate the manual operation described in 1870. Other patents followed.[44]

To summarise these incomplete and even conflicting accounts:

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39 *Penny Magazine*, X, 606 (11 September 1841), pp 359-360; see also XIII, 818 (28 December 1844), pp 503-5. For various developments of this system see *Mechanic's Magazine*, XXXIV, 924 (24 April 1841), p 326 (quoting the *Journal* of the Franklin Institute, January 1841); and *Builder*, VI, 277 (27 May 1848), p 262; VII, 331 (9 June 1849), p 274; XII, 595 (1 July 1854), p 351.

40 Great Exhibition of the Works of Industry of all Nations, 1851, *Official Descriptive and Illustrated Catalogue* (3 vols, London 1851), II, p 629.

41 Hibbs, 'Great Manufactures', p 12

42 *Builder*, 4 August 1866, p 585.

43 Great Britain, patent no 4,057 to J Cornforth, 9 December 1873; no 4,063 to T Ashford, 10-December 1873.

44 Great Britain, patent no 337 to D Wormald, 27 January 1874; no 4,185 to J Comery, 5 December 1874; no 2,479 to W S Hutton, 9 July 1875; no 1,227 [provisional]. to J Dimelow, 22 March 1876; no 3,575 to J R Danks, 12 September 1876.

- Simple triangular bills or sprigs could cut from a flat sheet, either by shifting the angle of the cutter between strokes, or by shifting the angle of the nail strip as it was fed in.

- By allowing extra iron at the broad end it was possible to provide for the formation of as true three-dimensional head by a separate process.

- By using shaped cutters it was possible to cut brads, in more complex shapes than the basic triangle, and to create a head of sorts still within the same plane.

- A head-to toe arrangement could be achieved either by having two cutters on the flywheel, operating alternately, or by turning the strip over to feed into a single cutter.

- Turning the strip was at first done nanually, later mechanically.

How the three-dimensional head was formed remains to be considered. An English patent was granted in 1808 to Joseph Willmore and John Tonks of Birmingham for a more elaborate method of making nails, which were supposed to be capable of clenching. In broad terms, a piece of nail rod was cut to the approximate dimension; it was held in clamps with a portion protruding, which was formed into a head; it was placed into an appropriately shaped steel bed and struck with a punch to form the end into a chisel shape, then turned at right angles and struck again to create a point; it was annealed to give it the capacity for clenching; and finally it was made red hot and quenched in water or other liquid, making it hard enough to drive.[45] An account of the 1860s is basically similar. The cut nail was held in a pair of nippers to form the neck, then struck with a hammer, which formed the head at one blow. It then remained for the nail to be annealed to make it partly malleable, which was done by heating it to red-hot within an airtight iron box.[46]

By 1843 American prices had fallen from 25 to 3 cents a pound,[47] and in the fifties the prices of the inferior English nails were even cheaper, for the market had been flooded,[48] though the price of iron rose with the Crimean War. In 1853 the *Australian Builder* quoted an English report that:

> The quality of nails made at the majority of English works is, at present, so far inferior to that of the United States productions, that the English makers find themselves quite shut out from many foreign markets, in spite of the much higher price charged by the Americans. The general character of the machinery employed in the country for cutting nails, is of a very low class, both the design and the workmanship being exceedingly rude. Indeed we believe there are not more than 4 English makers who can supply good nails at all times. Large quantities of zinc and copper nails are made by the 'cut process' for sheathing and slating, the cut nails having to a very great extent superseded the use of

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45 Patent to Joseph Willmore and John Tonks, 28 May 1808, in *Repertory of Arts, Manufactures and Agriculture,* 2nd series, XIII (London 1808), pp 366-9. See also Rees, 'Nails', who refers to 'Wilmore and Tonk'.

46 Martineau, 'Cut Nails', pp 614-5.

47 S Giedion, *Space, Time and Architecture* (Cambridge, Massachusetts, 1963 [1941]), p 348.

48 *Builder*, XI, 529 (26 March 1853), p 198.

> wrought nails for most purposes. But the wrought nail is still made in very large quantities by hand and hammer in the neighbourhood of Pudley. For work where nails are required to clench, cut nails are obviously inadmissible, as they are not sufficiently fibrous and ductile; otherwise it seems not improbable that the use of wrought nails would be still more interfered with.[49]

d. the Ewbank nail

Even the American nails could not be driven into Australian hardwoods without breaking, as was admitted by the Melbourne merchant G F Train, himself an American. The Ewbank pressed nail was much better, and had resolved this problem,[50] but it was still under patent, and the exclusive product of one British manufacturer. It was a resilient nail which was much liked and widely used in Australia, in sizes from one to six inches (25 to 150 mm), but its origin and its relationship to other British developments remains somewhat obscure.

In Britain Ledsam & Jones's patent of 1827 described a machine which seems more to have stamped the nails out of a sheet, rather than simply cut them off.[51] J J Cordes received a patent in 1834 for improved nailmaking machinery which included what he called 'stretching rollers',[52] and may therefore have in some degree simulated the effect of working by a blacksmith. T J Fuller had received a patent in 1834 for mechanically hammering the points in such a way as to resemble hand forging,[53] and John Jackson a patent of 1840 for forming the heads of bolts, nails, rivets and nuts, by stamping.[54] Cordes's machinery was not his own invention but a communication from a foreigner living abroad, now deceased (one would normally assume an American, but there is some contrary evidence in this case).

It is difficult to relate these patents to the nails which actually came onto the market, but Cordes was the maker of the Ewbank nail, sold from the later 1830s, even if this is not the one to which his patent refers. Ewbanks were said to have been the first to produce nails which could compete with those forged by hand,[55] and the firm - presumably meaning Cordes & Co - is credited with introducing the Ewbank nail to Australia in about 1838.[56] Though described as 'wrought', the Ewbank nails were made by machinery, and in the Australian market in particular they largely supplanted hand-forged nails.[57] The Ewbank nail was rose-headed, almost chisel-pointed, and particularly adapted for hard woods. Higgs & George's patent wrought nails were not unlike the Ewbank, and perhaps even based upon it. They were available

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49 *Australian Builder*, 9 August 1855, p 11, quoting the *Mechanics Journal.*

50 G F Train, letter of 23 June 1853 in the Boston *Post*, 20 October 1853, reproduced in G F Train [ed E D & A Potts], *A Yankee Merchant in Goldrush Australia* (London 1970), p 25.

51 Hibbs, 'Great Manufactures', p 12.

52 Great Britain, patent no 6686 to J J Cordes, 1834, for machinery for the manufacture of nails.

53 Patent of Thomas John Fuller, 27 February 1834, quoted by Ure, loc cit.

54 *Mechanics Magazine*, XXXIII, 894 (26 September 1840]) p 349.

55 Papworth, *Dictionary*, sv Nail, quoting *Builder*, 1860, XVIII, p 156.

56 [Francis Young], *Every Man His Own Mechanic* (London, no date ?c 1882), §328, p 138.

57 Ball, 'Hand-Made Nail Trade'. p 112.

commercially in Britain by 1845,[58] though it appears that they were an American type, for which Higgs & George were merely the British licensees. They were claimed to be tougher and more uniform than the best hand-made nails. The flat-pointed rose nails in particular were recommended for use in oak or other hard woods, because they were 'perfectly chisel-pointed' and therefore required no boring, and could be driven into the hardest wood without splitting it. Moreover the heads were very strong, and would not fly off.[59] They also must have been extensively used in Australia, and in 1850 were being sold in Launceston in 1¼,1¾, 2, 2½, 3, 3½ and 4 inch sizes [32, 45, 51, 64, 76, 89, 102 mm], together with 2 and 2½ inch patent cut brads.[60]

The invention and early manufacture of the Ewbank nail are mysterious, for Henry Ewbank's name is strongly associated with it, and reference is commonly made to him as the inventor or manufacturer,[61] though it seems that he was no more than an initial partner in the manufacturing company, J J Cordes & Co. Ewbank had received patents for dressing rice in 1819[62] and 1827,[63] the latter in partnership with Jonathan Lucas. Lucas & Ewbank seem to have been well-known as London rice millers,[64] but there is no nail making patent in his name and no reason to suppose that Cordes's patent of 1834 was for Ewbank's invention, for Ewbank was not a foreigner living abroad, and nor was he deceased. If there was a Ewbank patent for nails it was earlier, perhaps under some other name, and Malcolm Johnson claims that he had patented 'automatic' machinery for nailmaking before 1823. We know no more of Ewbank except that he was described in 1819 as a merchant of London, and in 1827 specifically of Mincing Lane, of Idol Lane in the city of London, but Johnson gives a circumstantial and unsubstantiated description of him as an engineer and merchant who was aware of the nailmaking skills to be found in South Wales, and whose role was to be in manufacturing and engineering while Cordes would raise capital and manage the business.[65] He seems to have been bought out of the partnership in 1853 for £12,000.[66]

Cordes was an American born in the United States in 1798 and emigrated to Britain in 1823.[67] J J Cordes & Co was formed in 1835 as a partnership between James Cordes and Henry Ewbank, to which other partners were subsequently admitted, and in 1884

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58 *Builder*, III, 137 (20 September 1845), p 456, though Wyatt Papworth [ed], *The Dictionary of Architecture* (London 1853-92), sv Nail, refers to them as being 'submitted by the agents in London, Higgs and George, to the notice of builders' in 1852.

59 Wyatt Papworth [ed], *The Dictionary of Architecture* (London 1853-92), sv Nail.

60 *Launceston Examiner*, 29 May 1850, p 343.

61 According to Papworth, *Dictionary*, sv Nail, Ewbanks were succeeded as manufacturers by J J Cordes & Co of the Dos Works.

62 Great Britain, patent no 4340 to Henry Ewbank, for Cleansing and Dressing Rice.

63 Great Britain, patent no 5472 to Jonathan Lucas and Henry Ewbank, for Dressing Rice. For the Ewbank and Cordes patents I am reliant upon the initial searches of Richard Jones in 2005 at the Patent Office in Newport, South Wales, and the subsequent work of Chris How.

64 Towards 1830 Lucas & Ewbank of London experimented with the importation of rice from North America still in husk ['paddy'] rather than fully prepared, for this kept much fresher: Basil Hall, *Travels in North America in the years 1827 and 1828* (3rd ed, 3 vols, Edinburgh 1830), III, pp 164-5.

65 Johnson, 'A Place in Time', p 8.

66 Johnson, 'A Place in Time', p 23.

67 Johnson, 'A Place in Time', p 6.

it became a limited liability company.[68] At this time they bought the patent rights for improved nail making machinery from Samuel Slocum of London for £500,[69] and it must be assumed that this was important in their manufacture, therefore casting some doubt upon the significance of the presumptive Ewbank patent and the actual Cordes patent. Ewbank & Cordes signed a building lease on 5 December 1835 for a site in Newport on the Monmouthshire Canal, under which they were required to construct a factory and workmen's cottages.[70] As indicated above they must have been in production within three years at most, and in 1853 it was reported they were making eighty tons of nails weekly for export to all parts of the world.[71]

Cordes's Ewbank nails were described as flat-pointed rose nails (like those of Higgs & George) and flat-pointed strong wire nails. The former were made in sizes from 1 to 3½ inches [25-89 mm] long, the latter - which can be nothing to do with what we commonly know as Ewbank nails - from 1¼ to 4 inches [32-102 mm].[72] However, a large proportion of the Ewbank nails found in Australia seem to be very considerably larger, and, as will appear, sizes up to six inches [150 mm] were advertised locally. In 1869, or perhaps slightly earlier, Cordes & Co announced that they had adopted a star or cross as their trademark for the patent wrought nails known as 'Ewbank nails', of which they were the sole patentee and manufacturer (though of course no patent dating from as long ago as the 1830s could still be in force). All their exports except clasp nails would henceforth bear this mark.[73] Actual specimens of Ewbank nails are found to have a rectangular shank, tapering slightly in both directions, a pyramidal head, and rather than be 'perfectly chisel-pointed' like those of Higgs & George, have a curved end. Well preserved specimens show a slightly raised ridge along the arrises on the flat side of the shank, doubtless resultant from the pressing process. The head is basically of the rose type, and in some (presumably after 1869) bears a small equal armed cross or star motif rotated 45º relative to the hips of the pyramidal head. According to Chris How the partly formed nail blank was held (under the original patent) with two slightly cuspate plates, applied to the rear and the front face, and when it was struck with the die of the heading tool the haunches were forced out on either side of the clamps. The heads themselves have a lopsided look, and an irregular perimeter where the metal has broken out at the edges.[74]

Surviving specimens can thus be dated as before or after 1869 (or thereabouts) by the absence or presence of the star. A further change occurs within the star type, possibly in 1878, but is a harder to disagnose. Malcolm Johnson refers to the fact that patents for improved machinery were was taken out in 1870 and 1878 by a Cordes employee, J L Heward.[75] That of 1870 illustrated the nailmaking machine and is described as:

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68 Malcolm Johnson, 'A Place in Time: a Brief History of J.J. Cordes & Co. Newport 1835-1961' (typescript history, no place or date), p 4.

69 Johnson, 'A Place in Time', p 13.

70 Johnson, 'A Place in Time', p 10.

71 Johnson, 'A Place in Time', p 13.

72 [Francis Young], *Every Man His Own Mechanic* (London, no date ?c 1882), §328, p 138.

73 *Argus*, 15 May 1869, p 3 The advertisement may have appeared earlier than this, and certainly it continued unchanged for years afterwards, for example *Town and Country Journal*, 28 November 1874, p 876.

74 Chris How, email of 29 June 2006.

75 Johnson, 'A Place in Time', p 13: according to Chris How - CHECK THIS.

> In a machine for heading and finishing nails, shown in elevation in Fig. 1 and in sectional plan in Fig. 2, the nails are placed in dies *a*, which are fitted into notches a^1 in a wheel A, and are held loosely in place by rings or segments a^2, a^3. The wheel is carried upon friction rollers, and rotated step by step by a lever engaging ratchet teeth A^1. After receiving thne nails, the dies are pressed together by spring plates *b*, and, when opposite the heading-tool *c*, a greater pressure is put upon them by the squeezing-jaws *d, d*, these jaws and the heading-tool *c* being actuated by a slide c^1. After being headed, the nails fall from the dies, or are pushed out by a plate *e* in the groove A^x, or the dies may be opened by fixed cams A circular flat spring may be placed in the groove, to prevent the nails from being inserted too far, and also to remove then when finished.[76]

This machine was improved in a patent of 1881, not illustrated:

> Consists of improvements in machinery described in Specification No.2711, A.D. 1870. Four dies are used instead of two, the side dies as well as the header being placed in position by the forward motion of the slide box. The bottom die has removable wearing surfaces and is fixed in a die seat in the bedplate of the machine; it has a narrowed projection in front, against which the side dies come up, and two guides working up and down in a recessed chamber below. The top die is of the same shape but without the guides. While the nail shank is held firmly between these dies, the side dies are pushed along until a square hole is formed between the four dies, when, pressure being brought to bear on the top and side dies, the header moves forwards and spreads out the metal of the shank into the head of the nail. On the header returning, the top and side dies move away an the nail falls out. The top die works in a headstock on a shaft a double eccentric on which raises and lowers the headstock as the shaft revolves. This eccentric motion is converted into vertical motion by a knuckle joint. An eccentric in the the centre of the shaft works a spindle up and down inside the headstock and carries a cutter which cuts off the shank of the nail and points it while the head is being formed. At the same time the shanks are being straightened between another pair of top and bottom dies fixed behind those described. The nail rod is fed into the dies by a pair of feed rolls working with an intermittent motion from a ratchet plate and pinions.

The 1878 patent is not illustrated but seems less relevant:

> Relates to the heading of coopers' and other large-headed nails in two operations, with an annealing process betweeen. In the first operation the nail blank is held between grooved dies countersunk on the top side, the header also having a deep countersunk [*sic*] and thus producing a double pyramidal head. After annealing, the nail is held in other grooved holding-dies, and the head flattened out by a header with a broad shallow countersink [*sic*], giving an equal shoulder all round.[77]

It is not immediately obvious how these relates the visible characteristics of the Ewbank type. Of two later British patents in Heward's name, one is a means of cutting nail shanks and the other an improvement to the machine of 1870[78] seem even less relevant. How has interpreted the subtle change in the appearance of the nails in

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76 British patent no 2711, 14 October 1870 to J L Heward.

77 British patent no 1465, 12 April 1878 to J L Heward.

78 British patents nos 1829, 27 April 1881; 1830, 27 April 1881.

terms of his belief that the clamps are now applied across the diagonal of the nail blank, each one a right-angled V-shape, and together forming a perfect square. There is a bevel on the top edges of this square, and a small breakout of metal at the diagonal gap, creating what he calls a diagonal haunch. This gives rise to a twist in the top of these nails.[79]

The earliest reasonably authenticated Ewbank nail in Australia seems, in fact, to be earlier than 1838 and of a larger size than those described. It is one recovered from the cottage which was prefabricated in Sydney by the Royal Engineers for Captain William Lonsdale, and erected in Melbourne in 1837. It is a six inch [150 mm] nail which is severely corroded but undoubtedly of the general type, and seems to be correctly dated to 1837.[80] Ewbank nails are reported in a slab cottage at 44 Barden St, Tempe, Sydney, which has been claimed to date from about 1840 - though this seems to be entirely unsubstantiated.[81] They have also been found at 'Pontville', a house of the 1840s at Doncaster, near Melbourne;[82] in large numbers in the shearing shed at 'Warrock', Victoria, also of the 1840s; and it appears (for they are not identified as such by the investigators) in the homestead at Matanaka, New Zealand, also of the 1840s.[83] Ewbank nails have also been found in the shingle roof of a Melbourne cottage of 1853.[84]

The first documentary evidence of Ewbank nails in Australia is an advertisement by a Melbourne importer in 1852 for '500 kegs of Ewbank's patent nails',[85] and by 1862 they were listed in Mayes's pricebook in sizes from one to six inches [25-150 mm].[86] They were still listed in Mayes's price book in 1886, in the same sizes and at the same prices for the smaller ones, slightly less for the larger:[87]

size in inches	**lb wt per thou**	**price per cwt**	**price per lb**
1	2 1/2	80.0	0.10
1 1/4	3 1/2	62.0	0.8
1 1/2	4	68.0	0.7 1/2
1 1/2	7	36.0	0.4 1/2
1 3/4	8	34.0	0.5
2	10	33.0	0.4 1/2
2	7	45.0	0.6
2 1/4	12	30.0	0.5

79 Chris How, email of 29 June 2006.

80 This nail has been given to me by Ms Nada Brozel, who assisted in the dismantling of the cottage in the 1960s. Although the cottage had a chequered history, it had been moved bodily from site to site, and the later accretions had been stripped by the time the National Trust brought it back to Melbourne. Thus the nail came from the original section and, being so large, is likely to have been from the basic structure.

81 'The Hidden Cottage', *Heritage NSW*, V, 4 (Spring/Summer 2000), p 10.

82 Miles Lewis, 'Pontville' (typescript report to the City of Doncaster & Templestowe, Melbourne 1994).

83 Hardwicke Knight & Peter Coutts, *Matanaka: Otago's First Farm* (Dunedin 1975), p 29. The nail is illustrated, though not identified, and it is implied that it is from the original structure.

84 Miles Lewis, *370 Malvern Road, Prahran* (Melbourne 1989), p 14.

85 These were among goods advertised by Mitchell & Bonneau of Elizabeth St, as having arrived on the *Bernica* and other recently arrived ships: *Argus*, 9 June 1852, p 3.

86 C B Mayes, *The Australian Builders' Price-Book* (2nd ed, Melbourne 1862), p 107.

87 Charles Mayes, *The Australian Builders' Price-Book* (5th ed, Melbourne 1886), p 145.

2 1/2	17	28.0	0.4
3	25	26.0	0.3 1/2
3 1/2	32	24.0	0.3 1/2
4, 4 1/2, 5, 6	23	23.0	0.3 1/2

They were still being advertised by McEwan's of Melbourne at this time,[88] and apparently still in use in England at the turn of the century.[89]

In 1859 Charles Mayes recommended that nails should be manufactured in Victoria, because little manual labour was required, and the working expenses of machinery were less than in Britain or America.[90] In January of the same year a Victorian patent was granted for the forging of various objects, especially nails, by means of two anvils at an angle to each other being brought alternately into contact with the article to be forged, by means of a rocking motion, while at the same time it was struck with a hammer.[91] This was obviously designed to emulate the beneficial effect of hand forging, and was almost certainly the extension of an overseas patent (quite possibly that for the Ewbank nail). The Victorian patentee was John Robert Ricards senior, of Fisher, Ricards & Co, and it may be that local manufacture must have been seriously contemplated: if so, it did not eventuate, and it seems more likely that Ricards was establishing an agency.

The advent of wire nails, effectively in later 1860s, seems to have led to a rapid decline in the use of the Ewbank except in the largest sizes, commonly referred to as 'spikes'. These continued to be used, for example, in joining the top plates of bush huts to the column or post. Is 1879, however, Ewbank nails were still specified for the whole of the carpentry work of the Metropolitan Meat Market, in Melbourne,[92] and they were specified as late as 1891 for fastening the cleats of hammer beams, and for most of the roof framing, at 'Benvenuta', Melbourne.[93] Wrought and wire nails were used elsewhere in the building, and one might wonder whether the Ewbanks appear simply as the result of mindless copying of earlier specifications. However a catalogue of Harris, Scarfe, Limited of Adelaide, undated but perhaps about 1910, still lists 'Patent Steel Rose Nails (or Ewbanks) in sizes from two to five inches,[94] and Ewbanks were still advertised by James Moore & Sons of Melbourne in 1913.[95]

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88 Mayes, *Australian Builders' Price-Book* (1886), advertisements, p xix.

89 Joseph Gwilt [ed Wyatt Papworth], *An Encyclopædia of Architecture* (London 1899 [1842]), §2257b p 720, refers to Cordes' patent rose, flat points, 11/4, 11/2, 13/4, 2, 21/2, 3 and 6 inches long. However Young, *supra*, wrote of them as if they were specially geared to the Australian market, and no longer much used in Britain.

90 Mayes, 'Manufactures', p 325.

91 Victorian patent application no 195 to John Robert Ricards, 26 January 1859; see also Mayes, 'Manufactures', p 325. Fisher, Ricards and Co seem to have specialised in agricultural machinery, and they showed an improved mowing and reaping machine at the 1861 Exhibition. *Catalogue* of the Victorian Exhibition, 1861 (Melbourne 1861), p 224.

92 G R Johnson, 'Bill of Quantities Metropolitan Meat Market, Bank, Hotel, and Two Shops, &c' (Melbourne 1879), p 7.

93 W S Law, 'Specifications of Residence Drummond St. Carlton for Mrs. L. Abrahams' (Melbourne 1891), p 13.

94 Harris, Scarfe, Limited, *Engineers' Supplies* (Adelaide, no date [?c 1910]), p E12.

95 James Moore & Sons Pty. Ltd., *Price List 96 August 1913* (Melbourne 1913), p 4.

e. the wire nail

Wire nails are a useful tool for dating buildings in Australia, for they have usually been assumed to date from after 1870. However, there are some much earlier examples, and light wire nails for carpentry were used in France from at least the first decade of the nineteenth century. They were known as French nails or *pointes de Paris,*[96] which was to remain the French term for wire nails, and they were first made by taking a piece of wire, forming the point on a grindstone, then holding the shank in a vice and forming a head with one or two hammer blows.[97] Priess suggests that this was possibly no more than the transference of existing technology from bar stock to wire stock.[98] By 1810 the manufacture must have been well established, for the Messrs Mouchel, who were iron and steel wire makers at l'Aigle, Department of l'Orne, used the iron of the area because it was already known to produce the best wire for nails, screws and pins. It was hard and had a polish resembling that of steel wire.[99]

In March 1811 the American inventor James White, then living in Paris, took out a patent for a machine in which the wire was gripped vertically between two notched discs and it was cut to length, the head struck, and the point formed, all in a single operation. This machine, however, was not substantial enough to sustain a continuous manufacturing process, and the industrial production of wire nails was begun only in 1819 by the Lemires, father and son, of Clairvaux in the Jura, using processes developed by a number of inventors between 1806 and 1816. Other wire nail machines followed and by 1840 a number of Parisian works were producing *pointes* mechanically, notably Lenoble & Lambert at Popincourt, and Fiantz at La Villette.[100] By the late 1840s headed wire nails were being exported from France to the United States.[101]

The critical development was probably the wire nail machine invented by R Frey and shown at the Paris Exposition of 1844,[102] for it seems to have been the basis of large scale manufacture, and the wire nail machines of subsequent decades are all closely related to it. Its operation was described as: 'le fil de fer avançant à chaque tour de la manivelle d'une longeur constante, la tête est façonnée par refoulement, et la pointe formée par deux couteaux mus par deux excentriques qui coupent le fil de fer sous un

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96 Peter Priess, 'Wire Nails in North America', *APT Bulletin,* V, 4 (2003), p 91.

97 Michael Baackes, 'The History of the American Wire Nail Industry', *The Iron Age,* 2 January 1896, p 105. However Sickels, 'Nails and Nailmaking', p 68, states that the very first wire nails had no heads.

98 Priess, 'Wire Nails in North America', p 87.

99 'Extract from the Memoir of Messrs. Mouchel, of l'Aigle, in the Department de l'Orne, on the Manufacture of Iron and Steel Wire', *Repertory of Arts, Manufactures, and Agriculture,* 2nd series, XVI, 95 (April 1810), p 309.

100 Charles Frémont, 'Le Clou', *Bulletin de la Société d'Encouragement pour l'Industrie Nationale,* CXVII, March 1912, p 366-7.

101 Sickels, 'Nails and Nailmaking', p 68.

102 Frémont, 'Le Clou', pp 366-7. This may be the machine which according to Baackes was invented by a French mechanic at some time between 1840 and 1850, and in which a board on a single leaf spring was suspended from the ceiling, forced up by a cam, then released to create the hammer blow: Baackes, 'The American Wire Nail Industry', p 105.

angle aigu'[103] [the iron wire moves forward by a constant amount with each turn of the crank handle, the head is formed by pushing back against it, and the point is formed by two cutters moving on eccentrics which cut the wire on an acute angle]. According to Frémont, Frey's machine as well as two others by Stoltz were shown at the Great Exhibition of 1851 and the Paris Exposition of 1855.[104] But the 1851 catalogue reveals nothing by Stoltz, nor any French nail machine at all other than that of 'Frey junior', perhaps the son on the inventor, described as:

> A machine for nail-making, upon new principle.
> This machine if of small size, and is adapted for the manufacture of nails from two-fifths of an inch to one inch and one-fifth [10-28 mm] in length. The exhibitor has in his establishment seven various machines of the same description, which manufacture nails from one-fifth of an inch [5 mm] to eight inches [200 mm] in length. These machines are made with a plain framing, and are very easy to be set and repaired.[105]

At the Paris Exposition of 1855, Frey's and Stoltz's machines were joined by that of Rabeau, and Rabeau's was in turn to be the basis of Dubos's machine of 1862, and hence the later machine of Fagette, all of which bear a family resemblance. Frémont illustrates a machine of 1855 by Stoltz, preserved in the Conservatoire des Arts et Métiers, and a 1911 model by Dubos which is remarkably similar.[106] E-O Lami described the manufacture of wire nails in 1883 in terms recognisably similar to the original description of Frey's machine:

> Pointes de Paris. Ces clous se fabriquent aujourd'hui presque exclusivement à la machine. On fait les pointes de Paris avec du fil fer pris en bottes, et le travail s'exécute à froid sur le métal. Le fil de fer, saisi dans une mordache à la tête de la machine, avance, à chaque tour d'une manivelle reliée à l'arbre moteur, d'une quantité constante qui est engagée dans une contre-étampe dépassant légèrement aux deux extrémités. La pointe du clou est alors formée par deux couteaux mus par des excentriques, qui coupent le fil de fer sous un angle aigu, en même temps que l'étampe montée sur un arbre, que commande un excentrique particulier, vient former la tête par refoulement. Le clou se trouve terminé, pendant la période de retour des organes précédents à leur position primitive, un chasse-clou pousse légèrement le clou en dehors de la contre-étampe, et un crochet agissant sur la tête fait tomber le clou fabriqué en dehors de la machine, quoi se trouve dans la même situation qu'au point de départ, et donne lieu à la production d'en nouveau clou. Cette fabrication continue et très économique à l'aide de laquelle en peut, en se servent de fils de grosseurs diverse, établir des clous de modèles très variés, d'une exécution parfaite, a considérablement favorisée l'emploi des pointes de Paris, qui remplacent aujourd'hui avec avantage tous les petits clous forgés qu'on fabriquait autrefois.[107]

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103 Charles Laboulaye [ed], *Dictionnaire des Arts et Manufactures; Descriptions des Procédés de l'Industrie Française et Etrangère* (2 vols, Brussels 1845), I, sv Clou, and fig 549.

104 Priess, 'Wire Nails in North America', p 88, ref Charles Laboulaye [ed], *Dictionnaire des Arts et Manufactures; Descriptions des Procédés de l'Industrie Française et Etrangère* (2 vols, Brussels 1845, I, fig 549.

105 Great Exhibition, 1851, *Catalogue*, III, p 1254.

106 Frémont, 'Le Clou', pp 367, 365, 366.

107 E-O Lami, *Dictionnaire Encyclopédique et Biographique de l'Industrie et des Arts Industriels* (8 vols, Paris 1881-91), III, p 538.

> [Pointes de Paris. These nails are today made almost exclusively by machine. Pointes de Paris are made from iron wire in bundles and the metal is worked cold. The iron wire, gripped by a clamp at the head of the machine, moves forward at each turn of a crank linked to the drive shaft, by a fixed amount which is engaged in a counter-mould, while extending slightly beyond its two ends. The point of the nail is then formed by two cutters moving on eccentrics, which cut the wire at an acute angle, at the same time as a mandrel, which is mounted on a shaft giving it a particular eccentric motion, has formed the head by pushing back on it. While the components return to their original position, a punch gently pushes the completed nail out of the mould and a hook engages the head and throws it clear of the machine, which is now in its original position and begins to form the next nail. This continuous and very economical mode of manufacture, by which wire of various dimensions can be used to perfectly form a wide variety of nails, greatly favours the use of pointes de Paris, which today can advantageously replace all the small nails once forged by hand.

When Frémont described the process of manufacture in 1912 the most conspicuous difference was that he described the nail as being gripped by the neck during the process of formation, rather than along its full length.[108] However this can hardly have been new, as most wire nails even of the nineteenth century show the marks of the vice around the neck. Lami's description is not accompanied by an illustration of the nails produced, but Chabat illustrates what he calls a *clou d'épingle à chevron*, a *broche*, or a *chevillette*.[109] This is a wire nail, as it has a cylindrical shank, and in any case Tolhausen equates *clou d'épingle* with *pointe de Paris*.[110] The head of Chabat's nail is thin and flat, and the point is four-faceted, reflecting the action of the cutters. He divides the type into three categories, *clous à chevrons, clous fins* [fine nails], and *semence* [tack or sprig].

The British avoided wire nails for three or four decades for no discernible reason other than conservatism, and this all the more remarkable because the use of wire in making pins seems to have been well established.[111] But in addition to Frey's wire nail-making machine, wire nails themselves were shown at the Great Exhibition by a British maker who was almost certainly using Frey's or other French equipment. John Cornforth of Birmingham displayed his iron, steel and other wire, as well as examples illustrating the process of manufacturing it. It seemed to be more as a curiosity than anything else that he added:

> Wire nails of various sizes and forms. Heads and points of nails manufactured by the patent process known as the Pont de Paris [*sic*, for pointes de Paris], and used by the carpenters of that city, and of France generally, which may be made of any form.

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108 Frémont, 'Le Clou', p 367.

109 Pierre Chabat, *Dictionnaire des Termes Employés dans la Construction* (Paris 1875), p 318.

110 Alexander Tolhausen [rev Louis Tolhausen] *Technological Dictionary in the English, German & French Languages* (3 vols, Leipzig 1874-8), *Français-Allemand-Anglais* (1877), p 642.

111 William Bundy's patent for a method of heading pins refers to the raw material as being wire: *Repertory of Arts, Manufactures, and Agriculture*, 2nd series, XVIII, 106 (March 1811), pp 203-206.

It appears, then, that Cornforth must have acquired the British rights and was making wire nails, but did not see them as being important. This is consistent with the facts that even in 1866 none of the writers in Timmins's *Resources of the Birmingham and Midland Hardware District* made any mention of the wire nail, and in about 1870 Charles Hibbs, writing on nails, also ignored it.[112] Nonetheless another Continental patent, specficallty refering to 'Paris points' was extended to England in 1859, though it does not appear to have been of any consequence

Wire nail making machinery was equally slowly adopted in most other countries.[113] However, by 1851 Paul de Bavay of Brussels was making wire nails in iron, zinc, brass and copper which, like Cornforth, he referred to as *pointes de Paris,* and it seems likely that he had acquired the same French machinery.[114] Wire nails began to be made elsewhere in Europe in the early 1860s, and by the following decade Germany, France and Belgium were mentioned as major producers,[115] Belgium continuing in importance until about 1898.[116]

In the United States the first machine-made wire nails are said to have been made in New York in 1851 by either Adolph Felix Browne[117] or Morton & Bremner. Morton & Bremner's machine is said to have been designed by their foreman, William Hassell, though it seems certain that it was based upon Frey's or some other French patent. Hassell was to acquire all the firm's equipment in 1857, when the partners retired from business, and then established his own factory in Center Street, New York. The machine was called a 'pin machine' because it was used principally to make escutcheon pins, with nails as a secondary concern, and it operated for fifty-three years before Hassell's son John presented it to a company museum.[118] There are a number of other versions of these stories,[119] but on balance it seems that machinery was certainly being used in New York in about 1851, and this contradicts another claim to the effect that a wire nail machine installed at Montreal in 1870 was the first

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112 Charles Hibbs, 'Great Manufactures of Little Things - IX. Nails', *Technical Educator* (no date [c 1870], pp 11-13.

113 E F Carter, *Dictionary of Inventions and Discoveries* (London 1974 [1966]), p 122.

114 Great Exhibition, 1851, *Catalogue,* III, p 1162.

115 Baackes, 'The American Wire Nail Industry', p 105.

116 Fontaine-l'Eveque, in the Charleroi district, was the centre of nail making, with six factories, and there were one each at Brussels, Marchienne and Gentbrugge, as well as two small works at Hodimont and Luxembourg. The nail wire was imported from the United States, and by the 1890s the competition of the US, as well as that of France and Germany, was driving the Belgian product out of European markets, coming to a crisis point in about 1898. But there is no mention of such a crisis in France, and the German industry was prospering, with eighty-six works combined in a syndicate, and supported by an export premium *Scientific American Supplement no 12175,* 9 June 1900, pp 20439-20440.

117 Thomas Ritchie, *Canada Builds 1867 - 1967* (Toronto 1967), p 171; Rempel, *Building with Wood,* p 369.

118 Sickels, 'Nails and Nailmaking', p 68. Swank wrote in 1892 that six of the wire nail machines first used by Hassall were still operating in his son's factory: Swank, *Manufacture of Iron,* p 450.

119 Graham & Emery, *Audels Carpenters Guide,* I, pp 23, 25, refer to wire nails made by hand by William Hershel in 1851 or 1852, but Priess, p 88, gives this name as Hassall, and cites other contenders, Thomas Morton and Adolphe Brown: ref sources including James M Swank, *History of the Manufacture of Iron and particularly in the United States from Colonial Times to 1891* (New York 1892).

in North America. However this may be, wire nails were very little used in the United States before about 1883.[120]

In about 1871 some German residents of Covington, Kentucky, reportedly cooperated in importing three German wire nail machines. With these they made cigar box nails, small brads and nothing larger than a 3d fine nail, and met with little success until the company was reorganised in 1875 as the American Wire & Screw Nail Company.[121] Another version of the story is that in 1875 one Father Joseph Goebbels, a Roman Catholic priest, migrated from Germany to Covington, and began manufacturing wire nails on the basis of his German experience,[122] in partnership with Michael Baackes. The business was known as the Kentucky Wire Nail Company until it became a stock company in December 1875 as the American Wire & Screw Nail Company, later changed to the American Wire Nail Company.[123] It is said to have caused a rapid decline in the use of cut nails even during its first decade of operation.[124] Although the wire nails were at first taken up only by furniture manufacturers and cigar box makers, interest was aroused when the company won a silver medal at Philadelphia in 1876, and two other companies, William Hassall of New York, and A Field & Sons of Taunton, Massachusetts, entered the trade.[125] As William Hassall is undoubtedly the Hassell referred to above, the account is a flawed one, but it may refer to a shift in his output towards building nails.

According to Sickels it was the development of the Bessemer process in the 1880s and the invention of an improved wire nail machine by John Hassell in 1884, patented the following year, which caused the decline of iron (non-wire) nail making.[126] The first steel nails, made from Bessemer steel wire, were made by the H P Nail Company of Cleveland, Ohio, from 1879.[127] In making the nail the head was formed with a hammer-like blow from a cam-operated member, much as in the original French machine, and the point by a pair of pliers with V-shaped cutting edges.[128] These nails were harder and tougher, could bend, twist or clench without breaking, and were able to be driven into the hardest timber without breaking. Though at first the extra cost discouraged their use, by the mid-1880s the price was little more than that of iron nails, and they were coming into general use.[129] By 1885 there were twenty-five manufacturers in the United States, operating four or five hundred machines. In 1886 their association issued a card, which had been devised by a member company in the previous year, in which cut nails were compared to wire nails in standard sizes of from one to six inches [25-150 mm].[130] By 1890 there were fifty-seven wire nail

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120 Swank, *Manufacture of Iron*, p 450.
121 Swank, *Manufacture of Iron*, p 450.
122 Graham, *Audels Carpenters Guide*, I, p 25. Graham refers to Father Goebel, but Baackes to the Rev Joseph Goebbels.
123 Baackes, 'The American Wire Nail Industry', p 105.
124 Graham, *Audels Carpenters Guide*, I, p 25.
125 Baackes, 'The American Wire Nail Industry', p 105.
126 Sickels, 'Nails and Nailmaking', p 68.
127 Baackes, 'The American Wire Nail Industry', p 105.
128 *Scientific American*, 12 December 1903, p 438; October 1924, p 252. The latter is partly transcribed from the former, but gives 'dies' rather than 'pliers', presumably in error.
129 *Australasian Builder & Contractor's News*, 27 August 1887, p 250.
130 Baackes, 'The American Wire Nail Industry', p 105.

works.[131] In 1886 10% of US nails were of steel wire, but by 1892 they were in the majority, and by 1903 they constituted 90% of the market.[132]

But their advance was not inexorable, for in 1900 the *Scientific American* reported that the iron and steel cut nail industry was enjoying a great revival. Shingles fixed with wire nails were found to blow off after ten years, because they could not 'stand the weather' as wrought nails did, a problem partly attributable to the fact that the acid which was used in annealing the wire could not be fully cleaned off.[133] The practice was to clean the wire by dipping it into weak sulphuric acid, wash it in water and leave it long enough to corrode slightly, so as to make it easier to grip, then bathe it in lime to neutralize any remaining acid.[134]

According to Robert Varman wire nails were imported to Australia in 1853, though they were not cheap or plentiful until about 1870,[135] and this is borne out by the present research. Fine wire nails which probably date from the 1850s or 1860s have been found in the Sidney Seymour cottage at Romsey, Victoria - a strange building, the walls of which are entirely made of Singapore manufactured doors.[136] The first known Australian importer of wire nails was Frederic Lasseter of Sydney, who in 1863 had taken over the ironmongery business of Iredale & Co from his two partners. By the beginning of 1865 Lassetter was advertising 'best wrought wire nails' from 1¼ to 6 inches [32 - 150 mm] in considerable quantities.[137] These nails were clearly not from the United States but Europe, and at this stage not necessarily Britain. In this very year the Railway Manager's house was built at Rockhampton, using wire nails as well as Ewbanks,[138] and two years later 'Glengallan' homestead near Warwick also used both types.[139] Wire nails thought to be of about this date have also been found in a former billiard room at Chiltern, Victoria.[140] Generally, however, Varman's assessment is born out, and wire nails are not normally found before the 1870s.

In 1877 Lassetters were advertising 'Cornforth's best Wire Nails' from one to six inches [25 - 150 mm].[141] As no other brand has been heard of since Cornforth first showed his wire nails in 1851 it seems likely that he was the leading or sole British maker and the leading or sole exporter of wire nails to Australia during the

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131 Swank, *Manufacture of Iron,* p 451: according to Swank nearly all the nails were now of steel, but this must be an exaggeration.

132 Visser, 'Nails'.

133 *Scientific American,* 24 March 1900, p 188.

134 *Scientific American,* 12 December 1903, p 438; October 1924, p 252.

135 R V J Varman, 'The Nail as a Criterion for the Dating of Buildings and Building Sites', in Judy Birmingham & Damaris Bairstow, *Papers in Australian Historical Archaeology* (Sydney 1987) [first published in volume 10 no 1, March 1980]), p 107.

136 Miles Lewis, 'Sidney Seymour Cottage' (typescript report, Melbourne 1994): the cottage dates from 1855 and the nails are found in an extension of the shingle roof which, on the balance of probabilities, is very early.

137 *Bulletin* [Rockhampton], 12 January 1865, advertisement by Frederick [*sic*] Lasseter, late Iredale & Co, 421 George St, Sydney: courtesy of Margaret Strelow.

138 Margaret Strelow, 'A seemingly insignificant scrap of notepaper ...' (unpublished ms, Rockhampton [Queensland] 2002), passim.

139 Information from Margaret Strelow, 2003.

140 The building is believed to be of the 1860s and the nails seem to be contemporary, but as they have so been identified only in skirtings and architraves it is possible that they were later. Information from Deborah Kemp 2005.

141 Charles Mayes, *The Australian Builders' Price-Book* (3rd ed, Melbourne 1877), p 157.

intervening quarter century. This was now about to change. Meanwhile a British patent for a way of forming two wire nails simultaneously was taken out by B P Walker in 1878[142] - this may be associated with Cornforth's opeation, or it may reflect the existence of another British maker at this time.

In 1875 two Melbourne engineers, G S Evans and H O Christopherson, obtained a Victorian patent for improvements in wire nail-making machinery. As we do not know of wire nails being made locally at this stage, this was probably the extension of an overseas patent, though whether Evans and Christopherson were acting simply as agents for the overseas patentee, or had themselves secured the Victorian rights with as view to manufacturing the nails, is not apparent. Under this patent the wire was first straightened by passing it through a perforated plate and under a grooved roller, a number of lengths being handled simultaneously. As the roller moved back the heading die moved into place.[143]

By 1883 Mayes's *Australian Builders' Price-Book* listed wire nails in sizes from 3/4 inch to six inches [18.5 - 150 mm],[144] and in 1886 he noted that 'Patent Oval Samson Wire' cost much more than common wire, but was said to be so superior in strength that it was more economical to use.[145] The 'Patent Oval Samson Wire' must be a version of the 'oval wire nail with bradhead',[146] or 'oval steel brad', an English type which also appears to be a wire nail, for it is round (not oval) in section and has the characteristic circumferential grooving resulting from the grip of the vice. The head is round but rather deep, like a little drum. The 'French nail' is similar in appearance but that it has a rather large flat head, more like that of a clout, which is left to lie on the surface of the timber rather than being punched in, and which suggests it is the original *pointe de Paris* , the head of which is of this type. It was thought to be rather unsightly, though the nail itself was strong and tenacious.[147] The heads of the nails, it appears, were chequered.[148]

In 1885 the Anchor Nail Works in Palmer St, Richmond, Victoria, were established by Frank Gold. As the factory made other products, such as brads and roofing nails, we cannot be certain that wire nails were made from the outset, but it seems highly probable, and by 1901 there were thirteen wire nail machines, all practically identical but producing nails of different sizes, thirty-five in all. The wire was wound onto reels, or 'swifts', from which it was fed into the machine, which produced 200-300 nails per minute.[149] Although he made other types of nail from steel, it is possible the Gold was using iron wire for the nails, as in 1887 Bennie Teare & Co claimed to be the sole local patentees and manufacturers of the steel nails.[150]

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142 Great Britain, patent no 1,141 , 22 March 1878, to B P Walker.

143 Victorian patent no 2049 to George Sexton Evans & Henri Oscar Christopherson.

144 Charles Mayes, *The Australian Builders' Price-Book* (4th ed, Melbourne 1883), p 128.

145 Mayes, *Australian Builders' Price-Book* (1886), p 143.

146 T & W Farmiloe, *T. & W. Farmiloe's Miniature Catalogue* (London 1894), p 928. The word 'oval' probably refers to the practice in drawing steel wire of rolling it alternately into an oval and then a square section, which improved its properties: *Scientific American,* 12 December 1903, p 437; October 1924, p 252.

147 S Barter, *Woodwork* (London 1892), pp 85-6.

148 Farmiloe, *Miniature Catalogue*, p 928.

149 'Australian Manufactories No. II - The "Anchor" Nail Factory', *Australian Storekeeper's Journal,* March 1901, p 81.

150 *Australasian Builder & Contractor's News,* 3 September 1887, p 260.

In 1880, the English company John Lysaght of Bristol had established a selling agency in Melbourne managed by Thomas Davey, under the name of the Victorian Galvanized Iron & Wire Co, until 1899 when it became Lysaght's Galvanized Iron Pty Ltd.[151] In 1884 Lysaghts began producing wire netting from imported wire feed at Five Dock on the Parramatta River, New South Wales,[152] the source of the material being Rylands Warrington (UK). A local company was incorporated as Lysaght Bros and Co. Limited from 1 January 1886, but they do not appear to have been making nails at this stage. At the Melbourne Centennial Exhibition of 1888-9 Cordes & Co showed wire nails, and do not seem to have bothered with their traditional Ewbank type, though it was still manufactured.[153] A number of other British manufacturers showed wire nails at the exhibition, including C W M Wilson of London, proprietors of the 'Hercules' brand.[154] In 1889 it was reported that wire nails had almost driven the other types out of the market in Australia. Briscoe, Drysdale & Co of Sydney had thousands of cases of nails in stock, in all thicknesses and in lengths from one to six inches [25 to 150 mm].[155] This suggests that the larger nails and spikes of the earlier types may still have had a role, and it is true that these larger sizes seem to be found in later structures, though it is rarely possible to date them precisely.

f. roofing nails & screws

The best slating nails were of copper, but other types were of zinc or of 'composition', as specified for a pair of terrace houses in Melbourne in 1854.[156] The Vieille Montagne Company, leading zinc producers, made zinc nails for slating.[157] Composition, otherwise known as bell metal or yellow metal, was a mixture of 60% copper and 40% zinc, and the nails were formed by casting this in a bed of sand, into which holes of the required size were pricked.[158] Towards the end of the century wire slating nails with broad flat heads were advertised in Britain,[159] but if they were of iron or steel, as appears, they can hardly have been as satisfactory as those of copper or zinc. In 1890 a specification for a roof of English-made Roman pattern tiles called for every third course to be nailed with two zinc nails,[160] but the Marseilles tile which was to become more popular was usually tied with wire. M W Wigzell of Exeter patented a 'screw nail' in 1859,[161] and in 1861 his 'spiral fluted nail',[162] which now

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151 John Lysaght (Aust.) Pty. Ltd., *Lysaght Venture* (Sydney 1955), p 2.

152 John Lysaght (Aust.) Pty. Ltd., *Fifty Years of Industry and Enterprise 1885-1935* (Melbourne 1935), p 126.

153 Centennial International Exhibition 1888-1889, *Official Record* (Melbourne 1890), pp 466, 737, 964.

154 Centennial International Exhibition 1888-1889, *Official Record* (Melbourne 1890), p 469.

155 *Australasian Builder & Contractor's News*, 13 July 1889, p 46.

156 Russell, Watts & Pritchard, 'Specification ... for Dwelling houses ... at Elwood ,... for Joseph Docker', 13 December 1854 (Docker Papers, Manuscript Collection, SLV), p 18.

157 Halina Eckersley reported in 1997 discovering nonferrous nails labelled 'VIE ...' in the remains of a slate roof of the east wing of the Old Melbourne Gaol, possibly original to the work of the 1860s.

158 Frank Bennett & Alfred Pinion, *Roof Slating and Tiling* (London 1960 [1948]), pp 51-2.

159 Farmiloe, *Miniature Catalogue*, p 928.

160 Hyndman & Bates, 'Specification, &c, Villa Residence Tank +c / Camberwell / Arthur J Fuller Esq / Normanby Chambers Chancery Lane' (Melbourne 1890), p 20A.

161 Great Britain, patent no 14 to M W Wigzell, 1 January 1859.

began to be manufactured in England. This nail automatically revolved as it was driven in, and not even the largest sizes required pre-drilled holes.[163] These nails, however, did not find favour and were soon abandoned.[164]

The fixing of roofing iron was a specialised matter. At first large-headed galvanized nails were first used, but they proved a failure, and gave way to screws and washers, or occasionally bolts. A British patent of 1869 had a bolt head with a curved underside to match the corrugation (meaning, of course that the bolt could not be turned), while on the underside there was a rubber disc and curved washer, fixed with a nut had a domed head (so that it could turn).[165] However Thomas Hardy's notebook, of about 1862-72, shows a simple bolt passing from the top of the corrugation through the batten, with a washer beneath. He notes that they should have two coats of red lead. 'This is better than galvanized bolts which "go" (the man said)'.[166] Such bolts have not been reported in Australia. Screws or bolts required holes to be drilled, and time taken to turn the screws in - though this was sometimes avoided by hammering them in, with predictably poor results.[167] In other respects screws were very satisfactory, for they were strong and durable, and they made it easy to recycle the iron.

Andrew Learmonth wrote in 1859 to his brother Tom (about work in progress at their property 'Ercildoune', Victoria):[168]

> Roof with iron screwed into purlins, like the new part of the house and frame principally like it. Should we want to put another story on it can then be taken off in a few hours and plugged with a white-leaded pigment of oakum round the neck of the screw.

At 'Mount Rothwell' in 1872 '1 3/4 gal screws and washers of lead' were specified for fixing the corrugated iron,[169] while a South Australian specification of 1878 called simply for 'a 2 1/4 screw in every other flute',[170] subsequently revised to 'galvanised iron screws and washers spaced 12 and 18 inches apart respectively'.[171] In 1879 Brooker, Dore & Co of London showed 'Galvanized Cone Head Screws for Roofing' at the Sydney International Exhibition.[172] In 1890 the corrugated iron roofing of a

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162 Great Britain, patent no 1,369 to M Wigzell, 1 June 1861; also nos 1,998 and 1,999, both of 10 August 1861.

163 Papworth, *Dictionary,* sv Nail, citing *Builder,* XIX, 604 (1861), deriving in turn from the *Devonport Independent.*

164 Charles Hibbs, 'Great Manufactures of Little Things - XI. Screws (*continued*)', *Technical Educator,* IV (no date [c 1870]), p 219.

165 Great Britain, patent no 1,520 to G Allan, 1 May 1869.

166 Hardy, Notebook, p 53.

167 *Australasian Builder & Contractor's News,* 8 October 1887, p 358.

168 Andrew Learmonth to Tom Learmonth, 8 April 1859, Manuscripts Collection, State Library of Victoria, quoted by Hanut Singh-Dodd, Australian Architecture B, Melbourne University 1995.

169 Research by Jeananne Wells, 2001, quoting the Chirnside papers, State Library of Victoria.

170 G & W Sarat Dunstan, 'Specification for the Several Works required in the Erection of Banking Premises for the Bank of Australasia, Kooringa' (Aberdeen [South Australia] 1878), p [6].

171 Reed & Barnes, 'Specification of Work to be done and Materials to be used in the Erection of Banking Premises at "Kooringa S.A." for the Bank of Australasia' (Melbourne 1878), p 42.

172 Sydney International Exhibition 1879, *Official Catalogue of the British Section* (London 1879), p 181.

city building was specified to be 'all well screwed down and rivitted',[173] which is somewhat ambiguous, and may in any case represent the unthinking repetition of an old-fashioned specification clause, for screws were by now largely out of favour.

Roofing nails, as opposed to screws, regained some favour when they too were equipped with flexible heads to adjust to the shape of the corrugated iron, typically a cup head which would adjust as it was driven against the surface, with a washer to seal it. The cup form had already been developed for nails used in upholstery and related trades.[174] What may be the first roofing nail of the cup head type was designed for tiles rather than iron, and patented in 1873, providing for a cup head and leather washer.[175] In 1878 nails for iron and other roofing were patented, in which the iron head had a turned-down edge, which embedded it into a lead washer underneath.[176] But these were probably not the same as the 'corrugated iron nails' which they shown at the Melbourne Exhibition of 1880 by J J Cordes & Co of Monmouthshire, better known as makers of the Ewbank nail.[177]

A form of nail with a cup-shaped head, for use with corrugated iron, was developed by the Christchurch ironfounder W Stokes, and used in New Zealand from 1883.[178] The hollow head, of lead or other soft metal, adjusted as the nail was driven in, so as to closely fit the roofing iron. This appears to be the same as the 'Acme' roofing nail manufactured at a slightly later date by Samuel Parker's Southern Cross Galvanised Iron Manufacturing Co of Auckland, which was awarded a gold medal for its products at the Auckland Exhibition of 1898.[179] They may in turn be related to the galvanised conehead nails and galvanised conehead screws for corrugated iron roofing which were advertised in Britain in the 1890s, together with galvanised iron washers and lead washers. Nails of the Stokes type were used in New Zealand right up to the 1970s, and only then superseded by the 'Ter' screw and 'Ter' gun for fixing.[180]

A British patent was obtained for the Stokes nail in 1887,[181] and in the same year the rights were taken up by McLean Bros & Rigg of Melbourne.[182] They displayed the nails at the Centennial Exhibition in 1888,[183] and the nails appear to have been manufactured locally, probably at Gold's Anchor Nail Factory. In 1901 Gold was making galvanised iron solid-headed or mushroom-headed roofing nails, in which the even-shaped mushroom worked like a washer.[184] Bill Nairn of Adelaide has found specimens in place, but believes that - in contrast with the situation in New Zealand -

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173 Wright, Reed & Beaver, 'Specification for Erection of Premises for the National Mutual Life Association of Australasia. Corner of Collins & Queen Streets Melbourne' (Melbourne 1890), p 27.

174 Great Britain, provisional patent no 2,629 to W H Richards, 7 September 1867.

175 Great Britain, patent no 1,137 to J L Nancarrow, 27 March 1873.

176 Great Britain, patent no 678 to W A Barlow [J Hilgers], 19 February 1878.

177 Melbourne International Exhibition, 1880, *Official Catalogue of the Exhibits* (Melbourne 1880), II, p 387. Neither Hilgers nor Barlow are known to have been Cordes connections.

178 *Australasian Builder & Contractor's News*, 8 October 1887, p 358.

179 Geoff Chapple et al, *Corrugated Iron in New Zealand* (Wellington 1983), pp 27-8.

180 Information from Bill Nairn of Adelaide.

181 Great Britain, patent no 6,884 to F Chapman [communication of W J C Stokes], 10 May 1887.

182 *Australasian Builder & Contractor's News*, 8 October 1887, p 358.

183 Centennial Exhibition 1888-9, *Official Record*, p 736.

184 'The "Anchor" Nail Factory', p 81.

they were generally used only in limited areas, such as for fixing the ridge, and that they did not remain in use for long. In part, he suggests, this may have been due to the acquisition of the Lysaght parent company in Britain by Guest, Keen & Nettlefold,[185] itself a manufacturer of fixings. However the evidence suggests that other makers were more active at this time in the field of roofing nails.

In 1888 a British patent was taken out by E S Baldwin, on a communication from H Davenport, for a lead-headed nail designed for corrugated iron roofing. A nail either of the 'ordinary' or an 'improved' form, and preferably with a square shank, would have lead cast around its head (that is, presumably, the head would be suspended downwards in a small mould filled with lead).[186] The difference from the Stokes nail is unclear except that the leaden head was pressed or moulded on rather than cast. Nails of the Stokes or Davenport type must soon have been made in Australia. At Ercildoune, Victoria, lead-topped nails branded 'COOP'S LATEST' have been found Coop's eadworks established in Melbourne in 1854 is referred to elsewhere, and pipes were made there from 21857, but nothing is known ofrofing nails. ,[187] though it is most unlikely that these nails are nearly so early as the discussion between the Learmonth brothers quoted above. Similar nails, apparently of twentieth century date, have been found at the Venus Crushing battery, Charters Towers, Queensland, branded 'SAXON SEAL [?TIGHT]'.[188]

Two nails patented in February 1892 combined aspects of the cup head and the lead head. One had the lead head itself cast into a cup shape, much as in the Stokes nail.[189] The other had a cup-shaped dome or washer, and was inverted into molten lead or tin, so the cup was partly filled with the softer metal.[190] Whether either came into commercial use is not known, for a much simpler type had been patented by R E Evenden the year before. It was a wire nail, onto which a slightly conical washer was threaded below the head and pressed together.[191] It was presumably this type that was described in Australia ten years later as Evenden's Patent Spring-Head Roofing and Fencing Nail for galvanized iron,[192] though neither the source nor the local agency is known. Jeffries's *Australian Building Estimator* of 1907 lists both spring head nails and lead head nails,[193] and shottly afterwards Harris, Scarfe, of Adelaide three types of Evenden spring head roofing nails, the plain shank, the twisted shank, and the screw, nail, which are self-explanatory. They also stocked an Evenden springhead roofing screw.[194]

Though bolts were much more expensive than nails, their use was less problematic because they could be placed accurately, and the head or the washer could be pre-

185 John Lysaght Limited, *The Lysaght Century 1857-1957* (Bristol 1957), p 29.
186 Great Britain, patent no 2,748 to E S Baldwin (communication of H Davenport), 24 February 1888.
187 James Coop was the first to manufacture lead pipes in Melbourne, in 1857: Intercolonial Exhibition 1866-67, *Official Record*, pp 327-8
188 One has kindly been sent to me by Jinx Miles, who believes that the building was last re-roofed in the 1950s.
189 Great Britain, patent no 2,364 to G Thompson, 9 February 1892.
190 Great Britain, patent no 3,424 to J J Macky & J Mitchell, 22 February 1892.
191 Great Britain, patent no 16,133 to R E Evenden, 23 September 1891.
192 *Building, Engineering and Mining Journal*, 27 July 1901, supplement, no page.
193 Walter Jeffries, *The Australian Building Estimator* (Sydney 1907), P 153.
194 Harris, Scarfe, *Engineers' Supplies*, p E12.

formed to fit the shape of the corrugation, as in British patents of 1869 and 1889.[195] Bolts were indispensable in iron-framed structures, which would not take nails or screws, and hook bolts for fixing corrugated sheeting to iron or steel purlins are discussed below in the context of cyclone design, though they were by no means restricted to that purpose. Asbestos cement was a more delicate material and required specialised fixings. A British patent of 1928 covered clamps, each of which could secure the sheet to bolt, and hence to the frame below, but did not require any hole through the sheet itself. The clamps had teeth, spaced apart, which bit into the underside of the sheet. One model fitted below the convex and one below the concave section of the corrugation.[196]

g. local nail manufacture

By 1887, when McLean Brothers & Rigg may have begun making the Stokes nail in Melbourne, the hand forging of nails must have been almost a lost art, and there appear to have been no established nail factories. However in 1888 John Rose reached Melbourne from Dunedin, New Zealand, and in 1889 entered partnership with Alexander McNeil to establish the Titan Engineering Works. A factory was opened in Amess Street, North Carlton, for the manufacture of barbed wire from imported stock, and the barbed wire machinery was itself made on the premises to designs based on American models. Soon after the company moved to Spencer Street and then to South Melbourne, meanwhile expanding its operations to include wire nails and later a range of sheet metal goods.[197]

Soon Sydney Cooke was manufacturing a springhead roofing nail,[198] and Frank Gold of the 'Anchor' nail factory patented a solid head roofing nail made by using 'immense' pressure to squeeze the head into an evenly shaped mushroom which acted like a washer. In 1901 he had six machines to make these, each of which weighed nearly 2.5 tonnes. Gold also invented the 'combination' roofing screw, which could be either driven or screwed in and could be subsequently screwed out again, which minimised the damage to the roof sheeting. Patents were taken out all over the world.[199] James MacDougall's Austral Nail Co was established at South Melbourne in 1889, and confined itself to nail manufacture until 1905, when it began making barbed wire. Austral Nail was the first to begin wire drawing from imported rods in 1911, and in 1919 transferred to Newcastle to a new wire mill near to its new source of raw material, BHP's rod mill, which had been bought from the Morgan Construction Company of Worcestershire and begun production in 1918.[200]

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195 Great Britain, patent no 1,520 to G Allen, 18 May 1869; no 16,443 to H Smith, 18 October 1889.

196 Great Britain, patent no 326,177 to G R Speaker, 5 December 1928.

197 James Smith [ed], *Cyclopedia of Victoria* (3 vols, Melbourne 1903-5), I, p 569; *Fifty Years*, op cit, p 148.

198 Able Cooke Company records / corporate brochure 1992, quoted by Ivan Pavlekovic-Smith, History of Building, Melbourne University, 1992.

199 'Australian Manufactories No. II - The "Anchor" Nail Factory', *Australian Storekeeper's Journal*, March 1901, pp 81-2.

200 Helen Hughes, *The Australian Iron and Steel Industry 1848-1962* (Melbourne 1964), pp 82-4 , ref J K MacDougall, 'Some Reminiscences of the Wire Industry in Australia', *B.H.P. Review*, XIV, 2, p 2.

In 1921 Rylands Brothers of Warrington, England, set out to establish an Australian works for netting and wire products, but a merger with the Austral Nail Company was arranged in 1923 under the style of Rylands Brothers (Australia) Limited.[201] By 1925 there had been some trading and financial difficulties and BHP acquired a controlling interest in Rylands by a share exchange. It is now the Newcastle Wire mill. In 1927 the Titan company's nail and barbed wire manufacture was taken over by BHP, renamed the Titan Nail Wire Pty Ltd, and its production integrated with Rylands Bros (Aust) Ltd.[202] BHP also took a majority interest in Lysaght Bros in 1929, and the plant at Chiswick is now the Sydney Wire mill. A new factory was built in South Melbourne in 1935.[203] By the 1930s there were a number of special nails in production in Australia, designed to give enhanced holding power by means of twisted shanks, barbs, rusting with ammonium chloride, sand rumbling, or cement coating. These, however, seem to have been intended less for conventional carpentry than for packing cases, where the strains of movement tended to pull them.[204] In the 1950s Mills Scaffolds were selling an odd nail with a double head, called the 'Duplex'. The lower head would rest on the timber surface and complete a tight joint, but the shaft continued up to a second head which stood proud of the surface and could conveniently be used in extracting the nail. It was designed for temporary nailing in applications such as formwork.[205]

By 1934 BHP fully controlled the wire industry of Australia, and in 1958 Australian Wire Industries Pty Ltd was formed as a holding company, incorporating Rylands Bros (Aust) Pty Ltd, Lysaght Bros and Co Pty Ltd, Australian Wire Rope Works Pty Ltd and Bullivants Australian Co Pty Ltd. AWI was then one of the largest wire companies in the world in terms of volume and product range.[206] Since that time, AWI has produced all Australia's reinforcing wire requirements. Of recent years it has expanded into wire and strand for prestressing, and steel fibres for concrete.

h. screws

Screws were at first handmade and very expensive, and in the sevententh century, when they were coming into use for furniture, they acquired a quasi-mystical significance as exemplifying the moral virtue of 'jointness'. The church historian Thomas Fuller pointed the contrast with the nail, which if it did not break or bend in the driving, would 'rive ansd split that which should be fastened therewith'. Whereas 'That may insensibly be screwed which may not be knocked into people'.[207]

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201 *Fifty Years*, op cit, p 120; *Seventy-Five Years of B.H.P. Development in Industry* (Melbourne [c 1960]), p 81; Hughes, op cit, p 84.

202 Hughes, op cit, pp 101-2, ref 'The Titan Nail and Wire Proprietary Limited', *B.H.P. Review*, XV, 5, pp 10-11. For the Titan Nail Co products see *Handbook for ... the Broken Hill Proprietary Company Limited* [BHP *Shapes and Sections*] (Melbourne 1930), pp 499 ff.

203 *Age*, 8 October 1935.

204 Ian Langlands, *The Holding Power of Special Nails* [CSIR Division of Forest Products technical paper no 11] (Melbourne 1933).

205 *Building, Engineering, Lighting*, 25 February 1957, p 88.

206 *Seventy-Five Years*, op cit, p 81.

207 Adam Nicholson, *Power and Glory: Jacobean England and the Making of the King James Bible* (London 2003) pp 68-9.

The traditional British process of manufacture was laborious. Wire was cut into the required lengths, a head was formed in a shank by a blacksmith, a 'nick' was cut across the top with a fine-toothed handsaw, and finally the thread or worm was filed out by hand. The quality was poor but the product expensive.[208] The first machinery more or less replicated this process, and as described in 1851:

> Operation 1. From a coil of wire placed on a wheel and introduced into the screw-making machine, a piece, sufficient to form a screw is cut off, caught up, and headed; that is to say, the portion which forms the head is compressed into shape, and the now-called 'blank; is dropt into the receptacle below. Operation 2, consists in flattening the head and smoothing the countersink, which is performed by the 'blank,' being held in both clams, and having a small cutter revolving in front and another behind. 3. Slitting the head; the 'blank' is placed in a pair of nippers, which is moveable on centres by means of a lever action, the head is pressed against a small revolving circular saw, and the slit made. 4. Threading is effected by the 'blank' being introduced into a pair of clams which is attached to a spindle, the back part of which is cut by a worm or thread corresponding to that of the screw to be cut, and which propels forward the clams and the 'blank' against small-toothed cutters, which groove out the thread; three runnings down is sufficient to complete the manufacture of an ordinary sized screw. ‼ The difference in the finest threads arises from the shape of the cutters.[209]

Between 1751 and 1760 the brothers John, Job and William Wyatt, of Birmingham, effected various improvements, including the first successful automated manufacturing process. John Wyatt in particular is credited with the first parallel shank / parallel head wood screw, the parallel thread being the key to holding ability. At the beginning of the nineteenth century there were improvements in the manufacture of screw head blanks,[210] and then the process of manufacture was somewhat streamlined by the introduction of the continuous-action mandrel lathe, described by Mercer as

> axled on a guide screw, and which therefore, advancing as it revolves and clasping at one end the screw shank, threads the latter by twisting it through a knife-edged hole, or, more exactly, between two steel-cutting points compressible by a lever.[211]

Exactly how this was introduced is unclear. The details of a screw-cutting machine patented in the United States by J Andrews in 1817 are lost, but it has been argued that it was this machine, patented in England through the agent J Colbert, which was

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208 Joseph Chamberlain, 'Manufacture of Iron Wood Screws', in Samuel Timmins [ed] *The Resources, Products and Industrial History of the Birmingham and Midland Hardware District* (London 1866, pp 605-6.

209 Great Exhibition, 1851, *Catalogue*, II, p 629.

210 Warren Hewertson, 'Another Turn of the Wood Screw', *TATHS Newsletter* [90 (Autumn 2005), pp 2-3

211 H C Mercer, *Ancient Carpenters' Tools* (Mineola [New York] 2000 [1929]) p 256.

bought by the Nettlefolds and used at their new factory at Sunbury-on-Thames from about 1819.[212]

After 1840 screw-cutting lathes came into wide use.[213] However no uniformity or system had been established in the trade, in relation to size or shape, and this was remedied only in stages. Holtzapffel published a table of the screws used in their workshops,[214] and then in 1841 Joseph Whitworth [later Sir Joseph] tabulated a uniform system of screw threads for steam engines and machinery, which he submitted to the Institution of Civil Engineers. The thread was an isosceles triangle with an angle at the peak of 55º, though this was slightly rounded off, as was the angle of the groove.[215] In the United States, however, a different system was developed following a report in 1864 by a committee of the Franklin Institute, and it became known (for somewhat complex reasons) as the United States Standard, Sellers' and Master Car Builders' Thread - in section an equilateral triangle with one eighth the height chopped off the top, and the base of the groove filled by the same amount.[216]

The drawback of the new machinery was that it could not form a point, and though the shank might taper, it necessarily terminated in a blunt end.[217] Screws of this form are found in Australia, and were doubtless made on such machines probably in Britain. Hand-formed pointed screws likely to have preceded the machine have not been reported, and a pointed screw should normally be assumed to be later in date. Sloane illustrates three phases in the United States: until 1840 screws had no taper at all, the end was completely blunt, and the head might be formed by flaring out from the shank. After 1840 the end remained flat but there was a slight taper in the shank, and the heads were of modern form, either countersunk or domed and jutting out sharply from the flank. After 1846 screws become more tapered and fully pointed.[218]

Early forms of pointed screw were difficult to make and relatively ineffective in operation, but J T Sloan of New York patented a form in which the the thread continued to the point at the same pitch, and in 1846 developed a procees to manufacture it. The invention was licensed to companies in the United States, and he demanded £30,000 for the British rights. Nettlefolds were were obliged to raise the capital by taking Joseph Chamberlain into their business, as Nettlefold & Chamberlain, and thus acquired the rights in 1854, and henceforward made not only the screws but the manufacturing equipment.[219]

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212 Hewertson, 'The Wood Screw', p 3, citing G G Jenkinson, *Metal Wood Screws* (author, Adelaide 1999).

213 For example, the Small Slide and Screw-Cutting Lathe of Charles Watson, Leeds: *Imperial Journal of Art, Science, Mechanics and Engineering* (Manchester), I, no date, pp 627-8 & plate.

214 *Screws and Screw-Making* (Colchester [Essex] 1891), pp 9, 182.

215 *Screws and Screw-Making,* pp 9-11, 18-26.

216 *Screws and Screw-Making,* pp 10-11, 27-40, 178.

217 Mercer, *Ancient Carpenters' Tools*, p 256; Rempel, *Building with Wood,* p 103, also illustrates examples.

218 Eric Sloane, *A Reverence for Wood* (New York 1973 [1965]), p 25.

219 Hewertson, 'The Wood Screw', pp 3-4. Mercer, 'Dating of Old Houses', p 24, cites Sloan's patent as no 4704 of 20 August 1846.

At the Great Exhibition Whitworth & Co of Manchester showed, amongst other things, a self-acting bolt-head and nut-shaping machine, and a patent screwing machine for nuts and bolts,[220] and Andrew Shanks of London showed a bolt screwing and tapping machine.[221] The Patent Pointed Screw Company of Wolverhampton, however, showed screws of malleable iron, formed by casting in sand. It was claimed that these could be driven into wood without first boring a hole, which may have been a function of the more pointed form, as well as the fact the thread was sharper (though they were otherwise considered slightly inferior to the wire-formed screw).[222]

According to Hibbs steam screw cutting machinery was invented by a German called Colbert, and introduced in about 1849,[223] though this does not seem to be reflected in the exhibits of 1851. This was very soon surpassed by American machinery, which it is impossible to explain here,[224] but must be the same as the American patent self-acting machinery said to have been introduced to the United Kingdom in 1854.[225] W R Lake, one of the most prolific patentees of screw-making machinery in Britain, had at least two of the inventions communicated to him by the American Screw Co,[226] but it is not clear which company he belonged to. The American machinery required considerable capital and marked the end of the small manufacturer:[227] indeed in about 1866 the general wood screw trade of Birmingham was said to have been absorbed into the business of Nettlefold & Chamberlain.[228] Nettlefold is said to have introduced 'a beautiful screw' in which 'The shaft was tapering and pointed at the end; the thread was deep and bold, the under side having as great an inclination as could be given to it, while the upper side was almost flat.'[229] In about 1880, Nettlefolds, with J H Nettlefold as manager, took over the Birmingham Screw Company (Limited), as well as John Cornforth, the Manchester Steel Screw Company, and Lloyd & Harrison. Now something of a monopoly had indeed been established[230] F Lowe & Co of Melbourne were importers of Nettlefold's screws and bolts in the 1880s.[231] By 1888 Nettlefolds had works at London, Birmingham, Smethwick, Kings Norton and elsewhere, and at the Centennial Exhibition, Melbourne, they were able to show screws, nuts, bolts, fencing wire and wire nails.[232]

As with screws, the manufacture of nuts and bolts in Britain was revolutionised by the introduction of American machinery, in this case by one Watkins, of Watkins & Keen. The company moved its operations from Smethwick to London, and then in 1864 were bought out by the Patent Nut & Bolt Company. In 1865 this company

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220 Great Exhibition, 1851, *Catalogue*, I, p 296.
221 Great Exhibition, 1851, *Catalogue*, I, p 292.
222 Great Exhibition, 1851, *Catalogue*, II, p 664.
223 Charles Hibbs, 'Great Manufactures of Little Things - X. Screws', *Technical Educator* (no date [c 1870]), IV, p 117.
224 Hibbs, 'Screws', p 118.
225 Chamberlain, 'Manufacture of Screws', p 607.
226 Great Britain, patent no 3,998 to W R Lake [American Screw Co.], 16 October 1876, for 'machinery fof shaving and nicking screws'; no 4,891 to W R Lake [American Screw Co.], 18 December 1876, for 'an arrangement for dislodging the screws from [the machine]'.
227 Chamberlain, 'Manufacture of Screws', p 607.
228 Chamberlain, 'Manufacture of Screws', p 609.
229 Hibbs, 'Screws', p 117.
230 *Australian Engineering and Building News*, 1 June 1880, p 271.
231 *Australasian Ironmonger*, I, 7 (1 October 1886), advertisement p vii.
232 Centennial Exhibition 1888-9, *Official Record*, pp 468, 964.

amalgamated with Weston & Grice of the Stour Valley Works. This now extensive organisation produced bolts, nuts, rivets, coach screws, washers and other products for use in engineering, railway construction, bridge building, ship building and coach building.[233] The Patent Nut and Bolt Company had a number of factories in Britain, exhibited at Sydney in 1879, and had an extensive Australian connection, but this appears to have consisted principally in supply of railway fastenings (to all colonies other than Western Australia) rather than bolts for the building industry.[234]

Screws must have been cut locally when required, and indeed a patent screw-cutting lathe was demonstrated in action at the Melbourne International Exhibition of 1880.[235] But, both screws and bolts were normally imported into Australia until well into the twentieth century, and overwhelmingly from Britain. Although it does not appear that any screws were systematically manufactured in Australia, bolts and nuts of their own manufacture were advertised by the Victoria Iron Rolling Company of Melbourne in the 1880s.[236] In 1919 the majority interest in the English company of John Lysaght Ltd, associated with the Lysaght family, was sold to the Berry Group, and then in January 1920 the controlling interest was transferred to what had by now become Guest, Keen and Nettlefolds Ltd.[237] By 1924 Nettlefold's screws and other products were marketed in Australia through or in association with Lysaghts.[238]

i. anchorage

The usefulness of screws for fixing elements to the carcase of a building was greatly enhanced by the development of expanding plugs. Tradition had been to cut a hole, or gouge out part of a mortar joint, and drive in a wooden plug, but in principle this could be pulled out again when a load was applied to it. A wooden fixing brick was a better solution, but only when the fixing was planned in advance, and this was still more necessary for the use of the Ackrill's patent fixing bricks which have been discussed above.

There were numerous approaches towards prepared anchorages. One of the earlier British patents, that of R J Badge in 1857, was specifically designed for the trenails which fixed railway chairs to sleepers, but the principle was generally applicable, and was in fact the same as the stonemason's plug and feathers. A slightly waisted cylinder, divided into two or more parts, was first driven into the hole, then a pin was driven between them so as to force them outwards and lock them against the sides of the hole.[239] In 1902 a British patent was granted for a fixing system in which a socket or sleeve with a nut at the bottom was inserted into a pre-drilled hole. It was so shaped that when a bolt was screwed in it was forced to expand and lock firmly into

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233 Chamberlain, 'Manufacture of Screws', p 609.
234 Sydney Exhibition 1879, *Catalogue of British Section*, p 188.
235 Melbourne Exhibition 1880, *Catalogue*, p 50.
236 *Australasian Ironmonger*, I, 7 (1 October 1886), advertisement p viii.
237 John Lysaght Limited, *The Lysaght Century* (Bristol 1957), p 29.
238 John Lysaght (Aust.) Ltd., *The Referee* (14th ed, Sydney 1924), p 43. According to this John Lysaght (Australia) Ltd represented Guest, Keen & Nettlefolds in relation to plates, bars, pig iron, &c, but J K Merrott, of Melbourne and Sydney, in respect of screws, nuts, bolts and accessories.
239 Great Britain, patent no @,656 to R J Badge, 17 October 1857.

the masonry.[240] Later in the year a simpler design developed by W H Griffiths relied upon the forcing apart of the socket, but not upon the incorporation of a nut or the use of any complicated geometry.[241] Another type, of 1907, used a socket of which the inner part only was of soft metal, so the expansion would not damage the material of the wall.[242] The same inventor, H B Newhall, in 1909 developed a further type in which the pieces forming the socket had circumferential ridges around the outer face, to create a ratchet-like profile to lock against the masonry.[243] There many other inventions, of which few were probably brought into commercial use, especially given that a less elaborate model now supervened

In 1911 J J Rawlings patented a screw socket which was distinguished by its extreme simplicity, containing no metal parts and no complicated shapes. Strips or rods of material such as jute, hemp, asbestos, cardboard, or leather were to be arranged in a cylinder and loosely held together with an adhesive or a fabric sleeve. The cylinder was put into a pre-drilled hole, and when a screw was turned in it would cut its own thread and press the rods of material outwards, breaking the adhesive bond or the sleeve in the process.[244] The material actually used at this stage, according to the company history, was hemp.[245]

Further patents from 1924 onwards were taken out by Rawlings jointly with the Rawlplug Co Ltd. One improvement of 1925 provided for a lubricant such as graphite, within the fibre plug.[246] A further improvement of 1927, which seems to have originated with the American arm of the company, the Rawlplug Co, Inc, was to improve the durability of the fibre. Coagulated blood albumen was used as the adhesive, and materials such as resin and sulphur were added 'to render the plug resistant to moisture, to act as a preservative or antiseptic, and to exert a gripping action between the plug and the wall of the hole'.[247] In 1928 patents was taken out for indenting the outer surface of the cylinder to improve its grip,[248] and for providing a rudimentary thread at the top of the plug, to more readily receive coach screws &c.[249] What was probably a later improvement, for it is not mentioned in these earlier patents, was to twist the fibre itself in a spiral, such that the individual fibres would not be cut by the screw.[250]

After twenty years the Rawlplug was in worldwide use.[251] Indeed it was established in Australia well before this, for R F Higgs & Company of Sydney were advertising in 1927 as the Australian agents, not only of the standard fibre plug, but also of the 'Rawlplug Bolt Anchor' in which a bolt head is inserted into a hole in a hard material,

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240 Great Britain, patent no 5,344 to D W Bennett, 4 March 1902.
241 Great Britain, patent no 14,677 to W H Griffiths, 1 July 1902.
242 Great Britain, patent no 26,512 to H B Newhall, 30 November 1907.
243 Great Britain, patent no 8,571 to J W Mackenzie (communication of H B Newhall), 8 April 1909.
244 Great Britain, patent no 22,680 to J J Rawlings, 14 October 1911.
245 H A J Lamb et al, *Modern Fixing Practice* (London 1936), p 129.
246 Great Britain, patent no 257,303 to J J Rawlings and Rawlplug Co Ltd, 28 March 1925.
247 Great Britain, patent no 306,203 to J J Rawlings and Rawlplug Co Ltd (communication of Rawlplug Co Inc), 28 November 1927.
248 Great Britain, patent no 323,581 to J J Rawlings and Rawlplug Co Ltd, 18 October 1928.
249 Great Britain, patent no 323,583 to J J Rawlings and Rawlplug Co Ltd, 20 October 1928.
250 J Lamb et al, *Modern Fixing Practice*, p 130.
251 J Lamb et al, *Modern Fixing Practice*, p 130.

such as concrete, and is held in place by a conical ring of chilled iron, which digs into the side of the hole when tension is applied to the bolt.[252] By about 1936 D & W Chandler were selling Rawlplugs, though the bolt anchor is not mentioned.[253] The dating of this and other types is slightly problematic. The company history would have us believe that Rawlings's first plug was of metal, consisting of four sections of stamped brass, impressed with the rudiments of a thread, which could be inserted into the hole while folded together, but would expand under the action of the screw.[254] If this is true, it is not reflected in the patents, for it was in 1924 that Rawlings, jointly with the Rawlplug Co Ltd, first patented a metallic version. It was a cylinder of soft metal, shaped so that it would similarly break into a cluster of rods as a screw was forced into it.[255] Another scheme of 1926 for tubular metal sockets for screws and nails, patented in 1926, departs substantially from the basic rawlplug concept, and may or may not have been put into production.[256]

Despite the fact that there were many other inventions in the field, the rawlplug patents were so varied and extensive that it must at first have been very difficult for any competition to establish itself. But as these patents successively expired (normally after fourteen years) other makers could challenge the monopoly. In Australia the main rivals were probably the 'Sebco' anchors, marketed as 'Dryvin' for nails, 'Loxin' for bolts, 'Tampin' for machine screws or bolts, and 'Scruin' for wood screws. By 1937 they were being adverised by McPherson's of Melbourne,[257] though in 1949 they were, rather oddly, advertised in the British General Electric Co's Australian catalogue, together with at least some of the Rawl products.[258] According to the Sebco company their products were tested in the 1930s by 'a Commonwealth Government department', after which they were widely adopted by contractors.[259] In the 1950s these products were marketed by Ogden Industries, the proprietors of Lockwood products.[260]

j. ironmongery

Ironmongery was overwhelmingly imported from Britain during the nineteenth century, with the exception of some varieties of nails, and some simpler blacksmith's items like strap hinges. It is impossible to deal with the full range of such imported

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252 C E Mayes, *The Australian Builders & Contractors' Price Book* (9th ed, Sydney 1927), advertisement p 5.

253 Chandler, *Catalogue 48* [c 1936], p 26.

254 J Lamb et al, *Modern Fixing Practice*, p 130.

255 Great Britain, patent no 178,680 to J J Rawlings and Rawlplug Co Ltd, 18 March 1921. A related patent for a bolt anchor is no 249,922, to J J Rawlings and Rawlplug Co Ltd, 31 December 1926.

256 Great Britain, patent no 280,987 to J J Rawlings and Rawlplug Co Ltd, 24 July 1924.

257 McPherson's Proprietary Limited, *Catalogue for Engineers & Industrialists* (Melbourne 1937), pp 251-2.

258 British General Electric Co. Pty. Ltd., *B.G.E. General Catalogue* (4th ed, Sydney 1949), pp 400-402.

259 *'Sebco' Modern Masonry Anchoring Methods* (Huntingdale [Victoria], no date, c 1950s), passim.

260 F W Ware & W L Richardson [eds], *'Ramsay's Architectural and Engineering Catalogue* (3rd ed, Melbourne 1954), § 23/1.

goods, though some have been touched on already, and others, like grates and ventilators, will be considered in another place.

So scarce was iron in the earliest years that its use was avoided wherever possible, and James Tucker described door and window panels hung on wooden pins.[261] Elsewhere solid window panels were hung from the top with strips of greenhide.[262] Later, many items were custom made by local smiths, rather than imported from British manufacturers. An elegant form of casement window stay appears at 'Coryule', Drysdale, Victoria, of 1849-50, and seems to have been made locally, for there is no contrary indication in the drawings of the architect, Charles Laing. At the base of the sash is a quadrant consisting of two flat bars, one on top of the other. The lower bar marks the limit to which the sash can swing, but the upper one is slightly shorter and is sprung so as to pop up on a low angle when the pressure of the sash is removed from above. When the sash is as far open as the lower bar permits, it has passed the end of the upper bar, which is released and rises up to prevent the sash from swinging back again, in the manner of a ratchet. However a little pressure on the lower bar will allow the sash to pass over it again and to be closed.

By about the 1870s various brands of stays for transom lights had appeared, as has been discussed above. We do not know the nature of the window fasteners being promoted at the beginning of the twentieth century, though there was active competition between them. In 1901 Lascelles & Co managed to exhibit their 'Patent Safety Window Attachment' at a meeting of the Royal Victorian Institute of Architects. H C Crouch, the Borough Engineer of Kew, had his own patent on 'Improvements in Window Fasteners' and possibly demanded equal treatment, because members were now invited to the Institute's rooms to inspect his invention.[263] By the 1950s Arens window controls, an English product, were on sale in Australia. They were typically operated by turning a handle distant from the window and in a location convenient for the user. The turning motion was transmitted to 'a tightly compressed galvanised inner spring coiled round a tinned steel cable' which moved within a square or round casing and connected to the operating mechanism of the window.[264]

Some larger hinges for industrial or farm purposes were made locally, but most were imported. There were two traditional ways of making hinges, the wrought iron and the pressed rivetted, both of which were made early in the century by (for example) James Thornton.[265] In the welded wrought iron hinge a piece of wrought iron would be bent over at the knuckle and welded together to create each hinge flap. In the pressed rivetted hinge the knuckle was formed by rivetting rather than welding. The newer development from 1840 was the patent wrought iron hinge, which was first developed in America, though it is possible that it was independently reinvented in Britain. The iron was cut with the pieces to form the knuckle projecting as tongues,

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261 Tucker, *Ralph Rashleigh*, p 113.

262 Judith Wright, *The Generations of Men* (Melbourne 1959), p 20.

263 Royal Victorian Institute of Architects, Records, Box 8, scrapbook, MS 9454, Manuscripts Collection, State Library of Victoria.

264 *Ramsay's Catalogue* [1954], § 33/.2.

265 Jas. Thornton & Son, *Jas. Thornton & Son ... Manufacturers of Wrought Iron Hinges, &c* [single sheet flier, no date [?c1810]].

and these were then forced into appropriately shaped dies to bend them over. Thus the hinge relied neither upon welding or rivetting, but upon the strength of the bent-over iron.[266]

T & C Clark appear to have been the major, if not the only manufacturers under this patent. A small Singapore-made house of the early 1850s[267] had casement sashes carried on two inch [50 mm] butt hinges inscribed in script - and, oddly enough, on the face in contact with the timber -

T & C Clark & Cº Patent
№ 200 2 in

It is possible either that the hinges came from Singapore with the house, or that they were bought in Melbourne. A hinge on a small stone building at Barkers Creek, Victoria, probably about 1870 in date, is:

CLARK & CO BEST PATENT
№ 333

In 1879 they showed their products at the Sydney Exhibition,[268] and in 1890 Clark's butt hinges were specified for 'Benvenuta', an expensive Melbourne house.[269] Clark hinges have also been found in the United States,[270] as have one marked 'M.T.M.' and a number of 'Baldwin' or 'Baldwin / Patent.'[271] Baldwin, Son, & Co was another London manufacturer of hinges, as well as hollow ware, which exhibited at Sydney.[272] Other special hinges in Britain included Redmund's patent, with rising butts (that is, the hinge divisions are not horizontal but slightly sloping, so that the door rises slightly as it opens and, and when released tends to close again); Collinge's patent spherical hinge; and Smith's, Redmund's and Gerish's, two-way hinges for swing doors.[273]

Items such as sprung sash balances have already been dealt with in the context of joinery, and any number of other components could be arbitrarily named, but it is worth mentioning the 'Whitco' window fittings and 'Whitfast' fasteners which were especially prominent after World War II. The Whitco fitting was attached to the top and bottom of a casement sash, and took the place of both hinges and stays. An equivalent fitting was supplied for hopper sashes. These were manufactured by the company in Brisbane, which had agencies in all the Australian states, as well as New

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266 F E Martineau, 'Patent Wrought-Iron Hinges', in Samuel Timmins [ed], *The Resources, Products and Industrial History of the Birmingham and Midland Hardware District* (London 1866), pp 610-611.

267 The cottage was one of four which were put up as outbuildings behind a row of prefabricated iron houses in Brunswick Road, Brunswick, and the sash is now held by Andrew Muir: inspected 2001.

268 Sydney Exhibition 1879, *Catalogue of British Section*, p 109.

269 W S Law, 'Specifications of Residence Drummond St. Carlton for Mrs. L. Abrahams' (Melbourne 1890), p 30.

270 Donald Streeter, 'Early American Wrought Iron Hardware: H and HL Hinges, together with Mention of Dovetail and Cast Iron Butt Hinges', *APT Bulletin*, V, 1 (1979), p 44.

271 Streeter, 'American Wrought Iron Hardware', p 46.

272 Sydney Exhibition 1879, *British Section*, p 107.

273 John Gwilt [revised Wyatt Papworth], *An Encyclopaedia of Architecture* (London 1899 [1842]), p 721, §§ 2258b - 2258d.

Zealand and South Africa.[274] By 1954 it was stated that the fittings were manufactured in Australia for sterling currency areas, under licence from the Vincent Whitney Co of California.[275] It is unclear whether the Whitfast window fittings of New Zealand, referred to above, are attributable to the same source. A rival casement stay was the Agco, made in Australia by A F Agnew Pty Ltd.[276]

Door furniture, like so much else, was predominantly British in origin. Whitehouse's door furniture as listed in Mayes's price book of 1862, included knobs, finger plates and other items which came in:

china, white or black
ivory tint
gold scroll
gilt and flowers
plain gold lined
ebony
brass
imitation oak
fancy crystal glass
ditto amber cut [277]

The top of the range was the furniture of the E S & A Bank head office in Melbourne, of 1883-7, which came from Pugin's favourite suppliers, Hardman & Co of Birmingham.[278]

At the National Mutual Life Association building of 1890-3 'Hills Patent Flush Bolts'; were specified for the swing doors, and 'Hills Patent Bolts' for the office windows[279] - presumably made by the same Hill as the transom light fasteners in the specification. The *espagnolette* or *espagnolet*. is a closing device dating back at least to the seventeenth century, consisting of a single rod which rotates on its axis to lock in two catches, one at the top and one at the bottom of the door.[280] In 1815 espagnolets were being sold by the London ironmonger W Farlar for use on the then fashionable French windows; 'By means of this fastning [*sic*], the possibility of the rain driving in is completely prevented; and is not only useful but ornamental when affixed to those windows'.[281] Gwilt mentions the espagnolette as being French in origin, but 'much improved in its manufacture here.[282]

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274 F Wentworth & S L Richardson [eds], *Ramsay's Architectural and Engineering Catalogue* (Melbourne 1949), § 33/6.

275 *Ramsay's Catalogue* [1954], § 33.8.

276 *Ramsay's Catalogue* [1954], § 33.10.

277 Mayes *Price-Book* [1862], p 110.

278 Robyn Riddett, 'A Building "Worthy of the City"', in U M de Jong [ed], *W W Wardell: the Architect and his Era* (Geelong [Victoria] 2000), p 114.

279 Wright, Reed & Beaver, 'Specification for National Mutual Life', pp 20, 25.

280 Papworth, 'Espagnolette Bolt'; also Carlos Moreno, *De las Viejas Tapias y Ladrillos 4* (Buenos Aires 1995), p 202. Confusingly, as reported by Papworth, espagnolettes were shown at the Paris Exposition of 1855 under te name *crémones.*

281 W Farlar, 'Farlar's New Steam Kitchen Range, Improved Oven, and Self-Oiling Smoke Jack; together with an Improved Warm Bath, &c' [sheets extracted from a publication] (London 1815), p 4 .

282 Gwilt, *Encyclopaedia of Architecture,* [1899] p 721, § 2259.

The *espagnolet* came to be generally replaced by the *crémone,* in which the rotation of a central handle, instead of operating a single rod which turned catches at the top and bottom, operated two rods which extended as bolts at top and bottom, pulling one of them up and one of them down simultaneously. The mechanism is described as 'bascule', 'swipe' or 'seesaw'.[283] They were exhibited in 1851 by Jaquemart Brothers of Charleville, France, as 'cremons [*sic*] a new shutting piece for windows'.[284] Chabat describes them as 'remplaçant aujourd'hui l'*espagnolette*',[285] and they came to be widely used on the Continent for securing ordinary domestic doors, appearing as standard items in a French catalogue of the 1890s.[286] An improved type was invented in France by one Maury, who called them *serrures-crémones,* which shared the characteristics of a crémone and a lock. This version had the rod or bolt within a tube, so that its movement was not visible.[287] In Britain the name *crémone* was sometimes anglicised to 'cremorne'.[288] At the National Agricultural Show in Melbourne in 1887 the ironmongers Cozens & Harvey exhibited what is clearly the same device, for which they held the patent: an easily turned handle at a convenient height would simultaneously withdraw the bolts at the bottom and top of the door. According to Cozens & Harvey, these were now specified by the [Victorian] government for use in all public buildings.[289] An even simpler version, the 'Scapex' automatic panic bolt, was on sale in Australia in 1917, and had a horizontal bar which, when pressed, would release the bolts at top and bottom,[290] and this is still in use for emergency exits today.

The main types of door springs were Cartland's[291] and Smith's,[292] both Patent Double-Action, from the 1860s on, and Climax and Whitehouse's, somewhat later.[293] The Climax brand appears at 'Mount Rothwell' homestead of 1872, as:

[crest]
[upward arc:
CLIMAX
]
TRADE [very small 'CL' monogram] MARK

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283 Wyatt Papworth [ed], *The Dictionary of Architecture* (6 vols, London 1853-1892), sv 'Espagnolette Bolt'.

284 Great Exhibition, 1851, *Catalogue,* III, pp 1189-1190.

285 Chabat, *Dictionnaire des Termes,* p 380, with illustration.

286 Comptoire de l'Industrie, L Laurent, Carrée & Binoche (successors to L Laurent & Carrée), *Extrait du Tarif Articles du Bâtiment (No 14),* bound with Comptoire de l'Industrie, L Laurent & Carrée, *Tarif des Fournitures Générales pour l'Industrie* (Reims, no date [c 1890]). Although this price list is undated it has an item to be completed, 'Le ... 189...'.

287 F Monmory, 'Serrure', in E-O Lami, *Dictionnaire Encyclopédique et Biographique de l'Industrie et des Arts Industriels* (8 vols, Paris 1881-1891), pp 180-81.

288 Henry Hope & Sons Ltd, *Henry Hope & Sons Ltd* (Birmingham 1912), p 62.

289 *Australasian Builder & Contractor's News,* 7 September 1887, p 268.

290 Colton, Palmer & Preston, *You are Secure with Us for Builders Hardware* (Adelaide 1917), p 106.‼

291 C B Mayes, *The Australian Builders' Price-Book* (Melbourne 1862), p 110. Cartlands still advertised in *The Australasian Handbook* (London 1906), pp xvi-xvii.

292 Laxton, *Builder's Price Book for 1863,* advertisements, no page. As late as 1892 'Smith's patent double action spring hinges and pivots' were specified at 'Boisdale', Victoria: Purchas, 'Estimate for Boisdale', p 12.

293 Charles Mayes, *The Australian Builders' Price-Book* (4th ed, Melbourne 1883), advertisements p xvii. For a diagram of the inner workings of a Climax, see G L Sutcliffe [ed], *The Modern Carpenter Joiner and Cabinet-Maker* (8 vols, London 1903), II, p 341.

PATENT

At Government House, Melbourne, of 1872-6, most of the springs are Smith's, but at the south entry of the ballroom they are:

WHITEHOUSE'S PATENT
EXTRA STRONG.

At 'Bon Accord', Dawson Street, Sale,[294] probably of the 1870s, they are simply:

WHITEHOUSE'S
PATENT

At 'Rupertswood', Victoria, of 1875, there are springs enigmatically branded

W & SON
IMPROVED
N1350

which seem to be original to the house, and may also be those of Whitehouse. The National Mutual Life headquarters in Melbourne, of 1890-3, was specified to have thirty '"Norton" check door springs, No 1'.[295] In 1954 William Newman & Sons of Melbourne were marketing the 'Monarch', 'Britannic', No. 600' and 'Avon' floor springs, of which only the last appears to have been made in Australia.[296]

The pneumatic door closer, located at the top of the door, is a later development, but by 1880 Frederick Braby of London was selling the patent 'Lancaster' pneumatic closer. A closer at 'Wiridgil', Camperdown, which may be original to the renovations of 1902, is labelled

THE NORTON DOOR CLOSER AND SPRING

In 1917 the Russwin Patent Door Check and Spring, which has rather the appearance of a pneumatic closer, was available in Adelaide.[297] By about 1930 Chandler's of Melbourne were selling the Briton and the Yale.[298] By the 1950s the 'Briton' patent liquid door check and spring was being manufactured locally by William Newman & Sons at their factory in Footscray, Melbourne.[299] In about 1900 Frederick Ogle of Melbourne was advertising Irving & Hanlon's 'Great "Grippo" Door Fastener', which was the type in which a lever pressed down with the foot would engage with the floor and prevent the door from closing. It had apparently been used already in a number of town halls and public buildings.[300] This idea relates to that of the London ironmonger W Farlar, who in 1811 was selling a 'Rack, or self-Acting Bolt for

294 Inspected 2005.
295 Wright, Reed & Beaver, 'Specification for National Mutual Life', p 21.
296 *Ramsay's Catalogue* [1954], § 33/7.
297 Colton, Palmer & Preston, *You are Secure with Us*, p 106.
298 D & W Ltd, Chandler, [catalogue], (no date [c 1930]), p 106..
299 *Ramsay's Catalogue* [1954], § 33/7.
300 Ogle's broadside is reproduced in New Century Antiquarian Books, *Catalogue no 5, Aspects of Australia* (Melbourne 2003), pp 2-3.

Folding Doors.' 'By means of this fastening, Doors, of any dimensions, may be momentarily thrown open, and in shutting, instantly fasten themselves.'[301]

Another iron building component was a form of stair tread, designed to resist both wear and fire. One of the entrants to the Brisbane Treasury competition in 1883 announced that he proposed to build all the staircases on 'Hawksley's patent system'.[302] These 'patent treads' are mentioned in Gwilt's *Encyclopaedia* as being used in railway stations, warehouses and other heavily trafficked buildings, but they are not really explained.[303] The probability is that the metal framed treads used in the major staircases of the Treasury building as erected are in fact of the Hawksley type. So were those of the now demolished Australian Property and Investment Co [APA] building in Melbourne, of 1889.[304] Also in 1889 the Yencken Building in Melbourne had a main staircase with treads of bluestone and risers consisting of glass lights framed in cast iron, doubtless carried on an iron structural frame.[305] By 1904 Hawksley treads were apparently manufactured by the St Pancras Ironwork Company, of London.[306]

In 1853-4 'cast iron fluted plates' 3/4 inch [19 mm] thick were imported from England, probably from the Horsley Company, to cover the floor of a number of heavily trafficked areas in the Sydney Mint.[307] Cast iron floor tiles became were to become common in industrial buildings, such as the malt house of Haussen and Catchlove's Brewery, Adelaide, of 1868.[308] By the mid-twentieth century the Cheka Industrial Tile Co made 'Cheka' steel tiles for laying into a screed on a concrete floor, protecting it from impact and erosion,[309] and soon after Ogden Industries were making 'Stelcon' industrial flooring, of a similar nature.[310] In a linked area of activity, Gatic (Australia) was the most prominent maker of manhole covers and gratings.[311]

Stable fittings formed a complete category on their own. As early as 1862 the St Pancras Iron Work Company of Old St Pancras Road, London, was advertising in Mayes's *Australian Builders Price-Book* a range of products from iron houses to fireproof safes, but giving prominence to stable fittings, enamelled mangers and patent racks.[312] The firm showed its fittings at Sydney in 1879,[313] and this was the

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301 W Farlar, 'Farlar's New Steam Kitchen Range, Improved Oven, and Self-Oiling Smoke Jack; together with an Improved Warm Bath, &c' [4 pp single folded sheet, removed from a publication], (London 1815), pp 2-3.

302 'New Public Offices: Brisbane: Report Accompanying Plans: Bearing Motto', 30 November 1883 (held by Historic Buildings Branch, Brisbane), p 6.

303 Joseph Gwilt [ed Wyatt Papworth], *An Encyclopædia of Architecture* (London 1899 [1842]), §2180 p 668.

304 *Australasian Builder and Contractor's News*, 20 April 1889, p 379.

305 Hyndman & Bates, 'Warehouse for E L Yencken', p 20.

306 J T Rea, *How to Estimate: being the Analysis of Builders' Prices* (London 1904 [1902]), p i.

307 Archives Office of New South Wales 2/763, p 4, cited in Fiona Starr et al, *The Royal Mint, Sydney (1853-1926): a Survey of the Documents Associated with the Mint* (Sydney 2001), p 17.

308 E & R Jensen, *Colonial Architecture in South Australia* (Adelaide 1980), p 380, citing *South Australian Register*, 20 June 1868.

309 *Ramsay's Catalogue* [1949], § 28/7.

310 *Ramsay's Catalogue* [1949], § 28/7.

311 F W Ware & W L Richardson [eds], *Ramsay's Architectural and Engineering Catalogue* (Melbourne 1949), § 28/14; *Ramsay's Catalogue* [1954], § 28/24.

312 Mayes, *Australian Builders' Price-Book* (1862), p 154.

313 Sydney Exhibition 1879, *Catalogue of British Section*, p 315.

brand normally used in Australian stables of quality,[314] but T & C Clark of Wolverhampton (mentioned above as makers of hinges) and Musgrave & Co of Belfast, also produced stable fittings, which were exhibited at Sydney.[315]

k. locks

Locks and latches underwent extensive change during the late eighteenth and early nineteenth century, but Australia would have seen many of the more primitive forms before the improvements of Bramah, Chubb and others made themselves widely felt. Locks with fixed wards, quite easily picked, were in use even in banks, up to the mid-nineteenth century.[316] Such descriptions and references as survive are rarely sufficient to indicate the precise lock type, but they convey a general impression. In 1790 the prefabricated hospital sent to Sydney included '3 Brass plate copper-warded Spring Locks, 2 do. Latches, 4 Brass plate Spring Bolts and 1 Brass copper-warded Padlock with 6 keys'.[317] A local specification for a schoolhouse in 1839 calls for a 'ten inch [250 mm] rim lock with Scotch springs complete' for the main door, and eight inch [200 mm] locks of the same sort for the other doors.[318] These were probably locks of the older generation. Early rim locks tend to be large, in heavy iron cases, unbranded, or with relatively unknown brands such as:[319]

[upper half of circle:
MORETON & LAIDLEY
]
[lower half"
WOLVERHAMPTON
]

The evolution of the newer locks began with Barron's patent of 1774, in which two tumblers were kept in place with a spring, and a key cut in steps of the two appropriate radii would raise them to the precise height to bring the studs in line and allow the key to turn. The upper edge of the bolt was notched so that a picklock would be unable to tell whether either tumbler was lifted too high.[320] The principle of the overlift, whereby the lock would not open unless the tumbler was raised to the

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314 *Australasian Builder and Contractor's News*, 21 May 1887, p 31; 2 July 1887, p 125.

315 Sydney Exhibition 1879, *Catalogue of British Section,* pp 302, 313.

316 John Chubb, *On the Construction of Locks and Keys* [offprint from the *Proceedings* of the Institution of Civil Engineers, vol X] (London 1850), pp 9-10.

317 Robert Irving, 'The First Australian Architecture', (MArch, University of Sydney 1975), p 487, and Peter Bridges, *Foundations of Identity* (Sydney 1995), p 16, quoting Colonial Office 201/4, f 60 (meaning Colonial Office series 201 at the Public Record Office, London: despatches from New South Wales, book or box 1, folio or page 60).

318 [Joseph Burns], 'Specification of sundry works required to erect and complete a School-house, in connection with the Presbyterian Church, Melbourne, according to the accompanying plans', in Michael Cannon [ed], *Historical Records of Victoria*, III (Melbourne 1984), pp 517.

319 At 'Stratford Lodge',. Metcalfe, Victoria, inspected 2004

320 Chubb, *Locks and Keys*, p 11. See also J C Tildesley, 'Locks and Lock-Making', in Samuel Timmins [ed] *The Resources, Products and Industrial History of the Birmingham and Midland Hardware District* (London 1866), p 82

exact height,[321] was a vast improvement, and was retained in Bramah's and Chubb's subsequent locks. In 1784 Joseph Bramah patented his more famous lock, in which the key was given what was described as a combination of 'endway pushing and revolving motion' instead of the simple rotatory action used in Barron's lock.[322] In 1790 Thomas Rowntree patented a much more elaborate version of the tumbler lock,[323] but it seems to have had little impact.

In 1818 Jeremiah Chubb patented what became known as the 'detector lock', which recorded any attempt to pick it, and which evolved through at least five successive patents by Jeremiah Chubb, Charles Chubb, Ebenezer Hunter and John Chubb, between 1818 and 1847.[324] In its last patented form it had six distinct double-acting tumblers, and a very distinctive detector mechanism. It also had the advantage that an almost infinite number of distinctively keyed locks could be produced, and grouped with master keys as required.[325] By 1851 their rim locks were available in Norman, Gothic and Elizabethan styles.[326] Chubbs were later to establish a company in Australia, but it was more concerned with safes than with locks, as will appear below.

In Australia, however, most of these improvements counted for little. All locks were imported, at first from Britain, but some from America towards the end of the century. In domestic work they were overwhelmingly the products of London firm of James Carpenter, or his imitators H & T Vaughan. Carpenter's first patent was taken out with John Young of Wolverhampton, in 1830, for a lock in which the action of the latch was vertical rather than horizontal, but the patent subsequently became the sole property of Carpenter so far as rim locks were concerned, while Young retained the rights for mortice locks. Carpenter later made various improvements which made for smoother operation and greater durability.[327] The Carpenter locks were soon known in Australia, and in fact they were manufactured mainly for the export trade, as the British market continued to favour rim locks with the older horizontal action.[328] In Australia the Carpenter type continued in use into the twentieth century. They are branded with a circular brass seal on the face, a typical one reading:[329]

WR
Nº 60
JAˢ CARPENTER
PATENTEE

The number 60 is one of the standard sizes, while the monogram WR, for William IV, continues to appear throughout the century, and presumably relates to the date of the patent rather than the manufacture of the specific lock. Rather surprisingly, some

321 Charles Tomlinson, *Rudimentary Treatise on the Construction of Locks* (London 1853), p 68.
322 Chubb, *Locks and Keys*, pp 11-13; Tildesley, 'Locks and Lock-Making', p 83.
323 Tomlinson, *Construction of Locks*, pp 50-52.
324 Chubb, *Locks and Keys*, pp 13-16; Tildesley, 'Locks and Lock-Making', pp 83-4.
325 Tildesley, 'Locks and Lock-Making', pp 83-4.
326 Great Exhibition, *Catalogue*, II, p 663.
327 Chubb, *Locks and Keys*, p 20; Tildesley, 'Locks and Lock-Making', pp 84-5.
328 Tildesley, 'Locks and Lock-Making', p 87.
329 There are innumerable examples, including two rim locks at 'Reedy Creek', Broadford, Victoria, and others at Blood's Cottage, Box Hill, near Melbourne.

Carpenter locks have been found which are marked 'patent expired', and which seem to date from the 1890s.[330]

Mayes's price book lists only two varieties of rim lock, 'Carpenter's Patent Rim Locks' and 'Imitation Ditto',[331] and there can be little doubt that H & T Vaughan were the principal imitators. Vaughan's locks were somewhat cheaper, but in sizes exactly corresponding to those of Carpenter. That there were some variations of their own is suggested by the appearance in the men's hut at 'Werribee Park', Victoria, of a lock branded 'H & T Vaughan No. 60A Real Patent'. In fact they claimed to be 'the only Firm in the world who make warded wrought-iron Locks by machinery, thus giving them an exactness and finish unobtainable by hand labour.'[332] In 1913 Carpenter's and Vaughan's were still being sold in parallel, at 4s.6d. and 2.6d. respectively for the six inch size.[333] Another lock on display at Werribee Park is 'Starkey & Sons Makers No. 60A Real Patent',[334] while at the Goornong police Station is a lock similarly branded

No 60 REAL PATENT
STARKEY & SON MAKERS

This suggests that Starkey's was a third company which fell into line with the Carpenter classifications (and probably the Vaughan variations as well). There even seems also to be a generic brand, two specimens of which have been identified:[335]

[upward arc
SPECIAL
]
LOCK
[central knob]
60A

The brand of Carpenter & Tildesley presents a problem, for it is not accurately dateable. James Carpenter died in 1844, and the business passed to his son-in-law James Tildesley, who is said to have continued to manufacture the same type of lock, bearing a seal marked 'Carpenter's Patent J. Tildesley Licensee'.[336] However it is not as simple as that, for no such seal has been identified in Australia, whereas for most of the century Carpenter's name keeps appearing with no reference to any licensee. Tildesley's name does appear in some cases, but it is as an apparent partner, 'Carpenter & Tildesley', or in his own right. It is known that a patent was taken out by Tildesley & Sanders, of Willenhall and Wolverhampton, in 1841.[337] It is clear that in fact the brands overlap chronologically, and in 1851 the firm of Carpenter &

330 At 'Craigmoor', Hill End, New South Wales, possibly after 1890; 'Pastoria', near Kyneton, in an extension of the 1890s, inspected 2002; and 4 Seaby Street, Stawell, Victoria, on a door recycled from elsewhere.

331 Mayes, *Price-Book* [1877], p 123.

332 Sydney Exhibition 1879, *Catalogue of British Section*, p 192.

333 James Moore & Sons Pty. Ltd., *Price List 96 August 1913* (Melbourne 1913), p 4.

334 Information from Paul Roser, 2000.

335 One, inspected in 2004, is at 8 Glenelg Street, Portland, a somewhat primitive cottage believed to date from 1853: the lock, with its white porcelain handle, seems likely to be later. Another (like the Vaughan lock referred to) was on the Men's Hut, 'Werribee Park'.

336 D L Anderson, 'A Carpenter Lock from Minnesota's Historic Fort Snelling', *APT Bulletin*, IX, 4 (1977), pp 67-8, ref Robert T Trump, 'The Carpenter-Type Lock', *Antiques*, LXVI, 6 (1954).

337 Chubb, *Locks and Keys*, p 20.

Tildesley of Willenhall, near Wolverhampton, showed both Carpenter & Co and Tildesley locks, together with others for which they must have held rights or agencies - Sanders' and Baillies' patent locks, and Rock's patent Gothic Case locks.[338] But the situation is by no means simple, for in an 1864 directory dozens of firms in Willenhall, other than Carpenter and Tildesley of New Road, are listed as makers of locks, keys and related products, and many Tildesleys are listed, including two firms of key stampers, one brass and iron founder, and an iron and steel merchant.[339]

'Kolor' homestead in western Victoria, of 1868, has a Carpenter & Tildesley rim lock on the front door which appears to be original. In the same general area the house 'Gringegalgona', of 1872, carries locks by Carpenter, by Tildesley, and by the partnership. The original rim lock of the front door was labelled 'Carpenter & Tildesley / Manufacturers'. The mortice locks of the ground floor reception rooms are branded on the face plate (ie on the fore edge of the door)

JAMES
[in upward arc
TILDESLEY
]
[in downward arc
DOUBLE HAND
]
LOCK

whereas the bedroom rim locks are of the conventional James Carpenter type. A 'Tildesley Double Hand Mortice Lock' is also found in the drawing room of 'Mount Rothwell', of about 1872-3. Other examples by Carpenter & Tildesley tend to be later than this,[340] though it is difficult to be sure, given that old stock may be used, or locks even recycled. However the Carpenter & Tildesley door lock of the court house at Bathurst, New South Wales, can reasonably be presumed to date from the origin of the building in 1880. The correlation between these major brands seems to have ceased by 1917, when Colton, Palmer & Preston of Adelaide offered a Carpenter No 47 'English Pattern Draw Back Lock' of a different form, and two Vaughan locks with elaborate arabesque decorative cases, and a 'Double Handed Drawback Lock and Night Latch.[341]

Another brand of mortice lock, used at the Melbourne headquarters of the E S & A Bank in 1883-6, is

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338 Great Exhibition, *Catalogue*, II, p 664.

339 What is described as *Jones Iron District Directory 1864-5* is indexed on a web site, http://freespace.virgin.net/m.harbach/1864indWill.html, viewed 13 September 2001. Carpenter & Tildesley, oddly, appear as lock and curry comb manufacturers.

340 For example, the front door rim lock at 43 Mary St, Hawthorn, of 1896, and in the 1890s wing of 'Baroogah' homestead, New South Wales.

341 Colton, Palmer & Preston, *You are Secure with Us*, p 38.

45

[upward arc of lettering:
GIBBONS
]
MAKER
[downward arc of lettering:
WOLVERHAMPTON

SECURE
4
LEVER

The locks of Geo Harley & Company, of the Diamond Lock Works Wolverhampton, established in 1830, have yet to be identified in Australia, but were exhibited in Sydney and Melbourne in 1879 and 1880 and bore the brand:[342]

TRADE MARK
[horizontal diamond containing:
G. H. & Cº
]

Another brand, on a simple cupboard lock of about 1890, is that of B & S H Thomson of Birmingham.[343]

By the 1870s Chubb, Hobbs and Yale locks were on sale in Australia.[344] In 1875 the Bank of Australasia in Collins Street, Melbourne, had a safe or strong closet fitted with two Chubb patent locks, each valued at thirty-five shillings, and strong room gates with '"Chubbs" very best patent protector locks' worth forty shillings, with case-hardened steel cover plates fixed over each face to protect them.[345] In 1891 'Benvenuta' had Chubb six inch mortice locks throughout, except for Carpenter rim locks in the service areas, while the front door had a Yale latch plus an electroplated lock (for which the sum of 9 s 6 d was allowed).[346] In 1893 'Boisdale', Victoria, had a Yale latch, for which a cost of 10s. 6d. was allowed, in addition to three rebated mortice locks with brass furniture, seven 'best brass bushed' six inch mortice locks, and twenty-three Vaughan six inch rim locks.[347]

American imports are far less prominent than British in Australia, but there had been significant developments in the United States. Stansbury's lock, apparently developed in about 1810, was an effective modification of the traditional Egyptian type.[348] Yale's, somewhat later, bore a generic resemblance to the Bramah lock, and had two

342 Sydney Exhibition 1879, *Catalogue of British Section.*. p 184; Melbourne Exhibition 1880, *Catalogue*, II, p 318.
343 At 'Pastoria', inspected 2002.
344 Mayes, *Australian Builders' Price-Book* (1877), advertisements p vii.
345 Reed & Barnes, 'Specification of Work to be done and Materials to be used in making and fixing wrot Iron shelves and standards, also wrot Iron Safe with shelves and divisions for the Bank of Australasia, in Collins St. West, Melbourne' (Melbourne 1875), pp 5, 3.
346 Law, 'Specifications for Mrs. L. Abrahams', p 30.
347 Guyon Purchas, 'Estimate for New Residence and Stabling Boisdale Estate near Maffra Gippsland for A.M. Foster Esqre' (Melbourne 1892), p 18.
348 Tomlinson, *Construction of Locks*, p 83.

concentric cylinders, one working within the other, held together by pins passing through to the keyhole. A pin at the back of the inner cylinder fits into the bolt and moves it, when turned.[349] In Australia, rather as the Carpenter lock far outsold the more famous and sophisticated British locks which we have discussed, so most of those from the United States came from Russell & Erwin of Connecticut, rather than from more innovative locksmiths.[350] Of course the American Yale lock did in due course reach Australia and became, as it remains today, a market staple. A range of Yale night latches in the characteristically-shaped case, with an oval or circular knob, were available in Australia in 1917, together with a whole series of what seem to be imitations by Vaughan, branded 'H. & T.V.'[351]

In their 1875 catalogue Russell & Erwin actually offer what they call 'Carpenter pattern' rim locks, though the resemblance is only a loose one, as the elements on the face are quite differently arranged, especially the location of the seal (an eagle, rather than a coat of arms) towards the bottom left of the box.[352] Russell & Erwin rim locks have been found locally with the brand

[circle containing in upper arc
R. & E. MFG. CO.
]
[diamond registration mark in centre]
[and in lower arc
NEW BRITAIN CONN. U.S.A.
]

The use of a British diamond registration mark suggests that this was a line specifically aimed at the British or the colonial market, and the date indicated by it is 9 May 1878, providing a *terminus ante quem* for the locks.[353] Later examples, probably of about 1900, have been found with the initials 'RI' embraced between the giant 'C' and small 'O' of 'Co',[354] thus

[large letter C containing:
RIO
]
[horizontal rectangle containing:
USA
]

---

349 Tomlinson, *Construction of Locks*, pp 83-4.

350 For which see Russell & Erwin, *Illustrated Catalogue of American Hardware of the Russell and Erwin Manufacturing Company* (New Britain [Connecticut] 1875), facsimile with an introduction by L H Nelson, 1980.

351 Colton, Palmer & Preston, *You are Secure with Us*, p 36.

352 Russell & Erwin, *Illustrated Catalogue*, p 22.

353 Three of these are in a house at 5 Bowden St, Castlemaine, built in about 1870 but extended at various dates (inspected 005), and there is one on each of the front doors of two prefabricated houses of earlier date, one at 18 Douglas Street, Toorak, made by Robert Walker of Glasgow and put up in about 1853 (and recently restored); the other a house on the National Trust site at 399 Coventry Street, South Melbourne, attributed to Morewood & Rogers, and not original to the site (reported by Simon Reeves, 1997).

354 A rim lock in an outbuilding at 'Holey Plain', Victoria; another at 'Mount Rothwell', Victoria, not fixed in position (both inspected 2001), and a third on an internal door at 5 Bowden St, Castlemaine (inspected 2005).

In 1917 a Russell & Erwin rim lock on the Australian market, the 'SF', had an elaborately decorated bronzed iron case.[355]

American-type locks were introduced in Britain by Hobbs & Co, who took out various British patents in their own name. Hobbs's protector lock was related to the American locks of Day & Newell, but in 1852 he patented a lock of his own, would not open with the key in the hole. It was necessary to unscrew the stem of the key, leaving the business end within the mechanism, which could then be turned by a handle.[356] At the London exhibition of 1862 Hobbs offered three hundred guineas to anyone who could pick the lock, and nobody succeeded. Moreover he claimed that because the locks were made by machinery their prices were unprecedentedly low.[357] For the front door of a South Australian Bank in 1878 a prime cost of two shillings was allowed for 'one of Hobbs' patent night latch and 2 keys', and for the office drawers, five shillings each for '2 1/2 [?inch] Hobbs' patent iron locks with 2 keys'. In the cellar of 'Trawalla', Toorak, Melbourne, are two rim locks in very simple pressed steel cases,[358] branded:

[coat of arms]
BY APPOINTMENT
HOBBS & Co
CHEAPSIDE
LONDON
LEVER
MACHINE MADE

For some reason, however, Hobbs's locks were never nearly so prominent in Australia as they were in Britain.

Another manufacturer was Archibald Kenrick & Sons of West Bromwich. The original Archibald Kenrick had manufactured cast iron from 1791 and hollow ware from 1805, but had not been involved in locks at all.[359] At the Sydney and Melbourne International Exhibitions of 1879 and 1880, and then the Centennial Exhibition, Kenrick & Sons had shown only tinned and enamelled ware, and household castings,[360] By the early twentieth century had become lock manufacturers. A rim lock with their distinctive brand is found at 'Oak Dene', Kyabram, Victoria, of 1910 [?]:

[upward arc of lettering:
ARCHIBALD KENRICK & SONS LIMITED

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355 Colton, Palmer & Preston, *You are Secure with Us,* p 36.

356 Tomlinson, *Construction of Locks,* pp 99-102.

357 F W Laxton, *Laxton's Price Book 1863* (London 1863) pp 99-102.

358 Inspected April 2003.

359 William Kenrick, 'Cast Iron Hollow-Ware, Tinned and Enamelled, and Cast Ironmongery', in Samuel Timmins [ed], *The Resources, Products and Industrial History of the Birmingham and Midland Hardware District* (London 1866), p 107. At the Great Exhibition the firm showed a miscellany of cast iron tanks, pipes, pulleys, &c, but no locks: Great Exhibition, *Catalogue,* II, p 637.

360 Sydney Exhibition 1879, *Catalogue of British Section.*. p 112; Melbourne Exhibition 1880, *Catalogue,* II, p 341; Centennial Exhibition, *Official Record,* pp 467, 735, 963. E G Robertson, *Adelaide Lace* (Adelaide 1975), p 193, illustrated a door knocker branded 'A Kenrick & Sons', with a diamond registration mark which he could not decipher with certainty, but thought to be of 12 January 1854. That date is possible, as the firm was founded in 1791.

]
[circle containing at the centre an isosceles triangle, against the faces of which are three ogival triangles containing the letters 'A', 'K' and 'S'
[downward arc of lettering:
WEST BROMWICH
]

By 1917 Colton, Palmer & Preston were offering Cowell's patent mortice lock, which was ingeniously formed in a long cylinder, so that it could be fitted simply by boring a 7/8 inch [22.5 mm] hole horizontally into the leading edge of the door.[361] A lock of perhaps early twentieth century appearance is 'The Antipodean',[362] and another of twentieth century brand as yet unsourced, is the 'Erebus Patent Lift-Up' found in a 1930 house in the Melbourne suburb of Coburg.[363] By 1933 J Stratmann Pty Ltd of Melbourne were advertising 'Stratmann's New Plain Front Mortise [*sic*] Door Lock' and describing themselves as wholesale manufacturers to the trade. One infers, from the spelling, from a reference to 'Stratmann's English and American lock furniture' and from a reference to the lock as being patented, but without citing a local (or any) patent number, that this was the local branch of an overseas and probably an American company. A range of their locks and other products was displayed at Kelvin Hall in Melbourne, and their brand was 'J.S.' in a square.[364] In about 1936 they introduced a range of specially designed locks for narrow stile doors, both mortice and rebated.[365]

l. safes

Safes were generally imported, though their sources are not always clear. For example, the Bank of Australasia used Simpson's fireproof safe doors, the origin of which is not established.[366] The silver safe at Government House, Melbourne, of 1872-6, has a circular brand:

[outer annulus:
THOS PERRY & SONS
HIGHFIELD WORKS BLISTON
]
[inner annulus:
PATENT FIRE RESISTING
IMPROVED SAFE
]
[coat of arms at centre]

361 Colton, Palmer & Preston, *You are Secure with Us*, p 36.

362 On a kitchen door at 'Pastoria', Kyneton, inspected 2002; and at 9 Tyers St, Portland, photographs provided by Bob Stone, 2005.

363 123 Reynard St, Coburg, bearing the patent no 18,071: also reported by Simon Reeves, 1997.

364 Royal Victorian Institute of Architects, *Journal*, XXXI, 3 (July 1933), advertisement p xxx.

365 Royal Victorian Institute of Architects, *Journal*, XXXIV, 4 (1936), advertisement p xxii.

366 They were used at the bank branch at Kooringa, South Australia, and as they were to be supplied by the proprietor, they were probably in regular use by this bank: Dunstan, 'Banking Premises, Kooringa', p [3].

In Sydney H P Gregory & Co were the sole Australian agents for MacNeale & Urban's fire and burglar-proof safes.[367]

George Price of the Cleveland Safe and Lock Works, Wolverhampton, was a prominent British safe manufacturer whose products reached Australia in quantity. In 1863 he was advertising his 'treble patent fire resisting (212º) & burglar proof prize medal champion safes', his strong room doors, and his 'ne-plus-ultra' bank lock.[368] A Price's fireproof safe was installed in an architect's house at Ballarat, probably in 1865.[369] In 1879 he exhibited at Sydney, and was selling through his agents, Edwards, Dunlop & Co of London and Sydney.[370]

Even more prominent was Milner's company, which had succeeded to the business of Thomas & William Milner, which had developed a fire-resistant safe in 1840,[371] and by 1851 could exhibit a range of fireproof safes from five hundredweight [250 kg] to three tonnes in weight.[372] They mounted an extensive display at the Melbourne International Exhibition of 1880, winning both gold and silver medals,[373] and were the source of individual safes in many major buildings, and installed the basement safe deposit of the APA Building in Melbourne.[374] The company also entirely fitted out the strongroom of the Melbourne Safe Deposit Company, using quantities of steel and a number of protection devices which it is unnecessary to describe here. Mechanics were sent out from England for the installation, under the supervision of the company's representative, R F Whiteside, and it was said that only five other such safe deposits had been constructed, three in London and one each in Manchester and Liverpool.[375] The other main British supplier was Chubb & Son, and both companies received gold medals at the Centennial Exhibition of 1888-9.[376] Fireproof doors and shutters were a conspicuous use of iron, usually fabricated locally from plate iron on some sort of frame, but occasionally imported. Hoffnung & Co's premises in Sydney, of 1870, had fireproof strongroom doors by Cotterell & Co of Birmingham, with 'double acme locks'.[377]

At the exhibition of 1866-7 Reaney & Roberts of Melbourne showed 'Fire and Drill Proof Safes', but were presumably not themselves the manufacturers.[378] However, there were also local safe-makers, J Brandwood of Launceston,[379] Makutz & Burke of South Melbourne,[380] and J Pitt & Co of North Melbourne.[381] A Makutz and Burke

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367 *Australasian Ironmonger*, I, 7 (1 October 1886), advertisement p ii.

368 Laxton, *Builder's Price Book for 1863*, pp 206-7, and advertisement, unpaginated.

369 The architect was Henry Caselli, and the safe was amongst the house contents offered for sale in 1893: Dorothy Anderson, *The Tradesmen of Gazelle* (South Yarra [Victoria] 2000), p 146.

370 Sydney Exhibition 1879, *Catalogue of British Section*, p 189.

371 Sydney Exhibition 1879, *Catalogue of British Section*, p 186.

372 Great Exhibition, *Catalogue*, II, p 661.

373 Melbourne Exhibition 1880, *Catalogue*, p 613.

374 *Australasian Builder and Contractor's News*, 20 April 1889, p 379; also 10 September 1887, p 291, reporting the use of Milner's patent safe doors in the Commercial Bank branch at West Maitland.

375 *Australasian Builder and Contractor's News*, 7 June 1890, pp 1093-4, quoted in Allom Lovell & Associates Pty Ltd, *380 Collins St, &c* (Melbourne 1989), pp 36-8.

376 Centennial Exhibition, *Official Record*, pp 466, 467, 734-5, 963.

377 H M Franklyn, *A Glance at Australia in 1880* (Melbourne 1881), pp 353-4.

378 Intercolonial Exhibition, Melbourne, 1866-7, *Official Record* (Melbourne 1867), p 31.

379 Centennial Exhibition, *Official Record*, p 737.

380 Centennial Exhibition, *Official Record*, pp 621, 734-5.

'Fire Proof and Thief Resistant Safe' was installed in the prominent Melbourne house 'Bagatelle' in 1890.[382] Pitt had established his business in Elizabeth Street in about 1878, employing only two boys, but trade expanded until he moved to large premises in North Melbourne in 1885. Three years later he employed ten hands, produced 120 safes a year and 50 or 60 strong room doors, as well as other products. He obtained two successive three year contracts to supply the Victorian Government with safes, and had produced six hundred of them. In his safes he put a device to prevent the key being removed unless the door was locked.[383]

In Britain Chubb & Son were known for their locks, and though they showed a patent fireproof safe at the Great Exhibition,[384] safes seem to have been a minor part of their business until later in the century. In 1895 Chubb Australia Ltd was established in Market Street, Sydney, though its headquarters were in England and the safes were imported until 1921, when they opened their own factory at Waterloo. During the 1920s the company manufactured safes and strongrooms for the major Sydney banks, and the circular strongroom doors weighing thirty tonnes each which still guard the safe deposit vault of the Commonwealth Bank in Martin Place. The company also manufactured secure office equipment, such as fire-resistant filing cabinets.[385] In 1949 there were two other local makers advertising in *Ramsay's Catalogue*, the Bulldog Safe Works of Sydney, and M G Dyke & Sons Pty Ltd of Melbourne. Both manufactured strong room doors and wall safes, and Dyke also produced large self-contained safes.[386]

Although private safes were always unusual, the architect's safe at Ballarat and the silver safe at Government House were by no means unique. 'Benvenuta', Carlton, of 1891, had a complete strong room, doubtless necessitated by the peculiar business activities of the Abraham family, which will be referred to below. In about 1930 a secret built-in wall safe was provided as a standard item in a Melbourne display house.[387] At this time C J White & Sons of Melbourne were agents for John Tann's safes, an English type said 'never to have been opened by a burglar', and in particular for 'special wall safes for money and jewels', which could be placed behind a picture.[388] Tann's safes had been shown at the Great Exhibition in 1851, but seem not to have been common in Australia.[389]

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381 Centennial Exhibition, *Official Record*, pp 737.

382 Robert Trumble, 'Re "Bagatelle"' (manuscript, Melbourne), p 2.

383 Alexander Sutherland [ed], *Victoria and its Metropolis* (2 vols, Melbourne 1888), II, p 617.

384 Great Exhibition, *Catalogue*, II, p 663.

385 Jennifer O'Callaghan, *This Working Life* [exhibition catalogue] [Sydney 2002], pp 18-21.

386 *Ramsay's Catalogue* [1949], §§ 23/1, 23/2.

387 G C Dickson & Yorston (Builders) Pty Ltd, *The Exhibition Home, Redcourt Avenue, Armadale* (Melbourne, no date, ?pre-1930], no page.

388 *Australian Home Beautiful*, 1 July 1930, p 4. Tann had exhibited at Sydney in 1879: Sydney Exhibition 1879, *Catalogue of British Section*, p 191. In 1904 his safes were branded 'Anchor Reliance': J T Rea, *How to Estimate: being the Analysis of Builders' Prices* (London 1904 [1902]), p xxxviii.

389 Great Exhibition, 18511, *Catalogue.* II, p 651.