

12.02 Fireproofing

- a. mill construction**
- b. terra cotta & concrete**
- c. early fire protection**
- d. sprinklers**

This section is concerned with aspects of construction specifically designed for fireproofing and fire extinction. But there are many issues to do with fireproof construction which it has not been convenient to extricate from their more general context, the main ones being brick and terra cotta arched fireproof flooring; terra cotta cladding for structural frames; Fox & Barrett's and subsequent fireproof concrete floors; Traegerwellblech iron floor construction; plate iron shutters; automatically closing iron fire doors; iron roller doors; and panic bolts and related types of ironmongery.

A further topic which does not fit easily under any of these headings is the concept of fire rating, because it is as much an economic as a technical one, and stems from the requirements of fire insurance companies. A whole building can be said to be of 'first rate', 'second rate', &c construction in the sense that a well-protected building pays the first or lowest rate of insurance, though even a totally incombustible structure can be more or less destroyed by a fire in the contents. The important issues from the firefighter's point of view are how long the fire can be prevented from passing between one compartment and another, and how long it can be prevented from reaching and damaging critical parts of the structure (usually a metal frame): the number of hours grace which a door or material is expected to provide is its 'rating'. An interesting transitional example is an American recipe of about 1860 for a 'fire-proof composition to resist fire for five hours. This comprised one coat of pearl ash dissolved in water, then three coats of a mixture of pearl ash, fine yellow clay and paperhanger's flour paste; and finally two coats of pulverised iron filings, brick dust, ashes and glue water.¹

a. mill construction

The fireproof mill construction developed in England by William Strutt, Charles Bage and others, in the decade 1792-1802,² had become a standard form, which was

¹ I R Butts, *The Tinman's Manual and Builder's and Mechanic's Handbook, &c* (Boston 1861), p 84.

² See especially A W Skempton & H R Johnson, 'The First Iron Frames', *Architectural Review*, CXXXI (March 1962).

illustrated almost unchanged by William Fairbairn in 1854.³ It would certainly have been well-known in Australia, but there was little call for it, and no examples of this basic type have been identified here. In the typical mill shallow brick vaults between the floor beams created an essentially masonry floor, but the structural columns and beams were of timber. Thus the essential development was to replace the timber frame with an iron one, while the masonry shell remained. First the wooden columns were replaced with cast iron; then the underside of the floor structure was encased or faced in non-combustible materials; then the beams were replaced in cast, and later in wrought iron. The weak point remained the tie rods which were beneath the vaulting, and which would expand in a fire, and long before they reached melting point, would allow fissures to open up in the rest of the structure, within which sparks could lodge. By the time of Fairbairn's illustration the final step had been taken, that of raising the tie rod above the crown of the vault so that it was no longer exposed to flame.

In Australia many mills and warehouses perpetuated to pre-Strutt British tradition. The envelope of the building was of brick or stone. The columns were of square section timber, typically chamfer stopped. They carried timber spreaders or cross-heads, on which in turn rested the main timber floor beams. These beams carried joists, commonly herringbone-strutted, and floor boarding above, none of which was fire protected. Of course some changes were made in some local buildings. The timber cross heads were replaced by cast iron shoes to carry the beams, first in basement of the Cleve Brothers building in Melbourne in 1858, and much later in the Australasian Steam Navigation Company building in Sydney in 1883. Timber columns were replaced by iron ones in the ground floor of the Cleve Brothers building, as well as a number of others. But the timber beams and floor construction remained, and it is impossible to identify any complete multi-storey iron frame in Australia until the 1880s.

Other aspects of fireproof mill building took on a life of their own. One of Strutt's devices was to protect the triangular timber fillet, or skewback - which created the angled face from which to spring the brick vaulting - by wrapping it in sheet metal. It has not been generally recognised that this derived from the 1777 patent of David Hartley, which has been discussed above. Fairbairn's iron plate vaulting of the mid-century is a development of this sort of thinking, as in due course is corrugated iron vaulting generally and Traegerwellblech iron in particular.

b. terra cotta & concrete

We have seen also that Strutt used hollow terra cotta pots of the type invented by Eustache St-Fart, to build a vaulted ceiling to the top floor of his Derby mill of 1792-3. From this developed a series of hollow pot roofing and flooring types in England, culminating in Bunnett's system, from which in turn developed the American systems of the later nineteenth century, and their minor manifestations in Australia. These

³ William Fairbairn, *Treatise on the Application of Cast and Wrought Iron to Building Purposes* (London 1854), p 133.

terra cotta flooring systems are found in office buildings rather than in mills, and they are associated with terra cotta partitions and with components shaped for assembling around iron or steel columns

The fireproofing of public buildings evolved in another quite distinct way, beginning with Fox and Barrett's system and proceeding through to fully concrete floors. By a process of evolutionary convergence, these concrete floors were sometimes in the form of parallel vaults very similar in form to those of brick, of iron, and sometimes of terra cotta blocks. It is in such public buildings also that plate iron shutters, and later revolving steel shutters, are most fully exploited. Whilst it was certainly important that public records should be protected from fire, the initial concern was perhaps more to protect them from the potentially revolutionary mob - the same reason for which the pioneering shutters had been added to the Duke of Wellington's house in London.

Most later developments are more readily discussed in the context of the materials concerned, especially concrete, plaster and terra cotta, until the 1950s when sprayed finishes came into use for fireproofing metal frames. One early example was Hume House in William Street, Melbourne, where sprayed gypsum and vermiculite were used.⁴

c. early fire protection

Fires were extinguished in the traditional way by applying water from buckets, by hose if there was a reticulated supply, or with a pump or fire engine if available.⁵ One of the first local references to such an engine was when one Heartley or Hartley of Sydney offered for sale in January 1805 a 'strong Fire Engine, very easy to work, and capable of throwing water to a considerable height.'⁶ This sale reflects the fact that the basic responsibility for fire fighting was private, and until late in the nineteenth century was mainly undertaken by the insurance companies. A building would bear the mark of the company with which it was insured, in the form of a small metal shield, and that company's brigade would fight fires only in buildings so identified.⁷ Some fire marks have survived, including that on the shearing shed at 'Woolmers', Tasmania, labelled 'Life Insurance Cornwall',⁸ and one at 15 Heygarth St, Echuca, Victoria, of the 'Victoria Fire Insurance Company'.

⁴ *Cross-Section*, no 52 (1 February 1957), p 1.

⁵ John Timbs, *Curiosities of London, exhibiting the most rare and remarkable objects of interest in the metropolis, &c* (London 1855), p 298, gives an account of the traditional 'squirts' or syringes, which might be strapped to the body of a man, or might be of a larger size worked by three men. In London their numbers were greatly multiplied after the Great Fire, but they were soon replaced by regular fire engines, or pumps on wheels.

⁶ *Sydney Gazette*, 27 January 1805, p 4.

⁷ For details see A Chitty, 'Fire Insurance Offices and "Fire Marks" in Australasia. Part 1', *Victorian Historical Magazine*, VIII, 31 & 32 (1921), pp 81-93 & 113-116.

⁸ Harry Sowden, *Australian Woolsheds* (North Melbourne 1972), p 162.

It was not only cotton mills of the industrial revolution, like those of Strutt, which were susceptible to fire. At the Albion Flour Mills in London Samuel Wyatt installed 'an enormous fire engine' - which would be pump - and a tube by means of which, according to Humphry Repton, 'a vast column of water might be spread over every part of the premises'⁹ However this did not prevent the mill being entirely destroyed by fire a few days after Repton saw it in 1791. Despite this failure it became common in Britain and the United States, though possibly not in Australia, to have a permanently installed pumping machine for fire extinction in a factory building, rather than to rely solely upon the attentions of a fire brigade. The rotary pump was invented in France, and used two coarse gears with teeth which moved the water to the point where the gears met and the water was forced out under pressure. Although this was correctly described as a 'coarse mechanical movement; involving rapid changes in velocity' it was said to be the best pump ever made for mill purposes.¹⁰

In about 1844 Ebenezer Timmis of Birmingham received a patent for a system in which a tank of water in the basement or yard was fitted with a force pump connected to pipes leading to outlets in each room, where it was possible for the water jet to be pointed in any direction or to range back and forth. The advantages were that was no delay in procuring the water or connecting the apparatus, that every point in the building could be reached, and there was no necessity to open doors or windows, thus aggravating the draught and accelerating the fire.¹¹ Another machine was shown in 1851 by R Smith & Son of St Mary Cray, Kent, and was said to be for large public buildings, docks, warehouses and ships, though an installation for a private dwelling was illustrated, with the water being discharged from behind a central ceiling ornament.¹² In the United States Henry R Worthington invented a direct acting steam pump in 1844, and in 1849 manufactured the first one specifically for firefighting purposes, for the steamer *Bay State*, on which it operated satisfactorily for many years.¹³ Other fire pumps were made by the Deane Steam Pump Company of Holyoke, Blake & Knowles of Boston, and Cameron of New York,¹⁴ and the Holyoke Machine Co of Holyoke.¹⁵

Steam was first used to work a portable fire engine by Braithwaite of London, at a fire in the Argyll Rooms, Regent Street, in February 1830. It took eighteen minutes to bring the boiler to boiling point, which may explain why the building was substantially destroyed, despite the fact that the engine could throw thirty or forty tonnes of water per hour to a height of twenty-seven metres.¹⁶ The pumps that followed were quicker in operation. In London Adair & Co were manufacturing

⁹ Humphry Repton [ed Anne Gore & George Carter], *Humphry Repton's Memoirs* (Norwich 2005), p 134.

¹⁰ C J H Woodbury, *The Fire Protection of Mills; and Construction of Mill Floors, &c* (New York 1882), p 12.

¹¹ Ebenezer Timmis, *Fire Extinction* (Manchester [1844]), passim.

¹² London, Great Exhibition 1851, *Catalogue*, I, pp 227-8 & facing p 228.

¹³ Woodbury, *The Fire Protection of Mills*, p 20.

¹⁴ Woodbury, *The Fire Protection of Mills*, p 22.

¹⁵ Woodbury, *The Fire Protection of Mills*, advertisements, unpaginated.

¹⁶ Timbs, *Curiosities of London*, p 19.

patent double action pumps for fire engines and other uses by the 1860s.¹⁷ The best known of the fire engines were to be those made by Moses Merryweather of London. The model which he supplied to the London Fire Brigade was Simpkins's patent, which was a four wheeled cart pulled by two or four horses, carrying a pump with seven inch [178 mm] gun metal cylinders and folding handles, to be operated by up to thirty men.¹⁸ Another prominent British maker was Shand & Mason (formerly Tilley).¹⁹ In the United States the Amoskeag Company was making fire engines from 1859 onwards, though it is unclear whether they were steam operated at the outset.²⁰

An early form of portable fire extinguisher, the 'fire annihilator', was invented and patented by W H Phillips of London. It resembled an enclosed coffee jug or kettle, with a knob on top which was pushed down to initiate a chemical reaction, in which sulphuric acid was deposited onto potassium chlorate and sugar, causing the discharge of a mixture of gas and vapour 'with the power of steam'. Phillips marketed it through the Fire Annihilator Company.²¹ One account refers to the successful use of 'a machine, fetched from a shop a mile distant, and applied when the fire had been raging upwards of three hours.'²² In the short term such devices made little progress, and it was the development of the automatic sprinkler which effected the first real improvement.

d. sprinklers

In 1807 a British patent was issued to Dr John Carey for a 'shower bath' for checking fire, in which a cistern of water at the top of the building was connected by a pipe to a stopcock in the ceiling of any room, terminating in a rose. The cock was controlled by a weighed cord descending into the room, such that when any part of the cord was burnt through, the weight was released and the water sprayed from the rose.²³ In 1845 the first American example was installed by the Suffolk Manufacturing Company.²⁴ J B Francis, of Lowell, then introduced perforated pipes running across the ceiling in the centre of each bay, and William Whiting modified this system by running the pipes longitudinally under the beams, with orifices at 750 mm spacing.

¹⁷ Adair & Co, *Adair's Patent Double Action Pumps and Fire Engines for Ships, Mines and Land Use* (London 1869), cite in Steve Finer Rare Books, Catalogue 162 (Greenfield [Massachusetts] 2006), no 404.

¹⁸ London, Great Exhibition of the Works of Industry of all Nations, 1851, *Official Descriptive and Illustrated Catalogue* (3 vols, London 1851, I, p 226.

¹⁹ Amoskeag Manufacturing Company, *Amoskeag Steam Fire Engines* (Manchester [New Hampshire] 1874), cited in Steve Finer Rare Books, Catalogue 162 (Greenfield [Massachusetts] 2006), no 407.

²⁰ London, Great Exhibition 1851, *Catalogue*, I, pp 227-8 & facing p 228.

²¹ London, Great Exhibition, 1851, *Catalogue*, p 222; London, Great Exhibition of the Works of Industry of all Nations, 1851, *Reports by the Juries on the Subjects in the Thirty Classes into which the Exhibition was divided* (London 1852), pp 297-8.

²² *Builder* (UK), XI, 532 (16 April 1853), p 254.

²³ *Repertory of Arts*, 2nd series, X, 59 (April 1807), pp 407-422; see also Woodbury, *Fire Protection of Mills*, pp 41-2. I take this to be the same device as referred to by Sara Wermiel, *The Fireproof Building: Technology and Public Safety in the Nineteenth-Century American City* (Baltimore 2000), p 111, ref Charles Young, *Fire, Fire Engines, and Fire Brigades* (London 1886), pp 41, 44.

²⁴ Wermiel, *The Fireproof Building*, p 111.

This was further modified by the Providence Steam and Gas Pipe Company, which marketed the system.²⁵ Australia was not entirely isolated from these developments, for in 1858 a Victorian patent was granted to George Bate for, *inter alia*, the construction of hollow girders and beams which could be filled with water in case of fire.²⁶ This would seem a dubious device, certainly not appropriate to cast iron girders, and there is no indication that it was put into effect. However, it is interesting that it apparently preceded a similar invention in Britain, for in 1861 W H Hood of Reading advertised a 'hollow girder' pierced with numerous holes through which a continuous flow of water could be passed into a room.

In 1864-5 an English firefighter, Stewart Harrison, developed the 'head' which screwed into the supply pipe, with a solder seal which melted in a fire, causing an automatic spray, but the idea was not much taken up in Britain.²⁷ Various automatic sprinklers followed, with rose heads designed to discharge the water upwards and across as large an area as possible, and secured with bismuth solder which would melt in a fire and release the spray. The first fire to be extinguished by such a system was that in the Cathedral Building, Boston, in 1870,²⁸ and by 1882 thirty fires in mills had been extinguished.²⁹ Some types used in the United States were the Hub and the Standard, invented by Francis W Whiting; the Burritt, produced by the A Burritt Hardware Company of Waterbury, Connecticut; the Bishop, and that of A F Grainger. The Burritt was claimed to be absolutely reliable and to operate within 45 seconds.³⁰

However these were preceded by the first effective American automatic sprinkler patented in 1874 Henry S Parmalee of New Haven, with two types of head, the more successful having a cap sealed in place with solder.³¹ From 1878 the Providence Steam and Gas Pipe Company, makers of perforated pipe sprinklers, installed systems using Parmalee's heads. Then in 1881 Frederick Grinnell, president of the company, introduced a new type in which a seal was held in place by a lever soldered to the base, and released when the solder melted.³² The 'Grinnell Sensitive Automatic Sprinkler or fire extinguisher, and fire alarm' was introduced in America in about 1883 and reached Britain in 1885, in addition to which J G Ulrich patented a 'thermometric fire telegraph'.³³

The Grinnell sprinkler was tested with great success in 1889 at the Central Fire Brigade Station, Castlereagh Street, Sydney, under the supervision of Russell &

²⁵ Woodbury, *Fire Protection of Mills*, pp 37-8.

²⁶ No 60 to George Bate, 5 November 1857. This may relate to the English patent of Charles Cowper, in 1854, for various forms of rolled wrought iron beams and joists, including hollow beams and bresssummers. John Timbs, *The Yearbook of Facts in Science and Art* (London 1854), p 73.

²⁷ Wermiel, *The Fireproof Building*, p 129, ref.

²⁸ Woodbury, *Fire Protection of Mills*, p 42.

²⁹ Woodbury, *Fire Protection of Mills*, p 44.

³⁰ Woodbury, *Fire Protection of Mills*, pp 44-5 and advertisements, no page.

³¹ Woodbury, *Fire Protection of Mills*, pp 43-4; Wermiel, *The Fireproof Building*, pp 129-130.

³² Woodbury, *Fire Protection of Mills*, pp 46-8; Wermiel, *The Fireproof Building*, pp 129-130. See also the Providence Steam and Gas Pipe Co advertisement in Woodbury, advertisements, no page.

³³ *Australasian Builder & Contractor's News*, 6 April 1889, p 319.

Wormwald, the Australian agents. Russell pointed out that over 2,300,000 of the sprinklers had been installed in the United Kingdom and Ireland, and over 450 fires had been successfully extinguished.³⁴ Stanley Grey Russell and Joseph Dawson Wormwald applied for a New South Wales patent for 'improved apparatus for extinguishing fires and for automatically giving an alarm,'³⁵ but at some point Russell seems to have left the firm, which became Wormwald Brothers. It is not possible to trace the appearance in Australia of each improvement in sprinkler heads, but the broad picture is that in 1890 Grinnell introduced a type with a glass button rather than a metal stopper, and with various other new features, and this remained the standard type for a period of decades.³⁶ In 1904-5 Grinnell sprinklers were used throughout the New Palace Emporium in Sydney,³⁷ and in 1905 in the Marcus Clarke building in George Street. This was designed by James Nangle with careful attention to all aspects of fire protection and proofing, and because it was regarded as substantially immune from fire it incurred substantially lower insurance premiums.³⁸

By 1912 Wormwald Brothers advertised as specialists in the Grinnell automatic sprinkler and fire alarm systems, the Simplex chemical fire extinguisher, wired glass windows with metal frames and armoured fire-resisting doors.³⁹ By 1924 they were able to list many buildings to which the sprinklers had been fitted, in all the state capitals.⁴⁰ The company also manufactured fireproof windows and other elements, including the roller shutter doors which will be discussed below.⁴¹ In 1949 they were advertising that the Grinnell system had been used in Australia and New Zealand since 1886, which was not correct, and describing the sprinkler as 'an English product',⁴² which may mean that they imported Grinnell sprinklers which were manufactured in England, notwithstanding their ultimate origins in the United States.

Another sprinkler system was developed by Shand, Mason and Company, London hydraulic engineers and fire engine manufacturers, who appointed Campbell, Guthridge & Co of Melbourne, Sydney and Adelaide as their Australian agents. At a trial conducted in Melbourne an electric alarm bell (a feature of the system) sounded within about thirty seconds of a fire being lit in the test room, while water was sprayed on the contents and successfully extinguished the flames. The principle was simply that water was kept from the sprinkler at normal temperatures by a valve linked to levers fixed in place with solder. The solder was designed to melt at 160°F [105°C], when the valve would drop, releasing the water and simultaneously activating the alarm bell.⁴³ By the end of 1889 several types of sprinkler were on the market, generally on the same principle of a valve being activated by a fusible metal

³⁴ *Australasian Builder & Contractor's News*, 6 April 1889, p 319.

³⁵ *Australasian Builder & Contractor's News*, 13 April 1889, p 356.

³⁶ Wermiel, *The Fireproof Building*, p131.

³⁷ Emery Balint, *Record of Commercial Buildings Constructed in the Victorian Era in N.S.W.* (Sydney 1987), p 246 ref *Building & Engineering Journal*, 30 August 1904, p 225.

³⁸ Balint, *Record of Commercial Buildings*, p 250.

³⁹ Source?.

⁴⁰ Wormwald Bros. Ltd, *Fire Waste and its Prevention* (2nd ed, Sydney, no date [c 1924]), pp 43-4.

⁴¹ Wormwald Bros. Limited, *Protection Against Fire* (2nd ed, Sydney, no date [Sydney 1924]).

⁴² F W Ware & W L Richardson [eds], *Ramsay's Architectural and Engineering Catalogue* (Melbourne 1949), § 36/2.

⁴³ *Australasian Builder & Contractor's News*, 6 July 1889, p 6.

link. The insurance companies developed rules to ensure that these systems would be effective. The first was the provision of a duplicate water supply in case the first failed, and for this purpose various combinations of pumps and reservoirs were acceptable. Secondly, a table of sizes for supply pipes was laid down. Thirdly, all the non-fireproof portions of any one hazard had to be protected.⁴⁴

Whilst sprinklers were outstandingly successful, especially the Grinnell, a number of other fire protection devices were promoted at about the same time. In January 1889 a fire alarm was tested at the Government Printing Office in Brisbane, where a small fire was lit, causing an electric bell to ring within thirty seconds. The principle was that a tongue made of two metals with different coefficients of expansion, would deflect as it heated, until it touched a set screw and closed a circuit.⁴⁵ In February a demonstration was conducted at Sydney of Tatham's Heat Indicator and Fire-alarm, said to consist solely of a thermometer, Leclanché cells [batteries] and an ordinary electric bell. Reportedly the expansion of air by heat acted upon a small bulb of mercury, forcing the metal up a tube, but this is not consistent with the reference to a thermometer, and it seems more likely that it was the usual direct effect of heat which affected the mercury, not the expansion of air. One electric terminal was connected to the reservoir of mercury and another was in the upper part of the tube, so that when the metal rose high enough the circuit was closed and the bell rang.⁴⁶

By 1908 the Wunderlich Company was marketing the Morris automatic fire sprinkler,⁴⁷ but this was apparently short-lived. In 1954 Wormwalds, in addition to the Grinnell sprinkler, advertised the 'Mulsifyre' system, which when sprayed onto burning liquid converted it to an emulsion, the 'Kidde' carbon dioxide system, and a range of extinguishers and hoses. They illustrated the Grinnell sprinkler head in its original (purportedly 1882) form, in comparison with the 1954 version, to show that they were not stuck in the past.⁴⁸ The Atlas sprinkler, a British product, was to be marketed by Automatic Fire Sprinklers Pty Ltd of Sydney, a company established in 1925. Their patented 'Silica Bulb Fire Sprinkler (Type C)' was marked '1937', presumably the year of its origin.⁴⁹ The Central Automatic Sprinkler was apparently another well-known type, but a new company, the Central Automatic Sprinkler Co, was established to market it after World War II.⁵⁰

⁴⁴ *Australasian Builder & Contractor's News*, 9 November 1889, p 461.

⁴⁵ *Australasian Builder & Contractor's News*, 19 January 1889, p 55.

⁴⁶ *Australasian Builder & Contractor's News*, 23 February 1889, p 190.

⁴⁷ C E Mayes, *The Australian Builders and Contractors' Price-Book* (7th ed, Sydney 1908), advertisements p xvii.

⁴⁸ *Ramsay's Catalogue* (1954), § 36/3.

⁴⁹ *Ramsay's Catalogue* (1949), § 36/1; see also *Ramsay's Catalogue* (1954), § 36/1.

⁵⁰ *Ramsay's Catalogue* (1949), § 36/3; see also *Ramsay's Catalogue* (1954), § 36/2.

12.02 Fireproofing: illustrations:

a. mill construction

b. terra cotta & concrete

c. early fire protection

George Bate's patent of 1858 for, *inter alia*, hollow girders which could be filled with water in case of fire. Victorian patent no 60.

d. sprinklers

12.02 Fireproofing check:

a. mill construction

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c. early fire protection

Charles Young, *Fire, Fire Engines, and Fire Brigades* (London 1886), pp 41, 44, cited in Sara Wermiel, *The Fireproof Building: Technology and Public Safety in the Nineteenth-Century American City* (Baltimore 2000), p 111, for early sprinkler system.

d. sprinklers

Argus, 26 June 1876, p 5: report of a sprinkler system in the new Academy of Music, Bourke Street.

Building & Engineering Journal, 30 August 1904, p 225, cited in Emery Balint, *Record of Commercial Buildings Constructed in the Victorian Era in N.S.W.* (Sydney 1987), p 246, for Grinnell sprinklers in the New Palace Emporium, Sydney, 1904-5.

SLV LTDA29 Wormwald Bros Fire Protection Layout, cited by Dore.