9.10 Electricity

a. lightning conduction
b. lightning conductors in Australia
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a. lightning conduction

Lightning conduction, despite its initiation by Benjamin Franklin in 1752 or, as is sometimes claimed, the Bohemian monk Prokop Diwisch or Divis,[1] was very much a pseudo-science, because of the obvious difficulty of carrying out controlled experiments. In the United States Hudson Holly distinguished the 'lightning-rod man' as the 'one individual more remarkable than the rest ... whose ignorance and conceit are only equalled by his pertinacity, and ... is a type so peculiar that he may be set down as a character, excelling even the sewing-machine agent or the Yankee clock-peddler.'[2]

There were, however, changes in practice which were at least in part a response to genuine empirical observations. Lightning conductors were first adopted for buildings and structures, such as church spires, which were of exceptional height or exposure. Smeaton's account of the system used at the Eddystone Lighthouse in 1759 suggests that he already had a clear set of design principles:

> As the copper funnel reached through the ball, and from thence came down to the kitchen floor, above forty feet [12 m] ... I considered this as contaning so much metal, that, if struck by lightning, it would thus far be a sufficient conveyance; then joining the kitchen grate to the leaden sink, by a metal conveyance, the sink pipe of lead would convey it to the outside. From the sink pipe downwards, which being on the north-east side, was consequently the least subject to the stroke of the sea, we continued the electrical communication by means of a strap of lead, about one inch and a half broad and three-eighths thick [38 x 9.5 mm],

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1 Diwisch was a monk of Scuftenberg in Bohemia, and is reported to have set up a lightning conductor in the garden of the curate of Prendita, in Moravia, on 15 June 1774. It was in the form of an iron rod with curved-up branches, carried on a pole. *Scientific American,* citing the Austrian journal *La Lumière Électrique,* quoted in turn in the *Australasian Builder & Contractor's News,* 22 October 1887, p 388. Elliott locates Diwisch's 'lightning tower' at Primetice and dates it to 1754, but even this is two years after Franklin's description of a lightning conductor in *Poor Richard's (Improved) Almanac:* C D Elliott, *Technics and Architecture* (Cambridge [Massachusetts] 1992), p 201.

2 H H Holly, *Modern Dwellings in Town and Country adapted to American Wants and Climate, with a Treatise on Furniture and Decoration* (New York 1878), p 90.

> fixed on the outside by being nailed to oaken plugs, driven into two jumper-holes in the solid of each course; the prominent angles of the strap being chamfered off, it was bedded and brought to a smooth surface with putty. At the foot of the leaden strap, an eye-bolt of iron was driven into the rock; and to this was fixed an iron chain, long enough to reach at all times into the water; its lower end being left loose to play therein, and give way to the stroke of the waves: by this means an electrical communiucation was made from the top of the ball to the sea.[3]

Lightning conductors were also in demand for other buildings in which fire posed exceptional dangers. They are (with one odd exception) first heard of in Australia in connection with the powder magazines of the 1850s, and are not known to have been used on other buildings until the 1870s. This contrasts surprisingly with the hurried erection of conductors throughout Pietermaritzburg, Natal, following an electrical storm in 1849.[4] In 1838 the Indian military consulted Dr W B O'Shaugnessy, assistant surgeon, to advise upon the expediency of attaching lightning conductors to powder magazines. His response was that a conductor might protect a two storey building, but a powder magazine was low and not especially susceptible to lightning strikes, while there were reasons for thinking that the attachment of a conductor might actually increase the risk. His preferred solution was to surround the building with a ring of iron rods stuck upright in the ground at a distance of at least six metres. After an exchange of reports and letters O'Shaugnessy's views were rejected by the leading electrical authorities of the day, Professors William Faraday and J F Daniell in 1839 and 1841 and Charles Wheatstone in 1845. It became firm policy to provide powder magazines in India with lightning conductors, and much of the detailed theory and practice of their design was developed out of this detailed correspondence between the experts.[5]

Early nineteenth century conductors were iron rods held out from the wall by iron stays, and extending from above the highest point of the building down as directly as possible to the ground. Franklin had favoured a pointed termination to the conductor.[6] An early modification was to terminate the top of the conductor in a ball rather than a point, as at the Eddystone Light, but subsequent experiments showed that this sometimes gave rise to dangerous sparks and that the point was just as effective in collecting the charge.[7] By the later nineteenth century a common termination in England was a cluster

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3 Smeaton, quoted in Peter Nicholson, *An Architectural Dictionary, containing a correct nomenclature and derivation of the terms employed by architects, builders, and workmen &c* (2 vols, London 1819), I, p 345.

4 Brian Kearney, *Architecture in Natal* (Cape Town 1973), p 10.

5 India, Public Works Department, *Official Correspondence on the Subject of attaching Lightning Conductors to Powder Magazines* (Calcutta 1957), passim.

6 Elliott, *Technics and Architecture,* pp 202-4.

7 Wyatt Papworth [ed], *The Dictionary of Architecture* (London 1853-92), sv Lightning Conductor.

of five points, one at the centre and the others angled out from it. In France a modification of this was developed by Callaud, in which the central point continued up to a greater height than the others. It carried a flat copper ring, which had a number of short points sloping out radially (as many as ten in the illustration). The tips were sometimes made of an alloy containing 835 parts of silver to 165 of copper, which was almost totally corrosion-proof.[8]

Meanwhile it was found that broken or melted conductors were quite useless, or even dangerous, and that conductors ought to be as broad as possible, and should descend into the ground as deep as might be practicable. Wire rope and copper tubing did not present anything like the required breadth of material.[9] However, copper was the preferred material, as six times the cross-section was required to achieve the same degree of conductivity in iron.[10] The conductor was in the case of a lighthouse sometimes led down into the sea,[11] and opinion gradually firmed upon the idea that it was desirable that it should at least lead into moist earth, for dry ground was ineffective. This was the view expressed by the French Academy of Sciences in 1885.[12]

The next innovation, inspired by developments in telegraphy, was to carry the conductor down on ceramic or other insulators. When it was found that a lightning strike sometimes fused the top of the conductor, it came to be regarded as good practice to terminate it with three points tipped in platinum.[13] The available information is simply not adequate to provide a completely coherent account of subsequent developments, though some innovations can be identified. In the 1860s Hart & Son of London were advertising Spratt's Patent Battery Lightning Conductor.[14] Regularly available components included a patent galvanic band conductor, sold by length; copper wire; silver alloy reproducing points; glass insulators; and steel magnetic insulating clips.[15]

The French physicist J A C Charles introduced the concept of a cone of protection, in which everything was protected which fell within a cone having the point of the conductor as its apex, and a base of radius equal to twice the height of the conductor. This, the 'double cone of Charles', was opposed by the single cone, with a radius equal to its height, propounded by J L Gay-Lussac.[16] In France the most authoritative rules were those adopted on 20 May 1875 by a commission considering the installation of conductors on the municipal buildings of Paris. The commission determined that the platinum

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8 *Australasian Builder & Contractor's News*, 29 October 1887, p 410.
9 Papworth, *Dictionary of Architecture*, sv Lightning Conductor.
10 *Australasian Builder & Contractor's News*, 22 October 1887, p 391.
11 *Australasian Builder & Contractor's News*, 29 October 1887, p 410.
12 *Australasian Builder & Contractor's News*, 5 November 1887, p 466.
13 Papworth, *Dictionary of Architecture*, sv Lightning Conductor.
14 G R Burnell [reviser], *The Builder's and Contractor's Price-Book for 1865* (London 1865), advertisements.
15 Burnell, *Builder's Price-Book for 1865,* p 198.
16 Elliott, *Technics and Architecture,* p 208.

points previously used on rods were ineffective, and that the tip should be a spike of pure copper. In a return to pure Franklinian principles, the knob impaled on a conical spike (or 'olive', as the French engagingly called it) was discarded in favour of a knobless terminal of a sturdier and more obelisk-like profile (but circular plan). This copper terminal, about 500 mm long, was screwed, bolted and soldered to the end of a wrought iron rod, which was preferably galvanised with zinc, but on no account painted.

The rod was linked to a conductor made of solid iron bar or cable which was carried down the building and terminated underground in a form of two or three branched fork called the *perd-fluide.* The commission considered that such a conductor would protect a cone with a base diameter 3.5 times its height. This could be somewhat enlarged by linking the various rods together in a *circuit des faîtes,* running along the highest roof ridges of the building, and made of 20 mm square iron bars, bolted and soldered together.[17] In the United States R L Allen advocated lightning conductors for barns, which were particularly susceptible in the thunder showers which occurrred during the hot dry summers, especially when newly filled with hay and grain. He adhered to the double cone principle, and advocated a round or preferably square iron rod, the sections screwed or rivetted together for continuity, and the corners (in the case of a square rod) notched with a cold chisel at intervals to create new points of lightning attraction. The and was to be taken down to the level of permanent moisture, and buried in charcoal.[18]

In 1878 the US electrician Henry Spang published what seems to be a very sensible work in which he cricised current practice in lighning conduction. He was little concerned with issues like cones of influence. He advocated taking advantage where possible of metal roofs and downpipes, which could be turned into a lightning system by means of a few modifications like soldering the downpipe joints. At the base the downpipes (or indeed any conduction system) should be earthed to a greater depth than was commonly done, because moist soil was often deeper when in ground sheltered by a building. When the roof was not of metal, the conductors must be led very directly to the ground, because the discgarge would nut follow devious routes and sharp angles.[19] It apperas that these views were lasrgely ignored, especially in Britain.

In 1888 R C Cutting & Co of London advertised lightning conductors using solid copper tape, and Joseph Blackburn advertised 'improved registered lightning conductors, without giving any technical detail.[20] In the 1890s T W Farmiloe of London advertised two types of terminal, a single point, which was simply a long tapering needle, and a multiple point consisting of a similar

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17 Pierre Chabat, *Dictionnaire des Termes Employés dans la Construction* (2 vols, Paris 1875 & 1878), I, pp 964-8, sv Paratonnere.

18 R L Allen [revised R F Allen], *New* American *Farm Book* (New York 1869 [1846]), p 342.

19 H W Spang, *A Practical Treatise on Lightning-Conductors* (J Fagan, Philadelphia 1878), *passim.*

20 *Building News,* 20 April 1888, pp v, xxii.

needle passing through a ball, out of which at leats four spikes radiated up at an angle. The conductor itself was either copper rope or copper tape, with copper tubes for 'elevation rods'. Also available were couplings for joining the copper rope or tape, and saddles to support rods off a main roof ridge or apex. The point of the conductor, it was recommended, should extend at least four feet [1.2 m] above the highest point of the building. The rope or tape should be brought down in the most convenient way and buried in damp soil, embedded in crushed carbon, or immersed in a drain or pool about three metres out from the foundations. Although it was asserted that several conductors were required for large buildings, no rule for the coverage of each was propounded.[21]

b. lightning conductors in Australia

Governor Arthur Phillip's first permanent house in Sydney, built in 1788, had a simple spike rising from the centre of the roof.[22] This has been interpreted as a lightning conductor, and is difficult to explain in any other way: nor is it so surprising when once considers that this was the only two storey building on the continent. We know of no other lighting conductors in Australia for more than half a century.

In the 1850s conductors began to be used extensively on powder magazines on the Australian goldfields, and there was already a specialist literature on this building type.[23] In Victoria *An Act to Regulate the Importation, Carriage and Custody of Gunpowder* was passed in 1857, and made provision for the establishment of public powder magazines. One of the first magazines under the Act was designed for Portland, in western Victoria, in February 1858, and though it was not built, it closely resembles a number of other magazines, including that built at Beechworth in 1859-60, which survives and has been restored. The Portland drawings show a continuous rod running horizontally above the ridge, stepping down and along above the lower ridge of the porch, and then taken down to the ground. It is supported by uprights rising from the ridges, and by horizontal stays from the wall, and it branches up into terminals adjoining the main gable ends as well as the lower gable of the porch. It would seem that the termination of each of these is a central spike surrounded by four subsidiary spikes opening out on an angle. The conductor was only one of a number of precautions, for all metal fittings in the

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21 T & W Farmiloe, *T. & W. Farmiloe's Miniature Catalogue* (London 1894), pp 787-9.

22 [Anonymous], 'A View of Governor Philips [*sic*] House Sydney Cove Port Jackson taken from the NNW', watercolour, British Museum (Natural History) Watling Collection 19, reproduced in Tim McCormick [ed], *First Views of Australia 1788-1825* (Chippendale [New South Wales] 1987), p 52.

23 Papworth, *Dictionary of Architecture,* sv Powder Magazine, cites the *Papers* of the Corps of Royal Engineers, new series, XII, 40; *Allgemeine Bauzeitung,* 1849, pls 256-61; *Civil Engineer and Architect's Journal,* VI, 120 (1843). Later references include Papworth, 'Explosions of Gunpowder Stores', *Builder,* XIII, 761 (1865); *Builder,* XXXII, 923 (1874); and instructions in Army circulars of 1 May 1875.

building were copper, so as to prevent sparking, coopering tools were of wood or copper, and people entering had to wear galoshes or clogs.[24]

Powder magazines were a specialised building type with special problems of inflammability, and it is less clear when lightning conductors became common in conventional buildings in Australia. In 1855 the Royal Engineers installed two lightning cionductors 'made from ships fitting iron', and leading into a concrete tank filled with water, at the Fremantle Convict Establishment.[25] Professor Wilson of Melbourne University was probably in advance of his time in insisting on the provision of 'thunder rods' for the portion of the university building under construction in 1856, 'the exposed situation and the great height' of which rendered it 'especially liable to electric discharge'. Notwithstanding this, it was only two years later that the architect Balmain, of the Public Works Department (probably Thomas rather than James Balmain), recommended the removal of these lightning conductors and their replacement with copper rods or tubes, though this suggestion was not adopted.[26] This reflects the extent of the debate about lightning conductors, which continued unchecked because no protagonist could prove his position. The first commercial advertisement for lightning conductors is perhaps that of Robison Brothers & Co of the Victoria Copper Works, Melbourne, in 1862.[27]

High chimneys were especially vulnerable, and one at Ballarat in 1859 was equipped with a galvanized iron conductor 'surmounted by solid copper' and a gilt point.[28] Lighthouses were another specialised type because of their exposure, though most were of non-inflammable materials. The Point Lonsdale Lighthouse, however, was of wood. It did not burn when struck by lightning in 1888, and was probably saved by its conductor, which was 'fused and shattered from top to bottom'.[29] Lightning conductors were also used on church spires, and occasionally on other non-government property, but rarely on ordinary houses. It is a matter of surprise, therefore, that in 1888 conductors were added to a cottage on the White family property 'Samaurez' at Armadale, New South Wales.[30]

At Fremantle Gaol it appears that Manning proposed in 1876 that four copper-tipped lightning conductors should descend into a trench filled with old iron rather than connecting with small underground tanks, as was previously

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24 E A Beever et al, *The Beechworth Powder Magazine* (South Yarra [Victoria] 1966), unpaginated.

25 R M Campbell, 'Building the Fremantle Convict Establishment' (PhD, University of Western Australia, 2010), p 7.25.

26 Notes kindly supplied by George Tibbits from University of Melbourne records: UM series 312, Buildings Part 3 (1855); Professor W P Wilson to the Chancellor, 18 February 1856; Building Committee minutes no 44 of 18 February 1856, no 67 of 9 June 1858, and no 68 of 18 June 1858.

27 C B Mayes, *The Australian Builders' Price-Book* (2nd ed, Melbourne 1862 [1859]), p v.

28 Dorothy Anderson, *The Tradesmen of Gazelle* (South Yarra [Victoria] 2000), p 130.

29 *Australasian Builder & Contractor's News,* 1 December 1888, p 488.

30 Barry Maitland, *The Pender Index* (Maitland [New South Wales] 1999), unpaginated.

the case.[31] In 1882 the 'Lightning-Rod Conference' in Britain formulated a number of rules for the installation of lightning conductors,[32] and it was probably upon this basis that in 1883 Charles Mayes gave the very conservative rule that a conductor would protect an area no greater than the square of its height. Points, terminals and earth plates were to be of copper. Each earth plate was about thirty by fifteen inches [750 x 375 mm] by one sixteenth inch [1.5 mm] thick, and was inserted into damp earth at least two metres deep. It was generally surrounded by charcoal to attract moisture. Where rock prevented the plate from being sunk deep enough, an alternative was to provide it with copper wires radiating out in a number of directions.[33]

In 1886 Charles Mayes discussed of seven ply copper rope as a conductor, from a quarter to five eighths inch [6 to 16 mm] diameter, or copper bands from five eighths to one inch [16 to 25 mm] wide by one eighth inch [3 mm] thick. This was apparently to be fixed to the galvanized iron or lead ridge or hip capping, or iron spouting, and again provided with copper terminals and earth plates. Copper tubing could be used instead of wire, and it was important to avoid a wire on the market which was spuriously tinted to look like copper.[34] In 1908 C F Mayes listed both tape and rope conductors respectively $1\frac{1}{8}$ by $\frac{1}{8}$ inches [28.5 x 3 mm] and $\frac{1}{2}$ inch [13 mm] diameter; elevating tubes and terminals; copper earth plates; solid copper points, either plain or with three attractors; copper holdfast clips; and insulators. He stressed that it was important in using copper tubes or balls that all junctions should be sweated and soldered so that dust could not lodge inside and impair their effectiveness.[35]

In 1889 Henry Bastow, Chief Architect of the Public Works Department of Victoria, was directed to have lightning conductors installed at the various lunatic asylums. He told off J H Marsden to see R J L Ellery, the Government Astronomer, about the matter and, having established the necessary sizes for Yarra Bend and Ararat, to prepare a cost estimate. Ellery gave Marsden a pamphlet produced by the Royal Society of Victoria. It was in fact a reprint, produced by the Society in 1886, of a report and code of rules drawn up in Britain some years earlier by a conference of representatives of the Meteorological Society, Royal Institute of British Architects, the Physical Society, and the Society of Telegraph Engineers.[36] This was presumably the Lightning Rod Conference, already referred to.

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31 References supplied by Michal Bosworth from the data base on Fremantle Gaol. BL ACC1156 C9, 22 October 1872.

32 G L Sutcliffe [ed], *Modern House Construction* (new ed, 6 vols, London 1909), VI, p 400.

33 Charles Mayes, *The Australian Builders' Price-Book* (3rd ed, Melbourne 1883), p 113.

34 Charles Mayes, *The Australian Builders' Price-Book* (4th ed, Melbourne 1886), pp 127-8.

35 C E Mayes, *The Australian Builders & Contractors' Price Book* (7th ed, Sydney 1908), p 206.

36 Royal Society of Victoria, *Code of Rules for the Erection of Lightning Conductors* (no place or date [Melbourne 1886]), passim.

The code recommended a terminal ending in a shallow conical point, in which the height of the cone was not to exceed the radius of its base. A foot [300 mm] lower down there should be screwed and soldered onto the rod a copper ring carrying three or four sharp copper points about six inches [150 mm] long, and preferably platinised, gilded or nickel-plated to resist oxidation. The code did not claim to be able to specify an exact rule for the location of terminals, but it appeared to be generally taken in England that a terminal would protect a cone of a radius equal to the height or the terminal above ground (that is, that postulated by Gay-Lussac rather than Charles). Chimneys should have their own terminals linked into the system, and ornamental ironwork should also be connected. Much other detail about the route of the rods and the manner of fixing was specified, but the critical point is perhaps the material and size of the rod. Copper of at least sixty ounces per foot run [570 g per metre] was recommended, but iron of at least 2.25 lb per foot [3.4 kg per metre] was acceptable.

On the basis of this Marsden returned with a proposal for one inch [26 mm] galvanized piping with copper terminals, fixed at the highest points of the buildings at about 250 foot [76 m] spacing. G W Watson apparently followed the same principles in his estimate for the Kew Asylum, including the Idiot Asylum.[37] Unfortunately the contract books do not list any installation of lightning conductors at Kew at this time or any other, though the remains of a system of conductors can be seen there today. The idea of the platinum point was taken up locally in the specification for the National Mutual Life Association Building, Melbourne, in 1890, where it was to be attached to copper rod, which is not further described.[38]

c. later forms

Lightning conduction became increasingly the domain of patented and proprietary systems. In 1889 a Melbourne building was specified to have McCardel's patent conductors - presumably British - though not much information was given about them, except that the ends were to be in charcoal beds.[39] By the turn of the century there were a number of competing lightning conductor specialists in England. J W Gray & Son and J W Gray & Co, both of London, pointedly denied any connection with each other, but both used copper tape conductors and they cited some of the same buildings as examples of their work, so they were probably the outcome of some family schism. R C Cutting & Co of London also used copper tape 'as approved by the "Lightning Rod Conference"'. Two other firms, W J Furse of

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37 'Asylums, Various Plates &c.', including ms Public Works Department memos, correspondence number 88-9/47/5827.

38 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 28.

39 Hyndman & Bates, 'Specification, &c, Warehouse & Offices / Flinders Street West / E L Yencken Esq / Flinders Street E.' (Melbourne 1889), p 47.

Nottingham, and Dixon & Corbitt and R S Newall & Co, Ltd of London, both offered copper rope and tape as alternatives. One of these firms, Dixons, illustrated a terminal consisting of a central spike surrounded with four spikes slanting outwards. Gray & Co illustrated two terminals of this form, one of which was said to be platinum tipped, and the other gold or silver plated.[40] This is similar to the conductor on the Washington Monument, Washington, DC, which had a cap of eight spikes or points, each made of gold and platinum.[41]

The recommendations of the Lightning-Rod Conference (and, *ipso facto,* those of Mayes) were proved in time to have been inadequate, and as a result of a paper delivered to the RIBA in 1900 by Killingworth Hedges,[42] the Lightning-Research Committee was set up with Hedges as honorary secretary, and in 1905 produced recommendations which were not in fact radically different from those of 1882.[43] In the twentieth century it came to be held that the extreme height of some conductors in the past was superfluous, and the normal range became 900 mm down to as low as 113 mm, which might be scarcely visible from the ground. On a roof covered with inflammable material it was held that the points should never be less than 250 mm high. Spacing along the ridge should be no more than 4.5 m for short terminals, less than 500 mm high, or 7.5 m for taller ones.[44] The most bizarre lighting provision in Australia must have been at the house 'Myendetta', Charleville, Queensland, of 1908-10, where the architect Robin Dodds reportedly placed a lead ball on top of a roof ventilator to repel lightning strikes[45]

d. pioneering in electricity

Electric lighting was first used as a festive decoration in Sydney in 1863 to celebrate the marriage of the Prince of Wales, when an arc lamp was installed at the Observatory, powered by a battery consisting of a hundred cells of cast iron, each 200 mm high by 100 mm in diameter.[46] It was then used in Melbourne in 1867 for the visit of the Duke of Edinburgh, and the first permanent installation was made in 1877 (rather ironically) in the Apollo Stearine Candle Co works at the Melbourne suburb of Footscray,[47] using what was believed to be the only Gramme generator in Australia.[48]

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40 J E Sears [ed], *The Contractors,' Merchants,' and Estate Managers' Compendium and Catalogue* (15th ed, London 1901), pp 298-302.

41 James McCawley, *Roofing* (New York 1938), p 352.

42 See Killingworth Hedges, *Modern Lightning Conductors. An illustrated supplement to the Report of the Lightning Research Committee of 1905, &*c (London 1905), cited in William Duck, *Catalogue 103* (Ashburnham [Sussex] 1905), no 123.

43 Sutcliffe, *Modern House Construction,* VI, pp 400-404.

44 McCawley, *Roofing,* p 352.

45 Robert Riddel*, Robin Dods 1868-1920 Selected Works* (Uro, no place, 2012), p 101.

46 G F Anderson, *Fifty Years of Electricity Supply* (Sydney 1955), p 7.

47 Michael Cannon, *Life in the Cities* (West Melbourne 1975), pp 107-8.

48 H M Franklyn, *A Glance at Australia in 1880* (Melbourne 1881), p 249.

In 1878 electricity was used to illuminate construction work at the Garden Palace building in the Sydney Domain,[49] but proved so expensive that the lights were taken down within a month. It was nevertheless a pioneering attempt, for even in 1898 the use of floodlights to allow work to proceed at night on the Fair Store, Chicago, was regarded as innovative.[50] In 1879 H H Kingsbury came to Sydney in charge of Edison's electric pen at the Sydney Exhibition. An effort was made on Edison's behalf to establish a telephone exchange, but this was baulked when the government prohibited the taking of wires across a public street, and instead an exchange was established at the Post Office by E C Cracknell. Kingsbury apparently continued to represent the Edison company, and in 1881 installed an arc light at Redfern Station in 1881, and lit the New South Wales Legislative Council Chamber, beginning in October 1883. It is unclear when he severed his connection with Edison, but in April 1889 he turned to the system of the Thompson Houston Company when he installed a central station 'of 1500 lamps' at Young, New South Wales, to light both the streets and the houses of consumers.[51]

In 1879 electricity was being regularly used to light the Melbourne Cricket Ground for night sporting events.[52] In 1884 the Bank of Australasia in Melbourne became 'the first institution of the kind in Victoria to be lit by electricity',[53] and the trustees of the Exhibition Building invited tenders for lighting it by electricity, the tenderers being required to supply a plan indicating the number of lamps used and their candlepower.[54] By 1886, 160 new bedrooms in extensions to the Victoria Hotel, Melbourne, were fitted up by the Australian Electric Co in such a way that the 'electric lights [could] be turned on and off - a feature new to the colonies'.[55] In 1888-9 the Exhibition Building in Melbourne was lit using forty-one Brush arc dynamos for arc lights, and seven Brush Victoria dynamos for incandescent lights.[56]

With the partial exception of ‘Ontario’, below, the first house to have electric lighting installed may have been P A Waite’s ‘Urrbrae House’, Adelaide, of 1890-2. There is some reason to believe that Waite, a technical innovator by nature, always intended it to be lit by electricity, though the details of the installation are added onto the architectural drawings. Family tradition has it that the design of the electrical installation was by William Goodman of Poole & White, London, whom Waite could have consulted when in England early in 1890. The was a 100 watt direct current generator powered by a steam

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49 Anderson, *Fifty Years of Electricity Supply,* p 8.

50 Theodore Turak, *William le Baron Jenney: a Pioneer of Modern Architecture* (Ann Arbor [Michigan] 1986), p 289.

51 *Australasian Builder & Contractor's News,* 30 November 1889, pp 509-10.

52 Cannon, *Life in the Cities,* pp 107-8.

53 *Argus,* 26 July 1884, p 9.

54 *Argus,* 20 September 1884, p 15. This appears to have been superseded by a new or extended scheme for the 1888-9 Exhibition, designed and executed by the Australasian Electric Light, Power and Storage Company under the supervision of K L Murray, for the commissioners: *Australasian Builder & Contractor's News,* 16 March 1889, p 246

55 *Argus,* 19 October 1886, p 9.

56 Melbourne, Centennial International Exhibition 1888-1889, *Official Record* (Melbourne 1890), p 149.

engine, which charged about fifty cells in the battery house to the east, and this was later supplemented by the first wind powered generator in South Australia. here were between ninety and a hundred lights, both internal and external, with eight and sixteen watt globes.[57]

A certain lack of faith in the new form of power was demonstrated by those who installed bivalent fittings. At Wertheim's building in Sydney in 1889 the gaseliers were designed to be powered by either gas or electricity,[58] and the lights on the staircase of the Melbourne house 'Ontario' ['Labassa'], of a similar date, were also designed on the belt and braces principle. The National Mutual Life Association building in 1890 was not specified to have electric lighting but the contractor was to 'Make necessary provision in anticipation of Electric Light being used, lay all tubing and proper insulated wires to all places which "Gas fittings" are arranged for.'[59] By the time the building was complete, however, it appears that 246 electric lights had been installed.[60] In 1891 as many as 750 incandescent lights were installed at the Mutual Store in Melbourne.[61]

In 1887 the new building at Anthony Hordern's store in Sydney was lit throughout with electricity generated on the premises, using the same engines as powered the goods, passenger and service lifts.[62] In 1889 A J Arnot of the Union Electric Company of Australia carried out an elaborate installation at the Hotel Metropole in Bent Street, with a complete duplicate set of plant to guard against failure: two Elwell-Parker dynamos, each capable of supplying five hundred lights of sixteen candlepower, and driven by a sixty horsepower [80 kW] high speed Williams engine with steam from a Babcox and Wilcox water tube boiler. Each circuit was brought directly to the engine room, so that there were forty different circuits, using about nineteen kilometres of wire.[63] It has been claimed that City House in Pitt Street, headquarters of the City Bank of Sydney, of 1893, was one of the first in the city to be lit throughout by electricity,[64] but as this was six years after the Hordern building, the claim seems difficult to sustain.

One city after another was thrilled by the first local installation, as at Adelaide, where the Adelaide Arcade was lit throughout in 1885.[65] Electric light was soon installed at Kither's butcher's shop in Rundle Street, but in 1887 L

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57 Swanbury Penglase, 'Urrbrae House Conservation Management Plan' (Adelaide 2007), pp 35-7 Check all details.

58 *Australasian Builder & Contractor's News,* 7 December 1889, p 579.

59 Wright, Reed & Beaver, 'National Mutual Life Association', p 32.

60 Wright, Reed & Beaver, 'Statement of Accounts accompanying Final Certificate drawn in favour of R Gamlin Esq Contractor for the New Premises Collins St. known as "The National Mutual Building" erected for the National Mutual Life Association of Australasia, Limited' (Melbourne 1893), pp 7,11.

61 *Building and Engineering Journal,* 5 September 1891, p 113.

62 *Australasian Builder & Contractor's News,* 25 June 1887, p 120.

63 *Australasian Builder & Contractor's News,* 7 December 1889, p 535.

64 Emery Balint, *Record of Commercial Buildings Constructed in the Victorian Era in N.S.W.* (Sydney 1987), p 212.

65 Susan Marsden et al, *Heritage of the City of Adelaide* (Adelaide 1990), p 84.

Conrad's butchery was the first shop to be completely lit by electricity. A thirty light dynamo made by R E Crompton & Co of London was installed on the premises[66] by Crompton's local representatives C J Otte & Co, who then went on to use Crompton plant to light the Adelaide Oval for a cycling meeting in February 1889, as well as Fulton & Co's foundry at Kilkenny, the roller flour mills of Harrison & Co and John Dunn & Co, and the factory of W H Burford & Co in Sturt Street (where a previously installed Woodhouse & Rawson machine was replaced).[67] The first domestic installation in the colony was probably Peter Waite's 'Urrbrae House' at Netherby, of 1890.[68]

In 1886 E C Barton, of Barton White & Co, connected Parliament House, Brisbane, by cable to the Government Printery, where the steam engine which drove the presses had already been used to generate electricity, and this enabled arc lighting to be used in the parliament. The firm went on to build a power station in Creek Street in 1888, and undertook many individual installations in sugar mills elsewhere in the colony.[69] Late in 1888 Barton White supplied two electric fans to the Gaiety Theatre, powered by accumulators which had to be taken to the company's plant in Elizabeth Street each day for recharging.[70] In Perth the Lands Department building in 1894 was lit exclusively by electricity, so as to avoid the risk of fire posed by gas.[71]

In October 1887 the council of Tamworth, New South Wales, accepted a tender from Harrison and Whiffen of Sydney, representatives of R E Crompton & Co of London and Chelmsford,[72] and the first system of electric street lighting in Australia was completed in 1888 (preceding that at Young, mentioned above). It used two compound semi-fixed twelve horsepower [9 kW] engines and two Cromptons patent XV dynamos, with ten kilometres of main lead, ten of branch lead, and 1.5 of arc lamp lead, all supplying two hundred incandescent street lamps and three Crompton arc lamps.[73] There were still varied and small scale competing systems of generation at this stage, but soon electricity became a public utility involving specialised technology, rather than a part of the regular building scene, and offered little scope for local innovation.

There were also setbacks and reactions. At Geelong one W Thompson - possibly a front man for the gas interest - in 1894 produced a booklet *Electric*

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66 *South Australian Register,* 31 October 1887, quoted in 'Zetetic', *Descriptive Australia* (Adelaide 1889), pp 149-50.

67 'Zetetic', *Descriptive Australia,* pp 146-50.

68 Malcolm Fraser et al, *Heritage of Australia* (South Melbourne 1981), pp 5 / 38-9.

69 Cannon, *Life in the Cities,* p 114, quoting the *Australasian Ironmonger,* July 1891; J E Morwood, *History of Electricity Supply in Brisbane* (Brisbane 1968); H G Egeberg, 'The Development of Electricity Supply in Queensland'; *Royal Historical Society of Queensland Journal,* September 1959.

70 *Australasian Builder & Contractor's News,* 17 November 1888, p 439.

71 *Tamworth Observer,* 14 November 1888, quoted in 'Zetetic', *Descriptive Australia,* pp 146-7.

72 *Australasian Builder & Contractor's News,* 22 October 1887, p 381.

73 I R Lobsey, *City of Light* (Tamworth [NSW] 1988), pp 29-31.

Light! Its Cost, Disadvantages, and Danger. This showed, or purported to show, that at Tamworth the rates had to go up to fund the electricity supply; the Western Australian Electric Light Company was in liquidation; and the Melbourne Electric Light and Motive Power Company had spent over £70,000 on works, but showed a loss of £2,000 in the past year. The electric light installation at the Centennial Exhibition had cost about £60-£70,000, when gas would have cost £12,000. At the Palace Hotel, Melbourne, the manager estimated the electricity cost at £4,840, compared with the previous £1,500 for gas.[74]

These pioneeering installations were all presumably based upon direct current, and the change to alternating current is not well documented. In the USA direct current was used by the General Electric Company, formed by J P Morgan's merger of the Edison Compsany and others. Their compaetitor George Westinghouse had acquired patents from Nikola Tesla, and the Westinghouse Company marketed alternating current, their first major step being to secure the lighting contract for the Chicago Worlds Fair of 1893. There were also problems of differing standards and voltages. At about the turn of the century the old 100 volt systems were replaced in Melbourne by 230 volts, which was still different from other cities such as Adelaide, at 200 volts, and from country areas in Victoria like Geelong, Bendigo and Ballarat, all on 220 volts. The General Wiring Rules were adopted throughout Australia, and tended to strongly discourage the old wooden casings, and to favour metal tubing instead. However the wooden casings were actually prohibited only in specified situations, such as damp areas, and wiring which was to be embedded in plaster.[75]

Country areas were a different question, for many properties continued to install private generators, and they were varied in type. As early as 1890 E H T Plant's house at Charters Towers had 'an electric lighting apparatus' to serve the whole house, installed by Barton, White & Co.[76] In 1895 electric lighting was installed at 'Caragulac', Western Victoria.[77] An installation at 'Holey Plain', Victoria,[78] thought to date from about 1900, remains with a room full of glass battery cells, and a switchboard branded:

DRAKE & GORHAM LIMITED
ENGINEERS
LONDON
MANCHESTER GLASGOW

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74 W Thompson, *Electric Light! Its Cost, Disadvantages, and Danger* (Geelong 1894), passim.

75 H R Harper, 'Electrical Installation Work: with Remarks on some of the Well-Known Appliances of Electricity', *Journal of the Royal Victorian Institute of Architects,* II (November 1904), pp 142-7.

76 *Northern Miner,* 21 February 1890.

77 Heather Ronald, *Wool Past the Winning Post* (South Yarra [Victoria] 1978), p 154; the reference does not state that .

78 Inspected 2001.

By about 1920 C Rae of Sydney was advertising as agent for the Lalley Electric Light Plant, which was marketed for use in country houses,[79] and in 1925 the artist Arthur Streeton spoke proudly in 1925 of his 'Lister plant for light'.[80] By the 1930s Quirks, whose air gas plants have been discussed above, were advertising the Victory Light plants for country houses.[81]

Some larger country properties installed hydro-electric schemes. 'Myendetta', near Charleville, Queensland, of 1908-10, used the water flow from a bore to drive a Pelton wheel, connected to a 240 volt direct current generator. This was installed by the Sydney electrical engineers Stanton Cook and Company.[82] At 'Carranballac', Victoria, a large weir was built in 1919-21 to supply hydro-electric power to both the house and the shearing shed. The consultant engineer, B A Smith of Melbourne, installed two Westinghouse eighty horsepower [60 kilowatt] turbine generators, which were run twice weekly to charge 192 wet cell storage batteries, giving a 240 volt DC supply. In 1930, when the water storage proved inadequate for the demand, one the turbines was replaced with a Ronaldson & Tippett oil engine. All this survives today.[83] A hydro-electric scheme installed at 'Murndal' was less successful, for the water ran out immediately, and a Ruston Hornsby generator was installed instead.[84] Another Victorian example was at 'Ercildoune', near Ballarat, after its acquisition by Major Sir Alan Currie in 1920. At 'St Fillian's', Narbethong, a hydro-electric system imported from London for £3,000 was used.[85] By the 1920s generators by the Kohler Co of Kohler, Wisconsin, USA, were being sold in Melbourne through their agent, G Murray of William Street.[86]

Country properties also made use of wind generators, especially those manufactured by Gilco in South Australia, from the 1930s. One of these was installed at 'Galway Downs' (now 'Currareva') homestead in western Queensland in 1934, and another at 'Springfield' soon after, but they produced only 500 watts, which was inadequate for station purposes. After World War II Dunlite produced not only a 'Winlite' generator which suffered from the same limitation, but also larger models. However, a 110 volt, 1500 watt Winlite installed at 'Moothandella', Queensland, proved useless because there was never enough wind. They also made direct coupled plants up to quite large capacities, ten or more KVA, using Lister diesel engines, which

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79 *Book of Australian Bungalows* (Sydney, no date [c 1920]), rear endpaper.

80 Streeton to Baldwin Spencer, 28 January 1925; Streeton to Julian Ashton, 4 July 1934: Ann Galbally & Anne Gray [eds], *Letters from Smike* (South Melbourne 1989), pp 181, 202,

81 *Argus,* 4 February 1937, p 7.,

82 Robert Riddel*, Robin Dods 1868-1920 Selected Works* (Uro, no place, 2012), p 103,

83 Inspection, 2000, and Ronald, *Wool Past the Winning Post,* pp 141, 195.

84 Information from Mr & Mrs Winter-Cooke, owners of the property, 2000.

85 Built by Edward Dyason after 1937 (using material from a previous house: M R Clark, 'Wowser's Narbethong Retreat has many Lives', *Age,* 28 August 1993, Travel p 3.

86 Murray's stamp appears on copies of Kohler Co, *Press-the-Button Service from Your Own Electric Plant* (Kohler [Wisconsin] 1926).

are reported to have been very good machines,[87] hence Streeton's pride in his one.

e. appliances

The technology of electric lamps and appliances was, unsurprisingly, entirely imported from overseas. In 1873 a Victorian patent was granted to Alexander Nicolaievitch Lodighin of St Petersburg, Russia, for an improved electric lamp in which rather than a discharge between two carbon terminals, a continued 'stem' of carbon was used, becoming incandescent as the electricity passed through it. To avoid it being consumed it was enclosed in a vacuum.[88] It is unclear how this varied from J W Swan's first carbon filament lamp of 1860, but it preceded Swan and Edison's development of the workable incandescent lamp in 1878 and 1879, referred to below.

In practice, however, the first electric lamp to appear locally was the 'Jablochkoff Candle', a self-regulating arc lamp in which carbon points were controlled by springs. It was the invention of Jablochkoff, a Russian military engineer, and named in reference to the carbon electrodes, which were called candles. One of its earliest uses had been to light the façade of the Paris Opéra for the inauguration of the Avenue de l'Opéra on 19 September 1877.[89] The Jablochkoff lamp was first illustrated locally in the *Australian Engineering and Building News* in 1881,[90] but it belonged to a generation which would be swept aside by the incandescent filament lamp, and is of no importance in building terms. It had already been reported in Melbourne that the 'Jablochkoff Electric Candle' had been outperformed by gaslight when tested in London.[91] Nevertheless, in 1888 Alfred Upton Alcock and Henri Galopin of Melbourne obtained a Victorian patent for an 'automatic compensating feed electric arc lamp', which was presumably that of Jablochkoff.[92]

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87 Mr Tom Cartwright, Rockhampton, letter of 21 March 1994.

88 Victorian patent no 1770, 17 May 1873.

89 C C Mead, *Charles Garnier's Opéra: Architectural Empathy and the Renaissance of French Classicism* (New York 1991), p 196.

90 *Australian Engineering and Building News,* 1 July 1881 (here reported as 'Joblochkoff'). The Jablochkoff 'electric candle' worked on alternating current and required no regulator and little attention. For a time it was regarded as superior to direct arc lamps, and by 1880 was in wide use in France and elsewhere in Europe, and was installed in a number of London underground stations. Elton Engineering Books, *Catalogue Number 16, Gas and Electricity for Light & Heat, &c, &c* (London 2001), p 24, ref Société Générale d'Électricité (Procédés Jablochkoff), *Éclairage par la Bougie Électrique des Voies Publiques, des Grand Magasins, Cafés, Salles de Concerts, Théatres, Hôtels, Restaurants, &c* (Paris 1880).

91 Ray Proudley, *Circle of Influence: a History of the Gas Industry in Victoria* (North Melbourne 1987), p 70, quoting the Report of Directors at the Second Ordinary General Meeting of the Metropolitan Gas Company, 28 January 1879.

92 *Australasian Builder & Contractor's News,* 24 November 1888, p 475.

In 1882 more advanced lamps were shown at the Melbourne Electrical Exhibition: the Maxim, British, Bracket and Swan types.[93] By 1888 some electrical appliances were being manufactured in Sydney, though it is not clear which.[94] The invention of the incandescent lamp is of course credited jointly to Swan and Edison. Thomas Alva Edison patented his incandescent lamp in the United States in 1879, and lodged the same application in Victoria in 1880.[95] The Edison lamp was first demonstrated at the Sydney Exchange on 7 December 1882 by the local representative, H H Kingsbury, along with Edison's other improvements, the subdivision of the electric current, and the 'multiple arc' system.[9697] In 1888-9 the Exhibition Building in Melbourne was lit with 937 Brush arc lamps, five Brockie-Bell arc lamps for the dome, two Castle arc lamps, two thousand Swan incandescent lamps, and twenty-seven 'incandescent "Sunbeam" lamps', probably the equivalent of sunburners, as they ranged from 200 to 600 candlepower.[98] In 1928 Albion Walkley was specifying Edison lamps of 16 candlpower in a storeroom, 25 candlepwer in a passage, maid's room and laundry, and 50 candlepower in all the other rooms of a house.[99]

Although there were no significant local inventions in this field, there were some distinctive personalities. Miss Alice Cornwell was a patentee of inventions, mining entrepreneur, newspaper proprietor, company promoter, and lecturer. In October 1888 she invited the press to Hoffnung & Co's warehouse in Sydney to see a demonstration of the Schauschieff Electric Light. It had the useful quality (at least in one model) that it extinguished itself when inverted, and relighted when put upright again. It worked off a single fluid primary battery, charged by a solution of mercury salt, and required a liquid which could be bought at grocery shops, at a cost similar to kerosene.[100] By 1889 there was a Victorian Schauschieff Electric Light and Power Company, which in September successfully lighted a carriage on the Essendon Railway Line. All the materials except the patent incandescent lamps themselves were reportedly manufactured in the colony.[101]

The carbon filament lamp was challenged by the Nernst lamp, with a filament of zirconia and other rare earths, which was effectively a development of the

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93 Illustration from the *Australasian Sketcher,* 1 July 1882, reproduced in Proudley, *Circle of Influence,* p 71.

94 The new Central Station and Factory of the New South Wales Electric Light and Power Supply Company, in Kent St, was devoted 'solely to the manufacture of electrical appliances and the supply of electric light: *Australasian Builder & Contractor's News,* 3 November 1888, p 402.

95 Unitedf States patent no 223,898 of 1879; Victorian patent no 2,780, of 1880, cited in David Yandell, '150 Years of Victorian Patents', *The Source,* 14 (May-June 2004), p 11.

96 *Australasian Builder & Contractor's News,* 30 November 1889, p 509.

97 *Argus,* 19 October 1886, p 9.

98 Melbourne, Centennial International Exhibition 1888-9, *Official Record,* p 149.

99 A H Walkley, 'Specification for Brick Residence Riversdale Road Hawthorn for E.V. Jones Esq.' (Melbourne 1928) p 26.

100 *Australasian Builder & Contractor's News,* 13 October 1888, p 326.

101 *Australasian Builder & Contractor's News,* 14 September 1889, p 247.

Jablochkoff principle.[102] It had been invented in 1898 and by 1904 was available in Australia in an improved version, the 'Brilliant Nernst'.[103] But it was short-lived: as early as 1909 C J Robertson wrote that the Nernst lamp was almost obselete due to problems with the mounts, slowness in lighting up, unreliability, and relatively low efficiency.[104] It is unclear precisely what these are, but in 1906-7 the 'New Meridian electric light' was used in the display windows and 'Lucas patent incandescent light' in the interior of Dimelow & Gaylard's drapery store, Richmond, Melbourne.[105] The metal filament lamp, first introduced in 1907, reached Sydney in 1909 when the Council began replacing the carbon filament lamps in its own premises and in its contract lighting. It was only at about this time that metal filament lamps were first manufactured in Britain[106] It was the replacement of the earlier filaments with the osmium filament of Auer von Welsbach (already known for his mantle) which made this type really viable.[107] The much less brittle wire filaments of 1910 and the vastly brighter gas-filled lamp of 1912 probably arrived equally quickly. The Australian General Electric Co was advertising the Mazda drawn filament lamps ('stronger than steel') by 1912.[108]

In 1914 Fred S Lee of Sydney was advertising 'new electrical devices', and claimed to have samples and stocks always arriving. One was the Hubbell ceiling pull switch and rose, controlled by a chain hanging down from the ceiling fitting, and hence claimed to avoid disfigurement of the walls, as well as the problem of chasing out the plaster. Another was the H. & H. push button switch,[109] examples of which survive at 'Mount Pleasant' near Launceston, where the brand can be read as 'Hart & Hegeman Mnfg Co.'[110] and others (at east until fairly recently) at 31 Hampden Rd, Prahran, Victoria. Each switch has two buttons, linked so that when one is pushed in the other pops out, so that there are two separate configurations, one of which was off and the other on. The dimmer, which was the next major development in electrical switches, made its appearance in the commercial market only in the 1960s.[111]

In 1912 the Australian General Electric Company (clearly an offshoot of the American company, as it used its brand) was advertising a G.E. coffee percolator, 'disc stove', water heater, electric iron, 'Radiant Toaster', electric

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102 C J Robertson, 'Incandescent Lamps', in Magnus Maclean [ed], *Modern Electric Practice* (2nd ed, 6 vols, London, no date [1909]), III, p 282.

103 Harper, 'Electrical Installation Work', pp 155-6

104 Robertson, 'Incandescent Lamps', p 283.

105 *Richmond Guardian,* 2 & 16 March 1907, kindly supplied by Sam Furphy.

106 Robertson, 'Incandescent Lamps', p 289.

107 Robertson, 'Incandescent Lamps', p 284.

108 R A Prevost, *Australian Bungalow and Cottage Home Designs* (Sydney 1912), advertisements following p 62.

109 C E Mayes, *The Australian Builders & Contractors' Price Book* (8th ed, Sydney 1914), advertisement p 25.

110 Inspected 2006. They probably date from 1924, which is the date of the switchboard.

111 *Australian House and Garden,* October 1965, p 106.

kettle, and hot water cup or shaving mug.[112] By the 1920s the Edison Swan Company, with branches and agents in all Australian capitals, was selling 'Tricity' brand ovens and cookers. One of the latter, for example, had an oven, a griller, and two boiling rings on top. They also sold single boiling rings, hot plates, toasters, kettles and irons.[113] By the 1930s the local company Metters KFB was making a very similar range, though they were overseas models presumably manufactured under licence. The majority of the cookers were from the 'Moffat' range, while others used 'Hotpoint' elements, and bore that name as well as the Metters brand. A commercial range and a baker's oven were branded 'Therma', whilst radiators in various models using an element with a circular concave reflector behind were called 'Neptune', 'Mercury', 'Planet' and 'Sunlight' - obviously all from a single source Other items such as a commercial fish frier and an electric hot water tank were branded only 'Metters'.[114] Meanwhile in 1923 W G Allingham & Co of Melbourne was the sole distributor for Australia of McClary's electric ranges,[115] and at the Napier Waller house in the Melbourne suburb of Ivanhoe there remains a McClary's stove, apparently of 1927. It is a Canadian product of unusual design, with a circular door in the front. There is also an electric water heater, which has been mentioned above.[116] In 1925 H Rowe & Co of Melbourne were selling Jackson electric stoves, made in Britain, which they claimed to be 'more economical',[117]

In about 1928 the Melbourne architect J A B Koch patented an electric heater which could be hung from the ceiling like a light fitting, and was claimed to be suitable both for domestic use and, in large sizes, for public halls. No surviving example has been identified.[118] Between the wars the plain flat panel electric heater, like those used for diect gas heating and hot water radiation, became available in Britain. It consisted of a glazed fireclay or 'Morganite' panel 5/8th inches [16 mm] thick, within which was embedded a resistance element of graphite. The face of the panel was typically slate grey, though other colours were produced.[119] Another panel, the 'Electrorad', was not of the embededed element type but was a cast iron plate with two cores cast on the rear side, within which ran wire heating elements.[120] Neither type has so far been documented in Australia. After World War II electric convection heating became common, and H Rowe & Co advertised a console model, a wall mounted model, and another recessed into the wall so as to

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112 Prevost, *Australian Bungalow and Cottage Home Designs*, advertisements following p 62.

113 Edison Swan Electric Co. Limited, *Ediswan Electric Cookers and Appliances* (Melbourne, no date [c 1920s?]).

114 Metters KFB. Pty. Ltd., *Electric Cooking and Heating Appliances* (Melbourne 1934).

115 V C Marshall, *The 'Herald' Ideal Homes Exhibition, Wirth's Park, Melbourne* [catalogue] ([Herald, Melbourne] 1923), p 48.

116 Inspected 2003..

117 *Australian Home Beautiful,* 12 November 1925, p 13.

118 *Australian Home Beautiful,* 2 July 1928, p 23.

119 J F Stanley, 'Electric Heating', in A A Jones [ed], *Modern Heating and Ventilation* (3 vols, London, no date [c 1930]), II, pp 187-9.

120 Stanley, 'Electric Heating', pp 190-1 & illustration facing p 188.

present only a flush metal surface.[121] Ratherless forward-looking were the electric radiators which simulated the appearance of coal fires, including the 'Dawnberry', 'Glenberry' and 'Villaberry', produced (probably in Britain) under H H Berry's British and world patents, and sold by Warburton, Franki, of Melbourne.[122]

The first all-electric kitchen, including a dishwasher, was demonstrated at the Chicago Worlds Fair of 1893,[123] and the exhibitors would probably have been surprised to know how long it took for the device to be taken up by consumers. 'Dish-washing machines, clothes washers and electric hot water systems are with us now', wrote the Sydney architect Augustus Aley in 1927, while the Electricity Sales Branch in Sydney was prepared to assert that 'Washing-up Machines, driven by electricity, are a modern necessity'.[124] Again, both would have been surprised to learn that it was to be another forty years before the domestic dishwashing machine achieved any reasonably wide acceptance, a delay probably due to the arrival of the Great Depression, followed by World War II. Appliances such as television sets are not a substantial concern here, but when they are networked within a building they cannot be ignored. In Victoria the first school with a closed circuit television system, as well as a 'tele-distribution system for outside broadcasts' was Mount Scopus College, by Dr Ernest Fooks and Anatol Kagan, completed in 1960.[125] By now even remote controlled garage doors, like the 'Franklin;' were becoming available for domestic use.[126]

Neon (or luminous tube) lighting in Australia has yet to be comprehensively researched. Heinrich Geissler had experimented in 1856 with a sealed low pressure tube which produced light when a high voltage alternating current passed through.[127] However the first effective first luminous tubes were those of the Englishman D MacFarland Moore, filled with carbon dioxide and nitrogen, through which a current was passed between electrodes at either end. These tubes were used for signs and other purposes in England from 1893 to 1910, but proved not to be durable. Neon gas was discovered in 1898,[128] and the Frenchman Georges Claude discovered that he could create an intense red in a tube filled with the gas, as well as a greyish blue using argon. He showed his first luminous tube sign in 1910, sold the first

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121 F W Ware & W L Richardson [eds], *Ramsay's Architectural and Engineering Catalogue* (Melbourne 1954), § 39/11.

122 Magicoal Plus Fires, Heating *of To-Day* (no place [Britain], no date [?c1940]), p [3]: this apparently British leaflet bears the stamp 'Warburton, Franki, (Melb.) Ltd. / Electrical Engineers & Merchants / 560 Bourke St. / Melbourne'.

123 Larsen, *The Devil in the White City,* p 247.

124 Augustus Aley, 'Constructing the Home', in Bebarfalds Ltd, *Safe Home Planning* (Sydney, no date [1927]), p 51.

125 *Cross-Section,* 91 (1 May 1960), p 1.

126 *Australian House and Garden,* December 1965, p 102.

127 Rudi Stern, *Let There Be Neon* (New York 1979), p 16.

128 M F Crowe, 'Historic Neon Signs: their Origin, Use, and Maintenance', *Docomomo Journal,* 11 (1994), p 52. This is substantially the same paper as M F Crowe, 'Historic Neon Signs: their Origin, Use, and Maintenance', *APT Bulletin,* XXIII, 2 (1991), pp 30-37.

permanent sign to a barber's shop in 1912,[129] and erected a prominent 'CINZANO' sign in Paris in 1913.[130] Claude also patented the long life electrode, and by the mid-1920s he was able to establish franchises in the United States, Britain and British colonies,[131] the first neon sign being put into commission in the United States in 1923.[132] In the 1930s, following the expiration of Claude's patents, other manufacturers established themselves, and novel animation and design techniques were developed, especially in the United States.[133]

Claude received two Australian patents in 1924,[134] and in 1925 one Hack, of Collins Street, Melbourne, received a patent for an improvement described as a vacuum tube illuminating device.[135] Claude Neon is believed to have been established in Melbourne in the early 1930s,[136] and the first identifiable signs date from 1932, such as that on the Capitol Building, Swanston Street.[137] In about 1935 the Melbourne City Council refused to permit the neon sign proposed for the McPherson building in Collins Street.[138] The 'Pelaco' sign in the Melbourne suburb of Richmond is one of the oldest surviving examples in Australia, and dates from 1939,[139] though the 'chasing' border of white globes is a later addition.[140]

f. telephones

In general terms the telephone is outside the scope of this study, but it is worth recording that Alexander Graham Bell, who patented the telephone in the United States in 1876, was refused a Victorian patent two years later.[141] In January 1878 Sir Charles Todd had undertaken a trial of the apparatus in Adelaide, making use of existing telegraph lines. By July 1878 Briscoe & Co of Melbourne were operating a private telephone between their two sites:

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129 Crowe, 'Historic Neon Signs' pp 52-3.
130 R Stern, *Let There be Neon* (New York 1988), p 23.
131 Stern, *Let There be Neon*, p 27.
132 Stern, *Let There be Neon*, p 25.
133 Stern, *Let There be Neon*, p 27.
134 Australian patent no 16038/24, to Georges Claude, 1924, for 'A device for feeding rarefied gas tubes, &c'; no 16039/24, to Georges Claude, for 'Process for the shaping of glass tubes ...', cited in David Wixted & Anne Cahir, [Victoria, Historic Buildings Council, registration assessment for the Pelaco sign, 21-31 Goodwin St, Richmond (Melbourne 1995), p 3.
135 Australian patent no 25530/25, to Hack, 1925, for 'Vacuum tube illuminating device', cited in Wixted & Cahir, p 3.
136 Allom Lovell & Associates, [extract from a report on the Pelaco sign, Richmond] (Melbourne 1995), p 7, quoting information from B McClure, a former employee.
137 Wixted & Cahir, p 3.
138 Allom Lovell extract, p 7.
139 Wixted & Cahir, p 5.
140 Allom Lovell extract, p 7.
141 United States patent no 174,465, of 1876; Victorian patent application no 2,437 of 1878, cited in Yandell, '150 Years of Victorian Patents', p 11.

> Telegraph instruments, now largely employed by business firms, occupy a conspicuous corner, and the telephone lies ready for use whenever questions need to be sent to the iron yard at the top of Elizabeth-street.[142]

In mid-1879 the Edison telephone was brought to Australia, and a line was run between the head offices of Robison Bros, electrical contractors of Flinders Street, Melbourne, and their works at Queens Bridge. Then a telephone switchboard was tentatively opened by Henry Byron Moore in May 1880, and by the time it was more formally inaugurated in August, there were forty-three subscribers.[143] The National Mutual Building, of 1890-3, was provided with about thirty 'telephonettes'.[144] Meanwhile the first viable automatic system was patented in the USA in 1891 by Almon B Strowger, whose company went on to introduce various improvements, including the rotary finger wheel dial in 1896.[145]

The Postmaster-General's Department at first introduced the common battery (CB) system, on the advice of its engineer John Hesketh, but retained a potential interest in automatic telephony.[146] And in fact the Department quite shortly adopted the Strowger / Automatic Electric System, from the United States. A trial witchboard was imported by the company and installed at its expense at the Sydney GPO in 1911.[147] Then the PMG called tenders for the first permanent exchange at Geelong in 1912, and the contract was awared to the [Strowger] Automatic Telephone Company.

However Britain had adopted three systems, the Strowger and two others. One of these others, the Relay Automatic Telephone System, had been invented by Gotthilf Betulander of Sweden in 1897, using levers in a vertical plane to select the required line. From 1911 atempts were made to introduce this in Britain, France and elsewhere, and in 1915 the company became the Relay Automatic Telephone Company.[148] Relay attempted to break into the Australian market, but was repressed until about 1918 by Amalgamated Wireless Australia (AWA), the company which had been formed to represent a number of foreign interests and patents, including those of Marconi.[149] By 1918 AWA seems to have acquired the rights to the Relay system as well, and advertised itself as being that company's sole representative.[150] Whether

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142 *Argus,* 6 July 1878, p 6.

143 J M Crawford, 'The Development of Communication in Victoria', in *One Hundred Years of Engineering* (Institution of Engineers, Melbourne 1934), [part 1] pp 402-3.

144 Wright, Reed & Beaver, 'Accounts for National Mutual Building', p 8.

145 John Liffen, 'Epsom, Britain's First Public Automatic Telephone Exchange', *International Journal for the History of Engineering & Technology,* 82, 2 (July 2012), p 211; John Moynihan, 'Early Automatic Telephony in Australia', *One Hundred Years of Engineering* (Institution of Engineers, Melbourne 1934), p 100.

146 Moynihan, 'Early Automatic Telephony', p 100.

147 Moynihan, 'Early Automatic Telephony', p 101.

148 Liffen, 'Epsom', p 213.

149 Information from Andrew Willett, 2009.

150 *The Year-Book of Wireless Telegraphy & Telephony 1918* (Wireless Press, London [1918]), advertisements, p 3.

this was an ongoing arrangement is unclear, but the Relay company's own brochure in the 1920s lists amongst its customers Australia House, London, and in Australia itself only the offices of Winchcombe Carson in Sydney, and the West Australian Government Railways.[151]

The rise of the intercom also deserves a mention. In 1922 it was reported that just as 'the electric sweeper has long held sway over the broom' the intercom phone was to be means of internal communication: 'all tradesmen's inquiries may be answered, all orders sent through to the kitchen and garage, and all instructions passed on the instant they come to mind.'[152] These intercoms were marketed by the Western Electric Company (Australia) Ltd. of Sydney, and their Victorian representative, C R Foster.[153] A British type, the Relay Automatic Telephone System, was represented by Austrelectric Ltd of Sydney and Melbourne, and their 1920s

151 Relay Automatic Telephone Company Limited, *The "Relay" Automatic Telephone System,* pp 23-9.
152 *Every Man's Home,* 11 (October 1922), p 7.
153 *Every Man's Home,* 11 (October 1922), p 8.