

Early Automatic Telephony in Australia

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SUMMARY The paper discusses the initial installation of automatic telephone exchanges in Australian capital city networks in the 1910s and 1920s with particular discussion of problems associated with the Perth installation. Rural Automatic Exchange development in the 1920s and 1930s is briefly outlined.

1 INTRODUCTION

A fair proportion of engineering heritage matters deal with activity of which some sort of physical evidence remains, eg bridges. With communication engineering and allied fields such as electronics the working life of plant is relatively brief due to technological changes. Also as the plant is easily disposed of, few artefacts remain. Thus it is necessary to seek out the engineering heritage of communications from written records, photographs and the like. This paper is a case study assembled in that manner.

In this age of automation it is difficult to believe that automatic telephony was not readily received as it emerged. The paper examines the reasons for this, especially as these reasons affected the Australian scene.

Automatic telephone working was first patented in the USA in 1879 but it was some years before a workable system emerged and even this was limited by practical considerations.

After examination and consideration of both automatic and manual systems available world-wide, Australia opted for manual equipment in 1906. It was to take a second overseas trip by the Postmaster-General's Department's Chief Electrical Engineer John Hesketh in 1912 before automatic working began to be accepted in Australia. Even then troubles experienced with the Perth installation cast a brief cloud over the system's future. Subsequently World War 1 slowed up introduction of automatic telephone working to all Australian capital cities.

Rural Automatic Exchanges were introduced to Australia late in the 1920s, but their spread throughout the nation was slowed by the depression.

2 EARLY AUTOMATIC TELEPHONE SYSTEMS

Bell invented the telephone in 1876 and only three years later Connolly and McTighe were granted a USA patent for an automatic system. This and a number of other early systems, described in references 1-4, were not practical.

The first viable automatic system was patented by Almon B Strowger in 1891 and the first exchange of his type was commissioned at La Porte, Indiana late in 1892⁵. This system used five wires from the exchange to each subscriber. The

Strowger company's Alexander Keith together with John and Charles Erickson introduced an improved bi-motional selector in 1895 and the rotary finger-wheel dial in 1896. Other improvements took place and, by 1900, there were only two wires from exchange to subscriber; however a third wire connected to ground at the subscriber's premises was necessary to complete a call from an automatic telephone instrument - this was the so-called three wire working. In some, if not all systems, each instrument required a local transmitter battery.

Presumably there was some interest in Australia in the activity of the 1890s described above, but the writer has not researched that era.

3 AUSTRALIA : 1901-1910

The first mention of automatic telephony in an Australian publication seen by this writer is in the Melbourne Herald of June 1903. It was stated that the firm of Clarke, Padley and Coy of Melbourne had brought to the notice of the Postmaster-General an automatic telephone system for which they supplied a catalogue. Apparatus was not available for a practical test⁶.

At the formation of the federal Postmaster-General's (PMG) Department in 1901 there was initially no Engineering Department at the Melbourne Headquarters. Late in 1904 John Hesketh, Electrical Engineer for the PMG Department, Queensland, went on an overseas tour to study recent developments in the telephone art, including automatic working. Hesketh, an Englishman, had been brought to Australia by Queensland's Colonial Post Office as their Electrical Engineer in 1896. He was previously an Electrical Engineer with the Corporation of Blackpool.

On his return in 1905 Hesketh reported, inter alia, on automatic telephony; it was, he said, the most difficult problem to solve on his tour, ie, automatic versus manual systems. The greater majority of installations he saw were of the then modern common-battery (CB) manual switchboard. Also the automatic system would not, among other things, work party lines or private branch exchanges. Hesketh's report opted for the CB system but concluded that the PMG Department should not lose interest in automatic working altogether.⁷

John Hesketh was appointed to the PMG

Department's Headquarters Administration as the first Chief Electrical Engineer in February 1906. At that time a decision had to be taken as to what type of apparatus would be installed in new exchanges planned for Sydney, Melbourne and Hobart. PMG Austin Chapman decided on CB on Hesketh's advice⁸. Subsequently, Australia's first CB exchange was opened at Hobart in 1907.

Alexander Graham Bell visited Melbourne in 1910 and gave evidence to a Royal Commission investigating the Postal Service. Bell's opinion was that the CB system was "the most perfect system at present existing". He described automatic working as "still in the experimental stage" and seemed to be in favour of it being made "more practical"⁹. Bell was also very critical of the poor quality service being given in Australia by the single wire earth return subscribers' circuits. Only eight percent of lines in the nation were metallic (two wire) at 1901, by 1910 this had risen to fifty percent.

In discussing the state of telephone switching on the world scene as it was in 1910, Chapuis says: "In switching, manual telephony held undisputed sway in 1910, except among a few dissidents who were still regarded as exaggeratedly progressive. Manual telephony had reached a high degree of perfection, especially in the United States Indeed automatic exchanges were the exception to the rule and, in the United States, were operated by the independants (non-Bell companies). In Europe a few were put into service"¹

Chapuis then goes on to say that despite the doubts of most telephone authorities, automatic exchanges were proving that they worked properly and that the public was adapting to the new, albeit more complex method of operation.

4 AUTOMATIC TELEPHONY EMERGES IN AUSTRALIA

Obviously the PMG Department had been thinking of automatic telephone exchanges in 1910 as, in January 1911, tenders were called for a switchboard at Geelong which allowed for alternative tenders for manual or automatic equipment. The gazettal said that tenders would be accepted for either a branching multiple magneto lamp-signalling switchboard, or an automatic, or semi-automatic switchboard "together with all associated apparatus and subscribers' instruments".

In March 1911, the Sydney Morning Herald announced that a representative of the Automatic Telephone Company would soon arrive from America with an automatic plant capable of dealing with 100 subscribers; PMG Josiah Thomas was hopeful it would be installed in the Sydney GPO to allow automatic working to be given a practical and thorough test. The equipment was installed, at the company's expense, in Sydney's GPO and its operation was demonstrated to Prime Minister Andrew Fisher early in April. The exchange was brought into use on 4 May 1911, more or less as a PABX, there being at that time 29 GPO extensions and 2 lines each way connected to the City Exchange. The plant was eventually purchased for £500 in 1913¹⁰.

Obviously the Sydney GPO plant had the desired effect as the tender of Automatic Telephones (Australasia) Limited [AT(A)] of Sydney of £14,293 was accepted in October 1911 for "supply and delivery, and installation in working order

of an automatic switchboard, together with all associated apparatus at the Post Office, Geelong"¹¹. [AT(A) were the Australian agent for the Strowger company, which by 1911 was known as the Automatic Electric Company of Chicago (AEC)].

Unfortunately, no official records or drawings dealing with Geelong have survived in Australia, or with the manufacturer in America. The 800 line installation was placed in service on 6 July 1912¹². The first automatic exchange in England had been opened at Epsom only two months before, on 14 May 1912; 500 lines were installed. Both the Epsom and Geelong installations were of the Strowger type, using equipment manufactured by AEC. The Epsom installation's workings are described in detail, including circuit diagrams, at reference 13, it may therefore be assumed that much of this description is applicable to Geelong and other early installations in Australia. A general description of the Strowger system written in Australia at that time is at reference 14.

There had been a number of automatic exchanges opened in Canada prior to 1912¹⁵. Hence Australia was the third country in the then British Empire to have automatic telephone working.

The Geelong installation seems to have worked reasonably well after commissioning, but late in 1913 there were claims that "the service has deteriorated". Edward Howson, Assistant Engineer Telephone Equipment, Victoria, visited Geelong, examined the exchange and also discussed the matter with twenty-six important subscribers. He concluded that the claim did not have any foundation in fact; however Howson reported that a fair number of wrong numbers were called and that the calling device (dial) was capable of improvement¹⁶.

5 HESKETH'S SECOND OVERSEAS TOUR

A conference of PMG Electrical Engineers from all states met at Melbourne in July 1911. Automatic telephony was on the agenda and they visited Sydney to examine the GPO installation. In a subsequent minute to the Secretary of the Department, a document signed by all the State representatives recommended that a special study be conducted on the system, including an overseas trip by the Chief Electrical Engineer and two others¹⁷. The Secretary's reaction at that time is not known; however, when tenders were subsequently received for the Perth exchange, as discussed below, Hesketh went overseas to make enquiries about the relative merits of various automatic systems.

Hesketh travelled abroad, alone, from 12 February to 14 July 1912. On his return he wrote a report favouring automatic telephony. He pointed out that many advances had been made in the Strowger system since his previous trip in 1904; some of these were (a) use of a common battery instead of the local battery system, (b) use of two wire instead of the three wire system (two wire working was introduced in 1909), (c) adoption of party line working, (d) use of the Keith line switch (plunger uniselector) instead of the costly, individual bi-directional selector for each subscriber's line (the Keith switch had emerged about 1905).¹⁸

In 1910 Perth's city exchange was an overloaded Western Electric magneto multiple installation, its beginning dating back to 1892. Tenders were called in October 1910 for "the supply and delivery of one Common Battery Switchboard for the Perth Central Exchange".¹⁹ Five tenders were received, four for CB manual equipment and one for automatic equipment²⁰. The tenders for CB were in the range £10,500-£12,240 whereas that for automatic [from AT(A)] was for £23,500.

Hesketh considered the tenders and in June 1911 wrote a report saying in effect that automatic equipment should be considered for Perth and that fresh tenders be called for automatic or semi-automatic equipment. His recommendation was accepted and an appropriate notice appeared in the Gazette in July 1911²¹.

Tenders were lodged at Perth and sent to Melbourne. It appears that the highest tender for automatic equipment, including supply of telephone instruments, was £35,400 - which included £1020 to install the automatic exchange equipment. No further details of the second lot of tenders have survived as, in February 1912, the Deputy Postmaster-General Perth had all tender papers returned to him with instructions to return deposits to tenderers. The reason given was that, as the Postmaster-General had agreed to the Chief Electrical Engineer visiting Europe and America to enquire into automatic telephony, the matter was to stand over until his return. In making his submission to go abroad, Hesketh had made the point that, while Perth was the only exchange then under consideration, "several exchanges in Sydney and elsewhere require new equipment ... (and that) the Department's officers should be put into possession of all available information on which to decide whether the (automatic) system could be applied".

A week before Hesketh's return tenders were again called for Perth switchboards. It appears that the Minister was impatient in this matter, hence his not waiting for Hesketh's advice as to specifications. Tenders were invited for CB manual, or semi-automatic, or fully automatic boards.²²

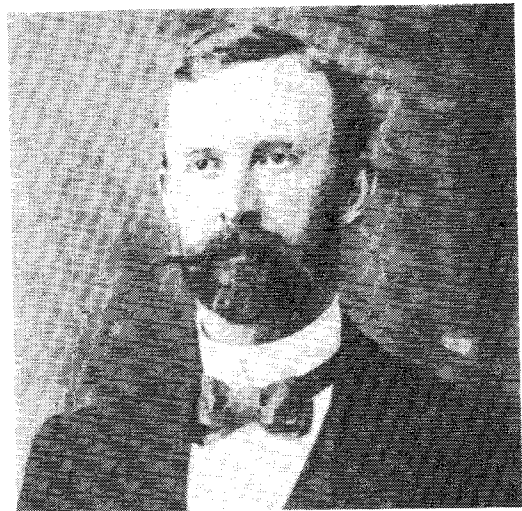
The offers received, arranged in order of annual costs, were:

	Annual Cost	Installed Cost
Western Electric Coy -) full automatic)	£5,062	£28,355
Western Electric Coy -) semi-automatic)	£5,569	£22,955
Siemens Bros - full) automatic)	£5,805	£35,109
Automatic Electric Coy-)) full automatic)	£5,924	£36,193
Western Electric Coy -) manual CB)	£6,250	£12,369

Hesketh wrote in favour of accepting a quote for automatic. He went on to point out that the Minister had directed that no order be placed on the Western Electric Coy "until certain questions of an important nature are settled". He also said that acceptance of Siemens' quote would

make it "necessary to obtain a satisfactory indemnity as to patents". The offers were referred to the Minister via the Secretary on 30 January 1913. On 10 February 1913, PMG Charles Fraser endorsed the file: "Accept tender of Automatic Electric Company". (In fact the tender had been lodged by AT(A) on behalf of AEC).

Hesketh finally had his way in regard to specifications, his recommendation that the tender of AT(A) be accepted subject to various conditions was accepted. These conditions, in fact variations and additions to the tender specification, cover five pages. Extant official papers make no mention of the size of the installation, however, a newspaper article gave this as 4000 lines of equipment. In addition to the exchange equipment, the final contract price of £42,612 10s included extra for the supply of 3350 wall telephones, 750 table telephones and 40 party line telephones, plus 100 public telephone coin collectors²³. Party line telephone bells were mechanically tuned to respond to one of the four frequencies 16, 33, 50 or 66 Hz.



John Hesketh

7 OTHER EARLY TENDERS

In March 1912, tenders were called for either automatic or CB switchboards at Newtown, Balmain and Glebe in NSW. This was followed by tenders being invited for a CB installation at Brighton, Victoria, two months later. In October 1912, it was announced that alternative tenders for automatic or semi-automatic equipment for Brighton would "receive consideration"²⁴.

Acceptance of tenders for automatic installations at Newtown, Balmain and Glebe does not appear to have been gazetted. Telecom in Sydney has it noted (without reference to source) that the tender of AT(A) was accepted and contracts signed on 3 February 1913, prices being Newtown £15,090, Balmain £8,195 and Glebe £12,975. The same firm secured the contract for an automatic installation at Brighton for £15,950 17s 10d²⁵. Thus these other four early Australian automatic exchanges were also of the Strowger type.

The five installations mentioned in the previous two sections were all commissioned within a short space of time. The PMG's Annual Report for 1913/1914 lists the following²⁶.

Exchange	Commissioned	Subscribers
Newtown	6.6.1914	1060
Brighton	11.6.1914	1160
Balmain	11.7.1914	610
Glebe	22.8.1914	950
Perth	26.9.1914	3200

It appears that all the early installations, except Perth, worked reasonably well-given the fact that the system was entirely new to both subscribers and those in the PMG Department associated with such work, thus requiring a settling down period after commissioning. The Perth installation was by far the largest then in service in Australia, also it was the only one in a central city business area and from the start there was trouble. Much of the early problem was due to two causes; firstly, subscribers having no knowledge of how to operate an automatic telephone instrument and, secondly, insufficient exchange equipment had been installed to carry the traffic offered by subscribers (although the contractors had been supplied with information on traffic through the manual switchboards). There were also other matters as discussed below.

There were the inevitable letters to the editor. A week after cutover one correspondent wrote "... In common with the rest of the people of this state, we business men have already to contend with three separate and distinct blights - the Scaddan Ministry, the war and a bad season; it is too much to expect that we shall remain silent when this burden is increased by what seems to be a most aggravating and unworkable telephone system'. A month later another correspondent suggested that on Guy Fawkes Day (November 5) Perth's schoolboys be allowed to collect all automatic phones to make a bonfire.²⁷

The poor performance of the Central Exchange Perth was aired in Parliament. This resulted in Perth subscribers being rebated one half of their rental charges for the first two week's operation of the new exchange.²⁸

Hesketh had been present at the Perth cutover in 1914. He returned in February 1915 for two weeks and subsequently prepared a report on his findings²⁹. He was critical of the maintenance and operation of equipment dealing with calls to and from the other (all manual) exchanges in the Perth metropolitan network; PBX operators tied up equipment and caused congestion; insufficient rotary connectors (PBX final selectors) had been supplied; there were insufficient junction lines to Fremantle, furthermore, construction of the open wire junctions to Fremantle was fault prone; it appears that insulation of some other junctions in the network was sub-standard; there was doubt about procedures to ensure proper issue and maintenance of telephone instruments, especially dials which were fault prone; trained switchroom staff were sometimes put on other duties to the detriment of switching equipment; routine tests on equipment were not carried out to schedule; fault analysis was off-handed; although line construction in the city itself was good (having been undergrounded in the years prior to cutover) some outlying areas were not up to standard, this situation was causing various

troubles; engineers and traffic officers had not met formally since May 1914; a scheme to observe subscribers' lines was to be provided.

The contractor's engineer, Harry S Janes, was still being held in Perth, also the Department still held the deposit (lodged with the tender) of £1090 plus £1150 as a portion of the contract payment.

Before he left Perth, Hesketh was interviewed by the press and gave the opinion that the service was as good as any manual system. He also went out of his way to make it clear that the under-trunking was the contractor's fault - it being written into the contract that sufficient apparatus to carry offered traffic be supplied. The press in its report did not seem entirely convinced in regard to the automatic service vis-a-vis manual³⁰.

Soon after Hesketh departed, the Deputy Postmaster-General, Perth, proposed to the Secretary that the contractor should be responsible "for the expense to which the Department has been put through their admitted failure to provide sufficient equipment"³¹. Soon after, the contractor tendered an account for £1087 12s 9d for the extra equipment supplied in order to carry offered traffic, the main item being 200 secondary line switches and 130 selectors. Discussion on the whole matter dragged on for some months, with Hesketh arguing that not all the problems and expense had been caused by the contractor. Finally, in August 1915, a legal agreement was drawn up and signed in Perth; the company agreed to withdraw the claim for extra equipment and the PMG Department paid all outstanding monies except £350 which was held to cover some miscellaneous items in need of attention. Harry Janes then left Perth and proceeded to work on the Burwood installation in Sydney.

9 ACCEPTANCE OF AUTOMATIC WORKING

In September 1915, a Parliamentary Committee on Public Works was formed to hear submissions on the provision of automatic exchanges at City North, Sydney, Malvern and Collingwood. By that time, automatic exchanges were already working in NSW at Mosman, Ashfield, Burwood and Homebush. (It was to be July 1919 before Victoria's second metropolitan automatic exchange was commissioned at Malvern).

In giving evidence Hesketh admitted to "the unfortunate experience at the beginning of the Perth system". He was, however, wholly in favour of automatic working and his evidence and the evidence of others swayed the Committee who in its final report of October 1915 said: "The Committee is satisfied from personal observation, from the evidence of the expert engineers of the Postmaster-General's Department, and from the testimony of commercial men who use the automatic telephones to a considerable extent, that the system is highly efficient and a distinct improvement on the manually operated system. It has, therefore, no hesitation in recommending that the automatic system be adopted in cases where the establishment of a new exchange of a sufficient size is in contemplation, or where manually operated boards of a sufficient size have outlived their period of usefulness and have to be replaced"³².

From that time, automatic telephony was accepted

in Australia although its spread, slowed by two world wars and a depression, was more gradual than would have been envisaged in 1915.

10 AUTOMATIC IN OTHER STATES

For the sake of completeness, the introduction of automatic working in those Australian states not already mentioned is discussed in this section.

The first automatic equipment in South Australia was, in fact, a semi-automatic installation. Under this system the subscriber lifted off the handset or earpiece and was automatically trunked to a telephonist. If the call was to another subscriber in the same exchange, the telephonist entered the required digits by means of a keysender and withdrew. The method of completing calls to or from other exchanges depended on the type of terminating equipment.

The Port Adelaide semi-auto was cutover in August 1916. The equipment was manufactured by Siemens Bros and, generally speaking, worked on a similar principle to Strowger equipment, ie using relays, uniselectors and bi-motional switches. Two other semi-auto installations were completed in 1919 - Unley and Norwood. These were both Western Electric (WE) installations, working on a different principle from those already discussed. The WE system used various units that were power driven by a continuously rotating shaft. A brief description of both the Siemens and WE systems and also the Strowger system is at reference 33. A highly detailed description of these three (and other) systems is at reference 34.

The first exchange using full automatic working came to the Adelaide network with the cutover of the new Port Adelaide Strowger (or step-by-step as it had become known) exchange on 3 April 1926.

In original planning for early automatic exchanges in Australia a number of exchanges in the Brisbane network had been under consideration. However World War I and other matters intervened and it was July 1925 before Queensland's first automatic exchange cutover at South Brisbane. This was the Siemens 16 system, which was step-by-step equipment.

Hobart's Central automatic exchange, also step-by-step, was placed in service in October 1929.

In regard to the Territories, Canberra's automatic exchange was cutover in March 1927 while Darwin's first installation - prefabricated in a portable building at Sydney - was commissioned in January 1958. This supplemented a manual exchange. All Darwin subscribers were cutover to a new automatic exchange in a permanent building during December 1959/January 1960.

11 INTRODUCTION OF THE ROTARY UNISELECTOR

John Hesketh, who must be considered as the father of automatic telephony in Australia, died aged 49 in 1917. Hesketh's successor was Frederick Golding from NSW. Golding made his mark in the history of Australian automatic telephony, but with unusual results.

In 1922, Golding was charged under the Public Service Act on eight counts. One of these was that he had arranged, without proper authority,

for AT(A) to substitute the superior 25 point AEC rotary uniselectors for Keith line switches, as secondary finders, in equipment to be supplied to City North, Sydney in 1920, the extra cost being £1933.

A number of witnesses were examined before it became clear that an AT(A) company engineer in Australia had cabled Chicago to make the change, after some months of unsuccessfully encouraging PMG engineers to place a formal order. Golding's part, it seems, was associated with authorisation of payment of the extra £1933 at a later date. This particular charge was found to be 'not proven'; other charges, strange by today's standards, were found to be 'proven' and Golding was demoted. This is not the place to discuss the case, but the assertion by Golding's advocate, Stanley Lewis KC, that his client had been "treated like a dog", seems apt³⁵.

12 RURAL AUTOMATIC EXCHANGES

Previous sections have dealt with metropolitan type, ie, large exchanges, each capable of expansion to nominally 10,000 lines. It is fitting to make brief mention of automatic working in the country.

Rural Automatic Exchanges (renamed Small Country Automatic Exchanges in 1964) are self contained unit type installations serving, in their early days, about 100 subscribers maximum.

Nelder claims that the first RAX in Victoria was built by the PMG Department and installed at Barep in 1925³⁶. It is possible that other exchanges in Victoria and perhaps other states were similarly served, ie by local design and manufacture, but this writer has not pursued that aspect and the remainder of this section deals with units purchased from commercial manufacturers.

The Annual Report of the PMG's Department for 1926/27 says that the first two RAXs were at Sutherland, NSW and Springvale, Victoria, being cutover on 1 December 1926 and 7 May 1927 respectively.³⁷ In 1947, a list of RAXs installed to that time, together with cutover dates was assembled by PMG Headquarters.³⁸ For the four states not already mentioned the first RAX cutovers listed were-Goodna (Qld) 20 May 1935; Willunga (SA) 10 January 1935; Brunswick Junction (WA) 17 July 1935 and Ross (TAS) 21 September 1935.

These dates illustrate that while less than ten RAXs had been installed in Victoria and New South Wales in the 1920s, the effect of the depression was to delay initial installations in other states. No technical details of early RAXs have survived but most, if not all, probably would have worked on the step-by-step principle.

13 CONCLUSION

Australia was fortunate with the introduction of automatic telephony in that John Hesketh was a man of vision and talent. He was instrumental in allaying the concern of both laymen and his fellow engineers, concern also felt in places other than Australia, at the introduction of a then suspect system. Engineers today can look back over the many decades of automatic working to see the solid foundation laid by Hesketh.

14 ACKNOWLEDGEMENTS

The author is grateful to Messrs M Gooley and K Work (Adelaide) for information on early South Australian installations. Mr J Lightfoot and other members of the Queensland Postal-Telecommunications Historical Society supplied information on John Hesketh's early days in Australia and also on Brisbane automatic installations. Staff of the State Reference Library of Western Australia were most helpful with newspapers and Commonwealth Government publications.

The author is especially grateful to Mr S R E Warner, Manager, Central Registry, Telecom Headquarters Melbourne, for his help over the years with early files of the PMG's Department.

The permission of the Chief General Manager, Telecom Australia, to publish this paper is acknowledged.

15 REFERENCES

1. Chapuis R J, 100 Years of Telephone Switching (1878-1978), Part 1. Manual and Electromechanical Switching. North-Holland, New York 1982.
2. Kingsbury J E, The Telephone & Telephone Exchanges, Their Invention and Development. Longmans-Green, London 1915.
3. Lawson R A, History of Automatic Telephony. Post Office Electrical Engineer's Journal (POEEJ) vol 5, 1912/13 pp192-207.
4. Hill R B, Early Work on Dial Telephone Systems, Bell Laboratories Record. January 1953 pp22-29 (Contains a list of US Patents for Automatic Telephone Exchange equipment issued during the years 1879-1900).
5. Hill R B, The Early Years of the Strowger System, ibid. March 1953 pp95-103.
6. Herald (Melbourne) 16.6.1903 p2, 17.6.1903 p3.
7. Reports by Mr John Hesketh ... on (1) Matters Investigated By Him During His Recent Tour of America and Europe (2) The Message Rate (Measured Service) or Toll System of Charging for Telephone Service (3) Further Report on the Automatic Telephone Exchange System. Commonwealth Parliamentary Papers, General (CPP), 1905 session, vol 2, pp1461-1485.
8. Argus (Melbourne) 20.2.1906 p7: See also Commonwealth Parliamentary Debates (CPD) 22.8.1906, vol 33, p3240.
9. Royal Commission on Postal Services. CPP, 1910 session vols 4 and 5; see Bell's evidence vol 5, particularly pp2417, 2418.
10. History of the Telephone Service in New South Wales, Section 13. Telecom Public Relations Section, Sydney, n d.
11. Geelong switchboard: Tenders called, Commonwealth Gazette (CG) 28.1.1911 p89; contract let CG 7.10.1911 p2020.
12. Articles on the Geelong installation appear in the Melbourne Argus as follows: 15.8.1911 p4; 2.11.1911 p6; 1.4.1912 p6; 25.4.1912 p9; 8.7.1912 p11; 9.7.1912 p6; 22.7.1912 p15; 1.8.1912 p10.
13. Bailey W J, The Strowger Automatic Exchange at Epsom, POEEJ vol 5 1912/13 pp 121-192.
14. Baer F L, Automatic Telephony, Proceedings of the Electrical Association of New South Wales, 1912/13 pp 125-139.
15. Collins R A Voice From Afar, The History of Telecommunications in Canada. McGraw Hill-Ryerson, Ontario 1977: Also, correspondence with Bell Canada, 1983.
16. Report on the Working of the Automatic Telephone Exchange Geelong. CPP, 1914 session, vol 1, pp337-340.
17. Australian Archives (AA) accession MP341, file 22/1324 'Telegraph Systems - Multiplex - Synchronism' (The papers on automatic telephony were obviously misfiled).
18. Hesketh's report is in PMGs Annual Report 1912/13 pp 35-38. See also 1911/12 Annual Report p23.
19. CG 15.10.1910 p1639.
20. Details re all tenders for Perth Switchboards in the period 1910-1913 are from AA acc MP33 file 16/558 'Perth Switchboards'.
21. CG 22.7.1911 p1700.
22. CG 6.7.1912 p1227.
23. CG 8.11.1913 p3024.
24. Newtown, Balmain, Glebe CG 30.3.1912 p442-444; Brighton CG 18.5.1912 p1008, 5.10.1912 p2243.
25. CG 9.5.1914 p840.
26. PMGs Annual Report for 1913/1914 p37 (It was common for these reports to list matters outside their nominal date range).
27. 'unworkable telephone system' West Australian 5.10.1914 p5; bonfire suggestion Daily News (Perth) 5.11.1914 p5.
28. CPD 11.11.1914, vol 75 p452: See also West Australian 30.11.1914 p6.
29. AA acc MP33 file 15/568 'Perth Automatic Switchboards, Report of CEE'.
30. West Australian 10.3.1915 p8
31. AA acc MP33 file 15/1835 'Perth Switchboards'.
32. Report of Parliamentary Committee on Public Works Relating to Provision of Automatic Exchanges at Sydney, Malvern and Collingwood. CPP 1914-1917 sessions, vol 4, pp 533-587.

33. Becher E, Automatic Telephony, Proceedings of the Electrical Association of Australia 1916/17 pp67-115.
34. Aitken W, Automatic Telephone Systems. 3 vols, Ernest Benn, London 1921, 1923, 1924.
35. The Golding enquiry, held at Melbourne in the period 9-21 October 1922, was reported in various newspapers: See also AA ACT series CRS A428, item G22-478, transcript of the Golding enquiry: See also CG 9.11.1922 p1969, Golding demotion.
36. Nelder R R, History of Small Country Automatic Exchanges in Victoria. Telecommunication Journal of Australia, vol 20, no 3, 1970 pp274-277.
37. PMGs Annual Report for 1926/27 p14, see under "Hours of Attendance at Exchanges".
38. Telecom Headquarters, Melbourne, file 293/7/27 : See also AA acc MP341 file 32/8673 "Telephone Matters - Rural Exchanges".
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